## PART 4

### Machinery and Systems

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PART 4  CHAPTER 1  Machinery, Equipment and Systems

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PART 4

CHAPTER 1 Machinery, Equipment and Systems

SECTION 1 General

1 Requirements for Classification (2012)

Part 4 contains general requirements for machinery, equipment and systems (Chapter 1) and the design requirements for piping systems (Chapter 2) and electrical systems (Chapter 3).

Part 5 contains the design requirements for safety systems, including fire extinguishing systems.

Part 6 contains the design, testing and survey requirements for the certification of equipment, machinery and system components at vendor’s shop.

Part 7 contains the survey requirements during construction of units at builder’s yard (Chapter 1) and the requirements for periodical surveys after construction (Chapter 2).

Part 8 contains specific classification requirements for each type of mobile offshore units as well as for specific machinery, equipment and system installed onboard for the intended offshore services.

3 Definitions (2012)

3.1 Control Station

A location where controllers or actuator are fitted, with monitoring devices, as appropriate, for purposes of effecting desired operation of specific machinery.

Control Station is defined exclusively for purposes of passive fire protection as intended by the IMO MODU Code, in 5-1-1/3.9.2.1.

Centralized Control Station is used in Part 4, Chapter 9 "Remote Propulsion Control and Automation" of the Marine Vessel Rules to refer to the space or the location where the following functions are centralized:

- Controlling propulsion and auxiliary machinery,
- Monitoring propulsion and auxiliary machinery, and
- Monitoring the propulsion machinery space.

3.3 Machinery Space

Machinery Space is any space that contains propulsion machinery, boilers, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, air conditioning and ventilation machinery, refrigerating machinery, stabilizing machinery or other similar machinery, including the trunks to the space. Machinery space is to include "machinery space of category A", which, as defined in 5-1-1/3.9.2.6, is a space and trunks to that space which contains:

- Internal combustion machinery used for main propulsion; or
- Internal combustion machinery used for purposes other than main propulsion where such machinery has in the aggregate a total power output of not less than 375 kW (500 hp); or
- Any oil-fired boiler (including similar oil-fired equipment such as inert gas generators, incinerators, waste disposal units, etc.) or oil fuel unit.
3.5 Essential Services

Essential services are:

i) Those services considered necessary for:
   ● Continuous operation to maintain propulsion and steering in self-propelled units (primary essential services);
   ● Systems of the unit whose loss or failure would create an immediate danger to the unit (primary essential services);
   ● Non-continuous operation to maintain propulsion and steering in self-propelled units and a minimum level of safety for the unit’s navigation and systems (secondary essential services)

ii) Emergency services as described in 4-3-2/5.3 (each service is either primary essential or secondary essential depending upon its nature, as described above); and

iii) Other special characteristics (e.g., special services) of the unit whose loss or failure would create a potential danger to the unit (secondary essential services).

Examples of primary essential services and secondary essential services are as listed in 4-1-1/7.11 TABLE 3 and 4-1-1/7.11 TABLE 4, respectively.

3.7 Hazardous Areas

Areas where flammable or explosive gases, vapors or dust are normally present or likely to be present are known as hazardous areas. Hazardous areas are, however, more specifically defined for those areas where the presence of flammable atmosphere arising from the operations is possible or for certain machinery installations and storage spaces that present such hazard, e.g.:

● Helicopter refueling facilities, see 4-2-6/7.1.2
● Paint stores, see 4-3-3/9.5

3.9 Dead Ship Condition

Dead ship condition means a condition under which:

i) The main propulsion plant, boilers and auxiliary machinery are not in operation due to the loss of the main source of electrical power, and

ii) In restoring propulsion, the stored energy for starting the propulsion plant, the main source of electrical power and other essential auxiliary machinery is assumed to be not available.

3.11 Blackout

Blackout situation means the loss of the main source of electrical power resulting in the main and auxiliary machinery being out of operation.

3.13 Definitions for Piping Systems

For definitions related to piping systems, refer to 4-2-1/3.

3.15 Definitions for Electrical Installations

For definitions related to electrical installations, refer to 4-3-1/3.
5 Machinery Plans (2012)

5.1 Submission of Plans
Machinery and systems plans required by the Rules are generally to be submitted electronically by the manufacturer, designer or shipbuilder to ABS. However, hard copies will also be accepted. After review and approval of the plans, one copy will be returned to the submitter, one copy will be retained for the use of the ABS Surveyor, and one copy will be retained by ABS for record. Where so stated in the shipbuilding contract, the Owner may require the builder to provide copies of approved plans and related correspondence. A fee will be charged for the review of plans which are not covered by a contract of classification with the shipbuilder.

In general, all plans are to be submitted and approved before proceeding with the work.

5.3 Plans
Machinery and systems plans required to be submitted for review and approval by ABS are listed in each of the sections in Part 4. In general, equipment plans are to contain performance data and operational particulars; standard of compliance where standards are used in addition to, or in lieu of, the Rules; construction details such as dimensions, tolerances, welding details, welding procedures, material specifications, etc.; and engineering calculations or analyses in support of the design. System plans are to contain a bill of material with material specifications or particulars, a legend of symbols used, system design parameters, and are to be in a schematic format. Booklets containing standard shipyard practices of piping and electrical installations are generally required to supplement schematic system plans.

5.5 Additional Notations
In the case of units for which additional class notations covered by other ABS Rules and Guides have been requested, machinery and systems plans related to the services covered by the additional class notations are required to be submitted for review and approval by ABS as indicated in the corresponding Rules and Guides.

7 Miscellaneous Requirements for Machinery

7.1 Inclinations (2012)
All machinery, components and systems for essential services, as defined in 4-1-1/3.5, are to be designed to operate under the inclinations as indicated for each of the conditions listed in 4-1-1/7.1 TABLE 1.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Static</th>
<th>Dynamic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column-Stabilized Units</td>
<td>15° in any direction</td>
<td>22.5° in any direction</td>
</tr>
<tr>
<td>Self-Elevating Units</td>
<td>10° in any direction</td>
<td>15° in any direction</td>
</tr>
<tr>
<td>Surface Units</td>
<td>15° list and 5° trim simultaneously</td>
<td>22.5° rolling and 7.5° pitching simultaneously</td>
</tr>
</tbody>
</table>

7.3 Dead Ship Start (2005)
Means are to be provided to bring the machinery into operation from a "dead ship" condition, as defined in 4-1-1/3.11. See 4-3-2/3.1.4 and 4-3-3/3.27 for the required starting arrangements.
7.5 **Unattended Machinery Spaces**

Controls necessary for safe operation are to be provided for machinery in spaces which are not normally manned. Relevant data is to be submitted to permit the assessment of the effect of such controls on the safety of the unit. See 4-2-4/3.7 for bilge alarm systems and 5-3-1/11 for fire precautions for such spaces.

7.7 **Ambient Temperature (2015)**

For units of unrestricted service, ambient temperature, as indicated in 4-1-1/7.7 TABLE 2, is to be considered in the selection and installation of machinery, equipment and appliances. For drilling units of restricted or special service, the ambient temperature appropriate to the special nature is to be considered. See 3-1-4/1.9.

Systems and equipment used solely for specific operations associated with class notations are to follow temperature requirements as outlined within the applicable recognized standards to which they are designed and constructed in accordance with 8-1-1/3.

Machinery, equipment and appliances related to marine equipment on the open deck for units with unrestricted service are to be rated for a minimum air temperature equal to the Design Service Temperature (DST) for the unit.

Control, monitoring and safety devices/systems of equipment for essential services (item (l) of 4-1-1/7.11 TABLE 3 and item (p) 4-1-1/7.11 TABLE 4), when located on the open deck are to be rated for a Minimum Air Temperature (MAT) of 15°C below the DST. If operation of the equipment is not anticipated at temperatures below the DST, these devices/systems need not be operable below DST but physical components are not to be damaged if exposed to temperatures down to the MAT.

### TABLE 2

**Ambient Temperatures for Machinery, Equipment and Appliances in Units of Unrestricted Service (2015)**

<table>
<thead>
<tr>
<th>Air</th>
<th>Location, Arrangement(^{(1, 2)})</th>
<th>Temperature Range (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machinery and electrical installations</td>
<td>Enclosed Spaces – General</td>
<td>0 to +45°C</td>
</tr>
<tr>
<td></td>
<td>Components mounted on machinery associated with high temperature</td>
<td>According to specific machinery and installation</td>
</tr>
<tr>
<td></td>
<td>In spaces subject to higher temperature (details to be submitted)</td>
<td>According to the actual maximum ambient temperature</td>
</tr>
<tr>
<td></td>
<td>In spaces with temperature lower than +45°C (details to be submitted)</td>
<td>According to the actual ambient temperature subject to minimum +40</td>
</tr>
<tr>
<td></td>
<td>Open Deck(^{(3)})</td>
<td>-25 to +45°C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water</th>
<th>Coolant</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seawater</td>
<td></td>
<td>+32°C</td>
</tr>
</tbody>
</table>

**Notes:**

1. (2014) Electronic equipment is to be suitable for operations up to 55°C. See also 4-3-1/17.3.
(2014) For environmentally controlled spaces, see 4-3-1/17.3.

(2015) The minimum air temperature need not be less than the service temperature identified for the unit (see 3-1-4/1.9 and 3-1-2/1) and documented in the unit's Operating Manual as per 1-2-5/1 of the ABS Rules for Conditions of Classification – Offshore Units and Structures (Part 1), except for control, monitoring, and safety devices/systems of equipment associated with essential services which are to be based on Minimum Atmospheric Temperature (MAT) as indicated in 4-1-1/7.7.

7.9 Materials Containing Asbestos (2011)

Installation of materials which contain asbestos is prohibited.

7.11 Materials and Welding for Machinery Components (2012)

Materials used in the construction of the machinery of units are to be in accordance with the ABS Rules for Materials and Welding (Part 2).

For welding procedures and details for machinery components, see Section 2-4-2 of the ABS Rules for Materials and Welding (Part 2).

### TABLE 3

Primary Essential Services (1 July 2019)

<p>| (a) | Steering gears |
| (b) | Pumps for controllable pitch propellers |
| (c) | (2010) Scavenging air blower, fuel oil supply pumps, fuel valve cooling pumps, lubricating oil pumps and cooling water pumps for main and auxiliary engines, turbines and shafting necessary for propulsion |
| (d) | Ventilation necessary to maintain propulsion |
| (e) | Forced draft fans, feed water pumps, water circulating pumps, vacuum pumps and condensate pumps for steam plants on steam turbine units, and also for auxiliary boilers where steam is used for equipment supplying primary essential services |
| (f) | Oil burning installations for steam plants on steam turbine units and for auxiliary boilers where steam is used for equipment supplying primary essential services |
| (g) | Azimuth thrusters which are the sole means for propulsion/steering with lubricating oil pumps, cooling water pumps, etc. |
| (h) | Electrical equipment for electric propulsion plant with lubricating oil pumps and cooling water pumps |
| (i) | Electric generators and associated power sources supplying primary essential equipment |
| (j) | Hydraulic pumps supplying primary essential equipment |
| (k) | Viscosity control equipment for heavy fuel oil |
| (l) | Control, monitoring and safety devices/systems of equipment for primary essential services |
| (m) | Fire pumps and other fire extinguishing medium pumps. |
| (n) | Navigation lights, aids and signals. |
| (o) | Internal safety communication equipment. |
| (p) | Lighting system. |
| (q) | Services considered necessary to maintain dangerous spaces in a safe condition |
| (r) | Blow-out preventer control systems |
| (s) | Well control systems |</p>
<table>
<thead>
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<th>Table 4: Secondary Essential Services (2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Windlass</td>
</tr>
<tr>
<td>(b) Fuel oil transfer pumps and fuel oil treatment equipment</td>
</tr>
<tr>
<td>(c) Lubrication oil transfer pumps and lubrication oil treatment equipment</td>
</tr>
<tr>
<td>(d) Pre-heaters for heavy fuel oil</td>
</tr>
<tr>
<td>(e) Starting air and control air compressors</td>
</tr>
<tr>
<td>(f) Bilge, ballast and heeling pumps</td>
</tr>
<tr>
<td>(g) Fire pumps and other fire extinguishing medium pumps</td>
</tr>
<tr>
<td>(h) Ventilating fans for engine and boiler rooms</td>
</tr>
<tr>
<td>(i) Navigation lights, aids and signals</td>
</tr>
<tr>
<td>(j) Internal communication equipment required by 4-3-2/15</td>
</tr>
<tr>
<td>(k) Fire and gas detection and alarm system</td>
</tr>
<tr>
<td>(l) Lighting system</td>
</tr>
<tr>
<td>(m) Electrical equipment for watertight and fire-tight closing appliances</td>
</tr>
<tr>
<td>(n) Electric generators and associated power sources supplying secondary essential equipment</td>
</tr>
<tr>
<td>(o) Hydraulic pumps supplying secondary essential equipment</td>
</tr>
<tr>
<td>(p) Control, monitoring and safety devices/systems of equipment for secondary essential services</td>
</tr>
<tr>
<td>(q) Inerting systems</td>
</tr>
<tr>
<td>(r) (2005) Ambient temperature control equipment required by 4-3-1/17.3</td>
</tr>
<tr>
<td>(s) (2010) Watertight Doors (see 3-3-2/5)</td>
</tr>
</tbody>
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Part 4
Chapter 1 Machinery, Equipment and Systems
Section 2 Machinery and Equipment

1 Prime Movers (2012)

1.1 Application (1 July 2015)

Prime movers (diesel engines, gas turbines, steam turbines) having a rated power of 100 kW (135 hp) and over, intended for essential services (see 4-1-1/3.5) or for services related to additional optional notations requested for the unit, are to be designed, constructed, tested, certified and installed in accordance with the requirements of Part 4, Chapter 2 of the ABS Rules for Building and Classing Marine Vessels (Marine Vessel Rules). Automatic air intake shut-off valves or equivalent arrangements are to be provided in accordance with 8-2-1/8.

Prime movers having a rated power of less than 100 kW (135 hp) are not required to comply with the provisions of Part 4, Chapter 2 of the Marine Vessel Rules, but are to be designed, constructed and equipped in accordance with good commercial and marine practice. Acceptance of such engines will be based on manufacturer’s affidavit, verification of engine nameplate data, and subject to a satisfactory performance test after installation conducted in the presence of the Surveyor. Automatic air intake shut-off valves or equivalent arrangements are to be provided in accordance with 8-2-1/8.

Prime movers having a rated power of 100 kW (135 hp) and over, intended for services not considered essential (see 4-1-1/3.5) and not related to additional optional notations requested for the unit, are not required to be designed, constructed and certified by ABS in accordance with the requirements of Part 4, Chapter 2 of the Marine Vessel Rules. However, they are to comply with safety features, such as crankcase explosion relief valve, overspeed protection, etc., as provided in 4-2-1/7 of the Marine Vessel Rules, as applicable. After installation, they are subject to a satisfactory performance test conducted in the presence of the Surveyor. Automatic air intake shut-off valves or equivalent arrangements are to be provided in accordance with 8-2-1/8.

3 Thrusters and Dynamic Positioning Systems (2012)

Compliance with the provisions of Section 4-3-5 of the Marine Vessel Rules is required for main propulsion thrusters for self-propelled units in all cases and for propulsion assist thrusters and athwartship thrusters where an optional notation in accordance with 1-2-2/15 or 1-1-3/5 of the ABS Rules for Conditions of Classification – Offshore Units and Structures (Part 1) is requested. Dynamic positioning systems, including their thrusters, are to comply with the ABS Guide for Dynamic Positioning Systems.

5 Moving Cantilevers, Skid Beams and Moveable Structures (2012)

A description of equipment for moving cantilevers, skid beams or moveable substructures, including piping and electrical systems, details of mechanical components, including hold-down devices and applicable strength calculations, is to be submitted for review.

7 Electrical Machinery and Equipment (2012)

For electrical machinery and equipment, refer to Section 4-3-4.
9 Certification of Machinery and Equipment (2012)

For certification of machinery and equipment required at vendor’s plant, refer to Part 6.

11 Unattended Machinery Spaces

Controls necessary for safe operation are to be provided for machinery in spaces which are not normally manned. Relevant data is to be submitted to permit the assessment of the effect of such controls on the safety of the unit. See 4-2-4/3.7 for bilge alarm systems and 5-3-1/11 for fire precautions for such spaces.

For self-propelled units where it is intended that propulsion machinery space be periodically unattended and that propulsion machinery be controlled primarily from the navigation bridge, \#ACCU notation will be assigned upon verification of compliance with the provisions of Section 4-9-6 of the Marine Vessel Rules.

For non-self-propelled units where it is intended that the machinery space(s) and the local centralized control and monitoring station(s) (if provided) be periodically unmanned, and that the machinery/ systems be controlled and monitored from a remote control and monitoring center located outside the machinery space(s), \#AMCCU notation will be assigned upon verification of compliance with the provisions of Section 3 of the ABS Guide for Automatic or Remote Control and Monitoring for Machinery and Systems (other than Propulsion) on Offshore Installations.

\#ACCU and \#AMCCU notations are not mandatory and will be assigned upon request.
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CHAPTER 2  Pumps and Piping Systems

SECTION 1  General

1  General Requirements

Piping systems are to be in accordance with the applicable requirements of this Section. Piping systems used solely for specific operations associated with class notations and complying with a recognized standard need not be in accordance with these Rules. All piping systems are to be installed and tested in accordance with the Rules or recognized standards to the satisfaction of the attending Surveyor.

1.1  Damage Stability

When considering the design and layout of piping systems, consideration is to be given to the damage stability requirements and the assumed extent of damage for the type of unit under consideration, as outlined in 3-3-2/3.5.

1.3  Segregation of Piping Systems (2016)

Piping systems carrying non-hazardous fluids are to be segregated from piping systems which may contain hazardous fluids. Cross connection of the piping systems may be made where means for avoiding possible contamination of the non-hazardous fluid system by the hazardous medium are provided.

Where an unsafe condition, due to interconnection of hazardous and non-hazardous piping is possible non-hazardous drains are to be fitted with a loop-seal to trap hazardous gases. If back-up of hazardous liquid into the non-hazardous areas is possible, a non-return check valve is to be installed. Height of the loop-seal is to be not less than 760 mm (30 inches) and the check valve is to be fitted downstream of the seal. Both the seal and the valve are to be accessible for maintenance by crew.

FIGURE 1
Typical Drain Connection (2016)
3 Definitions (2012)

3.1 Piping
The term *Piping* refers to assemblies of piping components and pipe supports.

3.3 Piping System
*Piping System* is a network of piping and any associated pumps, designed and assembled to serve a specific purpose. Piping systems interface with, but exclude, major equipment, such as boilers, pressure vessels, tanks, diesel engines, turbines, etc.

3.5 Piping Components
*Piping Components* include pipes, tubes, valves, fittings, flanges, gaskets, bolting, hoses, expansion joints, sight flow glasses, filters, strainers, accumulators, instruments connected to pipes, etc.

3.7 Pipes
*Pipes* are pressure-tight cylinders used to contain and convey fluids. Where the word ‘pipe’ is used in this section, it means pipes conforming to materials and dimensions as indicated in 2-3-12, 2-3-13, 2-3-16, and 2-3-17 of the ABS *Rules for Materials and Welding* (Part 2), or equivalent national standards such as ASTM, BS, DIN, JIS, etc.

3.9 Pipe Schedule
*Pipe Schedules* are designations of pipe wall thicknesses as given in American National Standard Institute, ANSI B36.10. Standard and extra heavy (extra strong) pipes, where used in these sections, refer to Schedule 40 and Schedule 80, up to maximum wall thicknesses of 9.5 mm (0.375 in.) and 12.5 mm (0.5 in.), respectively.

3.11 Tubes
*Tubes* are generally small-diameter thin-wall pipes conforming to an appropriate national standard. Tubes are to meet the same general requirements as pipes.

3.13 Pipe Fittings
*Pipe Fittings* refer to piping components such as sleeves, elbows, tees, bends, flanges, etc., which are used to join together sections of pipe.

3.15 Valves
The term *Valve* refers to gate valves, globe valves, butterfly valves, etc., which are used to control the flow of fluids in a piping system. For the purpose of these Rules, test cocks, drain cocks and other similar components which perform the same function as valves are considered valves.

3.17 Design Pressure of Components
*Design Pressure* is the pressure to which each piping component of a piping system is designed with regard to the mechanical characteristics of the component. The design pressure of a piping component is not to be less than the maximum working pressure in the section of the piping system where it is located, as defined in 4-2-1/3.19. However, the Rules may impose in some instances a specific minimum design pressure that exceeds the maximum expected service pressure. The design pressure will define the pressure rating of the component.

3.19 Maximum Working Pressure
The *Maximum Working Pressure* is the pressure of a piping system at the most severe condition of coincidental internal or external pressure and temperature (maximum or minimum) expected during service, including transient conditions. The maximum working pressure may be also known by the industry as design pressure of the piping system. For the purpose of the Rules, the maximum working
pressure may be taken as the setting of the pressure relief valve protecting the piping system or the section of the system.

3.21 Maximum Allowable Working Pressure

The Maximum Allowable Working Pressure (MAWP) is the maximum pressure of a piping system determined, in general, by the piping component with the lowest design pressure in the system. The maximum allowable working pressure is not to be less than the maximum working pressure, as defined in 4-2-1/3.19, and not to exceed the design pressure of any piping component in the system or section of the system, as defined in 4-2-1/3.17. Where pressure relief valves are fitted, the settings are not to exceed the maximum allowable working pressure of the piping system or the section of the system in which the relief valve is located.

3.23 Design Temperature

The Design Temperature is the maximum temperature at which each piping component is designed to operate. It is not to be less than the temperature of the piping component material at the most severe condition of temperature and coincidental pressure expected during service. For purposes of the Rules, it may be taken as the maximum fluid temperature for which the piping component is designed.

For piping used in a low-temperature application, the design temperature is to include also the minimum temperature at which each piping component is designed to operate. It is not to be higher than the temperature of the piping component material at the most severe condition of temperature and coincidental pressure expected during service. For the purposes of the Rules, it may be taken as the minimum fluid temperature.

For all piping components, the design temperature is to be used to determine allowable stresses and material testing requirements.

3.25 Maximum Working Temperature

The Maximum Working Temperature is the maximum fluid temperature of a piping system at the most severe condition of temperature and coincidental pressure expected during service, including transient conditions. The maximum working temperature of a piping system or a section of the system is not to exceed the design temperature of any piping component in the system or section of the system.

3.27 Flammable Fluids

Any fluid, regardless of its flash point, liable to support a flame is to be treated as a flammable fluid for the purposes of 4-2-1 through 4-2-6. Aviation fuel, diesel fuel, heavy fuel oil, lubricating oil and hydraulic oil (unless the hydraulic oil is specifically specified as non-flammable) are all to be considered flammable fluids.

3.29 Toxic Fluids

Toxic fluids are those that are liable to cause death or severe injury or to harm human health if swallowed or inhaled or by skin contact.

3.31 Corrosive Fluids

Corrosive fluids, excluding seawater, are those possessing in their original state the property of being able through chemical action to cause damage by coming into contact with living tissues, the vessel or its cargoes, when escaped from their containment.

5 Classes of Piping Systems (2012)

Piping systems are divided into three classes according to service, maximum working pressure and maximum working temperature, as indicated in 4-2-1/5 TABLE 1. Each class has specific requirements for
joint design, fabrication and testing. The requirements in this regard are given in 4-2-2/5 for metallic piping. For plastic piping, see 4-2-2/7.

### TABLE 1
**Classes of Piping Systems (2013)**

<table>
<thead>
<tr>
<th>Piping Class</th>
<th>Class I ( P &gt; P_2 ) OR ( T &gt; T_2 )</th>
<th>Class II Bounded by Class I and Class III - see chart above</th>
<th>Class III ( P \leq P_1 ) AND ( T \leq T_1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping System</td>
<td>bar, (^{(kgf/cm^2, psi)}) ( ^{\circ}C )</td>
<td>bar, (^{(kgf/cm^2, psi)}) ( ^{\circ}C )</td>
<td>bar, (^{(kgf/cm^2, psi)}) ( ^{\circ}C )</td>
</tr>
<tr>
<td>Corrosive fluids</td>
<td>Without special safeguards</td>
<td>With special safeguard</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Toxic fluids</td>
<td>All</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Flammable liquids heated to above flash point or having flash point 60(^{\circ})C or less</td>
<td>Without special safeguards</td>
<td>With special safeguards</td>
<td>Open-ended piping</td>
</tr>
<tr>
<td>Liquefied gas</td>
<td>Without special safeguards</td>
<td>With special safeguards</td>
<td>Open-ended piping</td>
</tr>
<tr>
<td>Steam</td>
<td>16 ((16.3, 232)) 300 ((572))</td>
<td>See chart</td>
<td>7 ((7.1, 101.5)) 170 ((338))</td>
</tr>
<tr>
<td>Thermal oil</td>
<td>16 ((16.3, 232)) 300 ((572))</td>
<td>See chart</td>
<td>7 ((7.1, 101.5)) 150 ((302))</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>16 ((16.3, 232)) 300 ((572))</td>
<td>See chart</td>
<td>7 ((7.1, 101.5)) 60 ((140))</td>
</tr>
<tr>
<td>Other fluids (including water, air, gases, non-flammable hydraulic oil)</td>
<td>40 ((40.8, 580)) 300 ((572))</td>
<td>See chart</td>
<td>16 ((16.3, 232)) 200 ((392))</td>
</tr>
</tbody>
</table>

---

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| Open ended pipes (drains, overflows, vents, exhaust gas lines, boilers escapes pipes) | Not applicable | Not applicable | All |
| (2013) Fixed Oxygen-acetylene System | High pressure Side | Not applicable | Low pressure Side |

**Notes:**
1. The above requirements are not applicable to piping systems intended for liquefied gases in cargo and process areas.
2. The above requirements are also not applicable to cargo piping systems of vessels carrying chemicals in bulk.
3. Safeguards are measures undertaken to reduce leakage possibility and limiting its consequences, (e.g., double wall piping or equivalent, or protective location of piping etc.)

## 7 Plans and Data to Be Submitted

### 7.1 Plans (2019)
Before proceeding with the work, plans are to be submitted, as applicable, showing clearly the diagrammatic details or arrangement of the following.

- General arrangement of pumps and piping
- Sanitary system
- Bilge and ballast systems
- Compressed air systems
- Essential control-air systems
- Vent, sounding and overflow pipes
- Fuel-oil filling, transfer and service systems
- Boiler-feed systems
- Steam and exhaust piping
- Lubricating-oil systems
- Hydraulic power piping systems
- Essential sea-water and fresh-water service systems
- Starting-air systems
- Fire-main and fire-extinguishing systems (see Part 5, Chapter 2)
- Steering-gear piping systems
- Systems conveying toxic liquids, low flash point below 60°C (140°F) liquids or flammable gas.
- Exhaust piping for internal combustion engines and boilers
- Exhaust gas cleaning system (as applicable, see 1/9.11 of *Guide for Exhaust Emission Abatement*)
- (2012) All Class I and Class II piping systems not covered above, except for those which form part of an independently manufactured unit.
- A description of the bilge, ballast and drainage systems
- A description of the ballast control system for column-stabilized units
A description and diagrammatic plans of all piping systems used solely for the drilling operations, including their cross connections, where applicable with other non-drilling related systems.

7.3 All Piping Systems

The plans are to consist of a diagrammatic drawing of each system accompanied by lists of material giving size, wall thickness, maximum working pressure and material of all pipes and the type, size, pressure rating and material of valves and fittings. Where superheated steam is used, the temperatures are also to be given.

7.5 Booklet of Standard Details

A booklet of standard piping practices and details, including such items as bulkheads, deck and shell penetrations, welding details including dimensions, pipe joining details, etc. is to be submitted. Pipe weld details are to comply with Chapter 4 of the ABS Rules for Materials and Welding (Part 2). Applicable limitations should be specified.

9 Material Tests and Inspection

9.1 Specifications and Purchase Orders

The appropriate material to be used for the various pipes, valves and fittings is indicated in 4-2-2/5 to 4-2-2/19. The material is to be made in accordance with the requirements in Chapter 3 of the ABS Rules for Materials and Welding (Part 2), except that tests of material for valves and fittings and fluid power cylinders need not be witnessed by the Surveyor. Where electric welding is used, the requirements in Chapter 4 of the above-referenced Part 2 are also applicable.

9.3 Special Materials

If it is desired to use special alloys or other materials not covered by the Rules, the use of such materials will be specially considered for approval.

11 General Installation Details

11.1 Protection (2012)

Reference is made to 7-1-3/11.3.

11.3 Pipes Near Switchboards (2012)

Reference is made to 7-1-3/11.5.

11.5 Expansion or Contraction Stresses (2012)

Ample provision is to be made to take care of expansion or contraction stresses in pipes due to temperature changes or working of the hull. Suitable provisions include, but are not limited to, piping bends, elbows, offsets, changes in direction of the pipe routing or expansion joints. Slip joints of an approved type may be used in systems and locations where possible leakage will not be critical. See also 4-2-4/5.3 and 4-2-4/11.3.

11.7 Molded Expansion Joints (2004)

Molded expansion joints may be Type Approved; see 1-1-A2 of the ABS Rules for Conditions of Classification - Offshore Units and Structures (Part 1).

11.7.1 Circulating Water Systems (2012)

Molded expansion fittings of reinforced rubber or other suitable materials may be used in Class III sea water piping systems in machinery spaces. Such fittings are to be oil-resistant. The maximum working pressure is not to be greater than 25% of the hydrostatic bursting pressure of the fitting as determined by a prototype test. Manufacturer’s name and the month and year of manufacture are
to be embossed or otherwise permanently marked on the outside edge of one of the flanges or other easily examined area of all flexible expansion joints intended for use in seawater piping systems over 150 mm (6 in.). Plans of the molded or built-up flexible expansion joints in seawater piping systems over 150 mm (6 in.), including details of the internal reinforcement arrangements, are to be submitted for approval.

11.7.2 Oil Systems
Where molded expansion joints of composite construction utilizing metallic material, such as steel or stainless steel or equivalent material, with rubberized coatings inside and/or outside or similar arrangements are proposed for use in oil piping systems (fuel, lubricating, or hydraulic oil), the following requirements apply:

11.7.2(a) Expansion joint ratings for temperature, pressure, movements and selection of materials are to be suitable for the intended service.

11.7.2(b) (2012) The maximum working pressure of the system is not to be greater than 25% of the hydrostatic bursting pressure determined by a burst test of a prototype expansion joint. Results of the burst test are to be submitted.

11.7.2(c) (2012) The expansion joints are to pass the fire resistant test specified in 4-2-1/11.7.3, below.

11.7.2(d) The expansion joints are to be permanently marked with the manufacturer’s name and the month and year of manufacture.

11.7.3 Fire Resistant Test (2012)
In order for a molded expansion joint of composite construction utilizing metallic material, as referenced in 4-2-1/11.7.2, to be considered fire-resistant, a prototype of the molded expansion joint is to be subjected to a fire test for at least 30 minutes at a temperature of not less than 800°C (1472°F) while water at or above the maximum working pressure is circulated inside. The temperature of the water at the outlets is not to be less than 80°C (176°F) during the test. The tested molded expansion joint is to be complete with end fittings, and no leakage is to be recorded during or after the test. In lieu of maximum working pressure, the fire test may be conducted with the circulating water at a pressure of at least 5 bar (5.1 kgf/cm², 72.5 lb/in²), and with a subsequent pressure test to twice the design pressure. This test may be performed in accordance with ISO 15540 and ISO 15541.

11.9 Metallic Bellow Type Expansion Joints (2012)
Metallic bellow type expansion joints may be used in all classes of piping, except that where used in Classes I and II piping, they will be considered based upon satisfactory review of the design. Detailed plans of the joint are to be submitted along with calculations and/or test results verifying the pressure and temperature rating and fatigue life.

11.11 Pipe Joints (2012)
Butt welded joints, socket welded joints, slip-on welded sleeve joints, flanged joints and threaded joints are to comply with the requirements of 4-6-2/5.5 of the Marine Vessel Rules. See also 4-2-2/11.

11.13 Mechanical Joints (2012)
Pipe unions (welded and brazed types), compression couplings (swage, press, bite, and flare types) and slip-on joints (grip, machine grooved and slip types) are to comply with the requirements of 4-6-2/5.9 of the Marine Vessel Rules. See also 4-2-2/11.
11.15 Bulkhead, Deck or Tank-Top Penetrations (2013)

11.15.1 Watertight Integrity
Where it is necessary for pipes to penetrate watertight bulkheads, decks or tank tops, the penetrations are to be made by methods which will maintain the watertight integrity. For this purpose, bolted connections are to have bolts threaded into the plating from one side; through bolts are not to be used. Welded connections are either to be welded on both sides or to have full penetration welds from one side.

11.15.2 Firetight Integrity
Where pipes penetrate bulkheads, decks or tank-tops which are required to be firetight or smoketight, the penetrations are to be made by approved methods which will maintain the same degree of firetight or smoketight integrity.

11.17 Collision-bulkhead Penetrations
Pipes piercing the collision bulkhead on ship type units are to be fitted with suitable valves operable from above the bulkhead deck and the valve chest is to be secured at the bulkhead generally inside the forepeak. Cast iron is not to be used for these valves. The use of nodular iron, also known as ductile iron or spheroidal-graphite iron will be accepted, provided the material has an elongation not less than 12%.

Tanks forward of the collision bulkhead on surface-type units are not to be arranged for the carriage of oil or other liquid substances that are flammable.

11.19 Sluice Valves and Cocks
No valve or cock for sluicing purposes is to be fitted on a collision bulkhead on ship type units. Sluice valves or cocks may be fitted only on other watertight bulkheads when they are at all times accessible for examination. The control rods are to be operable from the bulkhead deck and are to be provided with an indicator to show whether the valve or cock is open or closed. Drains from spaces over deep tanks may be led to an accessible compartment, provided they do not exceed 89 mm O.D. (3 inches nominal pipe size) and are fitted with quick-acting self-closing valves accessibly located in the compartment where they terminate. Sluice valves may be fitted on deep tanks where they are necessary for trimming.

11.21 Relief Valves
All systems which may be exposed to pressures greater than that for which they are designed are to be safeguarded by suitable relief valves or the equivalent, and pressure containers such as evaporators, heaters, etc., which may be isolated from a protective device in the line are to have such devices either directly on the shell or between the shell and the cut-off valve.

11.21.1 Exceptions
In pumping systems such as boiler feed, oil piping and fire main, where ordinarily relief valves are required at the pump, such valves need not be fitted when the system is served only by centrifugal pumps so designed that the pressure delivered cannot exceed that for which the piping is designed.

11.23 Common Overboard Discharge
In general, various types of systems which discharge overboard are not to be interconnected without special approval; that is, closed pumping systems, deck scuppers, soil lines or sanitary drains are not to have a common overboard discharge.

11.25 Remote Operation
Where valves of piping systems are arranged for remote control and are power operated, a secondary means for either local or remote-manual control is to be provided.
11.27 Instruments

11.27.1 Temperature
Thermometers and other temperature sensing devices registering through pressure boundaries are to be provided with instrument wells to allow for instrument removal without impairing the integrity of the pressurized system. Fuel oil tanks are to be provided with similar protection.

11.27.2 Pressure
Pressure sensing devices are to be provided with valve arrangements to allow for instrument isolation and removal without impairing the pressurized systems’ integrity.

11.29 Flexible Hoses (1 July 2017)
Flexible hoses are to comply with the requirements of 4-6-2/5.7 of the *Marine Vessel Rules*.

Hose connections utilized in cooling systems for engines with cylinder bores equal to or less than 300 mm (12 in.) will be subject to special consideration.

11.31 Control of Static Electricity (2012)
Piping systems that are routed through hazardous areas are to be suitably grounded either by welding or bolting the pipes or their supports directly to the hull of the unit or through the use of bonding straps. Reference is made to 7-1-7/13.5 with regard to testing and installation details.

Components of alarms and level indicating devices located within tanks are to be designed to account for conductivity.

11.33 Leakage Containment (1994)

11.33.1 Oil Leaks
For areas where leakage may be expected such as oil burners, purifiers, drains and valves under daily service tanks, etc., means of containing the leakage are to be provided together with adequate drainage. Where drain pipes are provided from collected leakages, they are to be led to a suitable oil drain tank not forming part of an overflow system.

11.33.2 Boiler Flats (2012)
Where boilers are located in machinery spaces on tween decks and the boiler rooms are not separated from the machinery space by watertight bulkheads, the tween decks are to be provided with coamings at least 75 mm (3 in.) in height. This area may be drained to the bilges.
PART 4

CHAPTER 2  Pumps and Piping Systems

SECTION 2  Pumps, Pipes, Valves, and Fittings

1  General

1.1  Service Conditions
The piping details determined in accordance with 4-2-2/5 to 4-2-2/17, inclusive, are to be based on the maximum working pressure and temperature to which they may be exposed in service under normal sustained operating conditions. For boiler-feed and blow-off service, see 4-6-6/3.5, 4-6-6/3.15, and 4-6-6/5.3.1 of the *Marine Vessel Rules*.

1.3  Standards for Valves, Fittings and Flanges
The following requirements for valves, fittings and flanges are based upon standards of the American National Standards Institute. The suitability and application of those manufactured in accordance with other recognized standards will be considered.

3  Certification of Piping Components (2012)
For certification of piping components required at vendor’s plant, refer to Part 6.

5  Metallic Pipes

5.1  Steel Pipe (2012)

5.1.1  Material Specifications
Material specifications for acceptable steel pipes are in 2-3-12 of the ABS *Rules for Materials and Welding (Part 2)*. Materials equivalent to these specifications will be considered.

5.1.2  Application of Seamless and Welded Pipes
The application of seamless and welded pipes is to be in accordance with the following table:

<table>
<thead>
<tr>
<th></th>
<th>Seamless Pipes</th>
<th>Electric Resistance Welded Pipes</th>
<th>Furnace Butt Welded Pipes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>permitted</td>
<td>permitted</td>
<td>not permitted</td>
</tr>
<tr>
<td>Class II</td>
<td>permitted</td>
<td>permitted</td>
<td>not permitted</td>
</tr>
<tr>
<td>Class III</td>
<td>permitted</td>
<td>permitted</td>
<td>permitted (1)</td>
</tr>
</tbody>
</table>

*Note:* 1 Except for flammable fluids.

5.1.3  Stainless Steels (2019)
For sea water piping systems in which sea water may be retained within the piping system in a stagnant or low flow condition (i.e., less than 1 m/sec), there is a potential for chloride pitting and the following grades are not to be used for the piping or piping components:

- 304 and 304L stainless steels
316 and 316L stainless steels with a molybdenum content of less than 2.5%

Other stainless grades when used are to be confirmed suitable for the application by the manufacturer.

Where the water spray system will be maintained in a dry condition and the system will only be exposed to seawater during actual operations of the water spray, 316 and 316L stainless steels with a molybdenum content of less than 2.5% may be used provided there are provisions to immediately flush the system with fresh water and then dry the internal portions of the system piping and components. The requirement for flushing and drying of the system and the procedures to carry out these efforts are to be clearly posted.

5.1.4 Fuel-Oil-Pipe

Steel piping is required for fuel-oil lines and for all pipes passing through fuel-oil tanks.

5.3 Copper Pipe

Seamless-drawn and welded copper pipe, unless otherwise specified, may be used for all purposes where the temperature does not exceed 208°C (406°F) and within the limitations specified in the material specification. Copper pipe used for steam, feed and blow-off lines is to be properly annealed before installation.

5.5 Brass Pipe

Seamless-drawn brass pipe, unless otherwise specified, may be used where the temperature does not exceed 208°C (406°F).

5.6 Other Materials (1 July 2018)

Piping containing flammable fluids is to be constructed of steel or other materials approved by ABS. Other equivalent material with a melting point above 930°C (1706°F) and with an elongation above 12% may be accepted. Aluminum and aluminum alloys which are characterized by low melting points, below 930°C (1706°F), are considered heat sensitive materials and are not to be used to convey flammable fluids, except for such piping as arranged inside cargo tanks or heat exchangers or as otherwise permitted for engine, turbine and gearbox installations, see 4-2-1/7.7 of the Marine Vessel Rules.

5.7 Design (2012)

5.7.1 Design Pressure and Minimum Thickness

The design pressure and the minimum thickness of pipes are to be determined by the following equations, due consideration being given to the reduction in thickness at the outer radius of bent pipes.

\[ W = \frac{K S (t - C)}{D - M (t - C)} \]

\[ t = \frac{W D}{K S + MW} + C \]

where

\[ K = 20 \text{ (200, 2)} \]

\[ W \text{ = design pressure, in bar (kgf/cm}^2, \text{ psi). See Note 1. (For feed and blow-off piping, see 4-6-6/3.5, 4-6-6/3.15 and 4-6-6/5.3.1 of the Marine Vessel Rules).} \]

\[ t \text{ = minimum thickness of pipe, in mm (in.). See Note 5.} \]

\[ D \text{ = actual external diameter of pipe, in mm (in.)} \]
S = maximum allowable fiber stress, in N/mm² (kgf/mm², psi), from 4-2-2/5.9 TABLE 1. See Note 2.

M = factor from 4-2-2/5.9 TABLE 1

C = allowance for threading, grooving or mechanical strength.
   = 1.65 (0.065 in.) for plain-end steel or wrought-iron pipe or tubing up to 115 mm O.D. (4 in. N.P.S.). See Note 3.
   = 0.00 mm (0.000 in.) for plain-end steel or wrought-iron pipe or tubing used for hydraulic piping systems. See Note 3.

C = 0.00 mm (0.000 in.) for plain-end steel or wrought-iron pipe or tubing 115 mm O.D. (4 in. N.P.S.) and larger. See Note 3.

= 1.27 mm (0.05 in.) for all threaded pipe 17 mm O.D. (3/8 in.) and smaller.

= depth of thread \( h \) for all threaded pipe over 17 mm O.D. (3/8 in.). See Note 4.

= depth of groove for grooved pipe.

= 0.00 mm (0.000 in.) for plain-end nonferrous pipe or tubing. See Note 3.

Notes:

1. The value of \( W \) used in the equations is to be not less than 8.6 bar (8.8 kgf/cm², 125 psi), except that for suction and other low-pressure piping of nonferrous material, the actual maximum working pressure may be applied if a suitable addendum is provided against erosion and outside damage. However, in no case is the value of \( W \) to be less than 3.4 bar (3.5 kgf/cm², 50 psi) for use in the equations.

2. Values of \( S \) for other materials are not to exceed the stress permitted by ASME B31.1, “Code for Pressure Piping - Power Piping” for marine and utility systems and ASME B31.3, “Code for Pressure Piping - Chemical Plant and Refinery Piping” for systems used solely for drilling.

3. Plain-end pipe or tubing includes those joined by any method in which the wall thickness is not reduced.

4. The depth of thread, \( h \), may be determined by the equation \( h = 0.8/n \), where \( n \) is the number of threads per inch, or in metric units by the equation \( h = 0.8n \), where \( n \) is the number of mm per thread.

5. If pipe is ordered by its nominal wall thickness, the manufacturing tolerance on wall thickness is to be taken into account.

5.7.2 Pipe Bending

Reference is made to 7-1-3/11.1.

5.9 Design Pressure and Thickness – Alternative Consideration (2012)

Consideration will be given to the design pressure and the minimum thickness of piping determined from criteria of applicable recognized standards.
<table>
<thead>
<tr>
<th>Material</th>
<th>ABS Gr.</th>
<th>ASTM Gr.</th>
<th>Nominal Composition</th>
<th>Tensile Strength N/mm² (kgf/mm², psi)</th>
<th>Maximum Working Temperature (°C)</th>
<th>Working Temperature (°C)</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20°C to 344°C</td>
<td>372°C to 800°C</td>
<td>453°C to 900°F</td>
<td>510°C to 1000°F</td>
</tr>
<tr>
<td>Gr. 1</td>
<td></td>
<td>AS-3-ERW</td>
<td>C, Mn</td>
<td>310 46.9 6.25</td>
<td>330 70.1 6.25</td>
<td>430 75.8 6.25</td>
<td>531 81.1 6.25</td>
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<td>45000 45000</td>
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<td>51000 51000</td>
<td>54000 54000</td>
</tr>
<tr>
<td>Gr. 2</td>
<td></td>
<td>AS-3-A, SML</td>
<td>C, Mn</td>
<td>330 46.9 6.25</td>
<td>350 70.1 6.25</td>
<td>450 75.8 6.25</td>
<td>551 81.1 6.25</td>
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<td>AS-3-B, SML</td>
<td>C, Mn</td>
<td>415 88.3 6.25</td>
<td>435 75.8 6.25</td>
<td>535 85.8 6.25</td>
<td>635 95.8 6.25</td>
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<td></td>
<td>54000 54000</td>
<td>57000 57000</td>
<td>60000 60000</td>
<td>63000 63000</td>
</tr>
<tr>
<td>Gr. 4</td>
<td></td>
<td>AS-3-A, ERW</td>
<td>C, Mn</td>
<td>330 46.9 6.25</td>
<td>350 70.1 6.25</td>
<td>450 75.8 6.25</td>
<td>551 81.1 6.25</td>
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<td>57000 57000</td>
</tr>
<tr>
<td>Gr. 5</td>
<td></td>
<td>AS-3-B, ERW</td>
<td>C, Mn</td>
<td>415 88.3 6.25</td>
<td>435 75.8 6.25</td>
<td>535 85.8 6.25</td>
<td>635 95.8 6.25</td>
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<td>Material</td>
<td>Tensile Strength</td>
<td>Maximum Temperature</td>
<td>Working Temperature</td>
<td>Temperature</td>
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</tr>
<tr>
<td></td>
<td>Nominal Composition</td>
<td>-29°C (0°F) to 344°C (650°F)</td>
<td>372°C 700°F</td>
<td>399°C 750°F</td>
<td>427°C 800°F</td>
<td>455°C 850°F</td>
<td>483°C 900°F</td>
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<tr>
<td>Gr.6</td>
<td>A355-P1 1/2 Mo</td>
<td>380 39 55000</td>
<td>95.1 9.70 13800</td>
<td>95.1 9.70 13800</td>
<td>95.1 9.70 13800</td>
<td>93.1 9.49 13500</td>
<td>90.3 9.21 13100</td>
</tr>
<tr>
<td>Gr.7</td>
<td>A335-P2 1/2 Cr 1/2 Mo</td>
<td>380 39 55000</td>
<td>95.1 9.70 13800</td>
<td>95.1 9.70 13800</td>
<td>95.1 9.70 13800</td>
<td>93.1 9.49 13500</td>
<td>90.3 9.21 13100</td>
</tr>
<tr>
<td>Gr.8</td>
<td>A135-A</td>
<td>330 33.7 48000</td>
<td>70.3 7.17 10200</td>
<td>68.3 6.96 9900</td>
<td>62.8 6.40 9100</td>
<td>53.1 5.41 7700</td>
<td></td>
</tr>
<tr>
<td>Gr.9</td>
<td>A135-B</td>
<td>415 42 60000</td>
<td>88.3 8.58 12200</td>
<td>75.8 7.73 11000</td>
<td>63.4 6.47 9200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gr.11</td>
<td>A335-P11 1/4 Cr 1/2 Mo</td>
<td>415 42, 60000</td>
<td>103.5 10.55 15000</td>
<td>103.5 10.55 15000</td>
<td>103.5 10.55 15000</td>
<td>99.2 10.12 14400</td>
<td>90.3 9.21 13100</td>
</tr>
<tr>
<td>Gr.12</td>
<td>A335-P12 1 Cr 1/2 Mo</td>
<td>415 42, 60000</td>
<td>103.5 10.55 15000</td>
<td>103.5 10.55 15000</td>
<td>103.5 10.55 15000</td>
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<td>Gr.13</td>
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<td>415 42 60000</td>
<td>103.5 10.55 15000</td>
<td>103.5 10.55 15000</td>
<td>103.5 10.55 15000</td>
<td>99.2 10.12 14400</td>
<td>90.3 9.21 13100</td>
</tr>
</tbody>
</table>

Notes:

1. Intermediate values of S and M may be determined by interpolation.
2. For grades of pipe other than those given in this Table, S values may be obtained from ANSI/ASME B31.1 Code for Pressure Piping.
Consideration to be given to the possibility of graphite formation in the following steels: Carbon steel above 427°C (800°F); carbon-molybdenum steel above 468°C (875°F); chrome-molybdenum steel above 524°C (975°F).

For low-temperature service, see 2-3-2/9 and 2-3-13 of the ABS Rules for Materials and Welding (Part 2).
7 Plastic Pipes (1997)

7.1 General (2015)

Pipes and piping components made of thermoplastic or thermosetting plastic materials, with or without reinforcement, may be used in piping systems referred to in 4-2-2/7.19 TABLE 2, subject to compliance with the following requirements. For the purpose of these Rules, "plastic" means both thermoplastic and thermosetting plastic materials, with or without reinforcement, such as polyvinyl chloride (PVC) and fiber reinforced plastics (FRP). Plastic includes synthetic rubber and materials of similar thermo/mechanical properties.

7.3 Plans and Data to be Submitted (2007)

Rigid plastic pipes are to be in accordance with a recognized national or international standard acceptable to ABS. Specification for the plastic pipe, including thermal and mechanical properties and chemical resistance, is to be submitted for review, together with the spacing of the pipe supports.

The following information for the plastic pipes, fittings and joints is to be also submitted for approval.

7.3.1 General Information

i) Pipe and fitting dimensions

ii) Maximum internal and external working pressure

iii) Working temperature range

iv) Intended services and installation locations

v) Level of fire endurance

vi) Electrically conductive

vii) Intended fluids

viii) Limits on flow rates

ix) Serviceable life

x) Installation instructions

xi) Details of marking

7.3.2 Drawings and Supporting Documentation

i) Certificates and reports for relevant tests previously carried out. See 4-2-2/7.9

ii) Details of relevant standards. See 4-2-2/Table 3 and 4-2-2/Table 4

iii) All relevant design drawings, catalogues, data sheets, calculations and functional descriptions

iv) Fully detailed sectional assembly drawings showing pipe, fittings and pipe connections.

v) Documentation verifying the certification of the manufacturer’s quality system and that the system addresses the testing requirements in 4-2-2/7.5.1 through 4-2-2/7.5.8. See 4-2-2/7.9.

7.3.3 Materials

i) Resin type

ii) Catalyst and accelerator types and concentration employed in the case of reinforced polyester resin pipes or hardeners where epoxide resins are employed

iii) A statement detailing all reinforcements employed where the reference number does not identify the mass per unit area or the strand count (Tex System or Yardage System) of a roving used in a filament winding process
(iv) Full information regarding the type of gel-coat or thermoplastic liner employed during construction, as appropriate

(v) Cure/post-cure conditions. The cure and post-cure temperatures and times employ for given resin/reinforcement ratio

(vi) Winding angle and orientation.

(vii) Joint bonding procedures and qualification tests results. See 4-2-2/7.11

7.5 Design

7.5.1 Internal Pressure (2012)

A pipe is to be designed for an internal pressure not less than the maximum working pressure of the system in which it will be used. The maximum internal pressure, \( P_{int} \), for a pipe is to be the lesser of the following:

\[
P_{int} = \frac{P_{sth}}{4} \quad \text{or} \quad P_{int} = \frac{P_{ltth}}{2.5}
\]

where

\( P_{sth} = \) short-term hydrostatic test failure pressure

\( P_{ltth} = \) long-term hydrostatic test failure pressure (> 100,000 hours)

The hydrostatic tests are to be carried out under the following standard conditions:

- Atmospheric pressure = 1 bar (1 kgf/cm\(^2\), 14.5 psi)
- Relative humidity = 30%
- Fluid temperature = 25°C (77°F)

The hydrostatic test failure pressure may be verified experimentally or determined by a combination of testing and calculation methods which are to be submitted to ABS for approval.

7.5.2 External Pressure

External pressure is to be considered for any installation which may be subject to vacuum conditions inside of the pipe or a head of liquid on the outside of the pipe. A pipe is to be designed for an external pressure not less than the sum of the pressure imposed by the maximum potential head of liquid outside of the pipe plus full vacuum, 1 bar (1 kgf/cm\(^2\), 14.5 psi), inside of the pipe. The maximum external pressure for a pipe is to be determined by dividing the collapse test pressure by a safety factor of three.

The collapse test failure pressure may be verified experimentally or determined by a combination of testing and calculation methods, which are to be submitted to ABS for approval.

7.5.3 Axial Strength

7.5.3(a) The sum of the longitudinal stresses due to pressure, weight and other dynamic and sustained loads is not to exceed the allowable stress in the longitudinal direction. Forces due to thermal expansion, contraction and external loads, where applicable, are to be considered when determining longitudinal stresses in the system.

7.5.3(b) In the case of fiber reinforced plastic pipes, the sum of the longitudinal stresses is not to exceed one-half of the nominal circumferential stress derived from the maximum internal pressure
determined according to 4-2-2/7.5.1, unless the minimum allowable longitudinal stress is verified experimentally or by a combination of testing and calculation methods.

7.5.4 Temperature (2012)

The design temperature of a pipe is to be in accordance with the manufacturer’s recommendations, but in each case it is to be at least 20°C (36°F) lower than the minimum heat distortion temperature of the pipe material determined according to ISO 75 method A or equivalent. The minimum heat distortion temperature is not to be less than 80°C (176°F). This minimum heat distortion temperature requirement is not applicable to pipes and pipe components made of thermoplastic materials, such as polyethylene (PE), polypropylene (PP), polybutylene (PB) and intended for non-essential services.

Where low temperature services are considered, special attention is to be given with respect to material properties.

7.5.5 Impact Resistance (2019)

Plastic pipes and joints are to have a minimum resistance to impact in accordance with a recognized national or international standard such as ASTM D2444, ASTM D6110, ASTM F2231, ISO14692-2, Clause 6.4.3 or other equivalent standards as appropriate for the resin type. ASTM D256 may also be considered, provided the average minimum required impact resistance is 961 J/m of width (18 ft-lbf/in of width) as per Test Method E or a value acceptable to the Surveyor.

7.5.6 Fire Endurance (2015)

4-2-2/7.19 TABLE 2 specifies fire endurance requirements for pipes based upon system and location. Pipes and their associated fittings whose functions or integrity are essential to the safety of the unit are to meet the indicated fire endurance requirements which are described below.

i) Level 1 will ensure the integrity of the system during a full-scale hydrocarbon fire, and is particularly applicable to systems where loss of integrity may cause out-flow of flammable liquids and worsen the fire situation. Piping having passed the fire endurance test specified in 4-2-2/7.13 of a duration of a minimum of one hour without loss of integrity in the dry condition is considered to meet the Level 1 fire endurance standard (L1).

Level 1W – Piping systems similar to Level 1 systems except these systems do not carry flammable fluid or any gas and a maximum 5% flow loss in the system after exposure is acceptable. The flow loss must be taken into account when dimensioning the system.

ii) Level 2 intends to ensure the availability of systems essential to the safe operation of the unit after a fire of short duration, allowing the system to be restored after the fire has been extinguished. Piping having passed the fire endurance test specified in 4-2-2/7.13 for a duration of a minimum of 30 minutes without loss of integrity in the dry condition is considered to meet the Level 2 fire endurance standard (L2).

Level 2W – Piping systems similar to Level 2 systems except a maximum 5% flow loss in the system after exposure is acceptable. The flow loss must be taken into account when dimensioning the system.

iii) Level 3 is considered to provide the fire endurance necessary for a water filled piping system to survive a local fire of short duration. The system’s functions are capable of being restored after the fire has been extinguished. Piping having passed the fire endurance test specified in 4-2-2/7.15 for a duration of a minimum of 30 minutes without loss of integrity in the wet condition is considered to meet the Level 3 fire endurance standard (L3).
Where a fire protective coating of pipes and fittings is necessary for achieving the fire endurance standards required, the following requirements apply.

i) Pipes are generally to be delivered from the manufacturer with the protective coating applied, with on-site application limited to that necessary for installation purposes (i.e., joints). See 7-1-3/13.5.3.vii regarding the application of the fire protection coating on joints.

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

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

iv) The fire protection coatings are to have sufficient resistance to impact to retain their integrity.

v) (2007) Random samples of pipe are to be tested to determine the adhesion qualities of the coating to the pipe.

7.5.7 Flame Spread

7.5.7(a) Plastic Pipes.

All pipes, except those fitted on open decks and within tanks, cofferdams, void spaces, pipe tunnels and ducts, are to have low flame spread characteristics. The test procedures in IMO Resolution A.653(16) Recommendation on Improved Fire Test Procedures for Surface Flammability of Bulkhead, Ceiling, and Deck Finish Materials, modified for pipes as indicated in 4-2-2/7.17, are to be used for determining the flame spread characteristics. Piping materials giving average values for all of the surface flammability criteria not exceeding the values listed in Resolution A.653(16) are considered to meet the requirements for low flame spread.

Alternatively, flame spread testing in accordance with ASTM D635 may be used in lieu of the IMO flame spread test, provided such test is acceptable to the Administration.

7.5.7(b) Multi-core Metallic Tubes Sheathed by Plastic Materials (2016).

The multi-core tubes in "bundles" made of stainless steel or copper tubes covered by an outer sheath of plastic material are to comply with the flammability test criteria of IEC 60332-3-22 or 60332-3-21, for Category A or A F/R, respectively. Alternatively, the tube bundles complying with at least the flammability test criteria of 60332-1-2 or a test procedure equivalent thereto are acceptable provided they are installed in compliance with approved fire stop arrangements.

7.5.8 Electrical Conductivity

7.5.8(a) Piping conveying fluids with a conductivity less than 1000 pico siemens per meter are to be electrically conductive.

7.5.8(b) Regardless of the fluid being conveyed, plastic pipes are to be electrically conductive if the piping passes through a hazardous area.

7.5.8(c) (2012) Where electrically conductive pipe is required, reference is made to 7-1-3/13.5.3.iv. for maximum values of electric resistance.

7.5.8(d) If the pipes and fittings are not homogeneously conductive, the conductive layers are to be protected against the possibility of spark damage to the pipe wall.
7.5.9 Marking (2012)
Reference is made to 7-1-3/13.5.

7.7 Installation of Plastic Pipes
(2012) Information to verify compliance with the following requirements is to be submitted for review. Refer also to 7-1-3/13.5.

7.7.1 Supports (2012)

7.7.1(a) (2015) Selection and spacing of pipe supports in shipboard systems are to be determined as a function of allowable stresses and maximum deflection criteria. Support spacing is not to be greater than the pipe manufacturer’s recommended spacing. The selection and spacing of pipe supports are to take into account pipe dimensions, length of the piping, mechanical and physical properties of the pipe material, mass of pipe and contained fluid, external pressure, maximum working temperature, thermal expansion effects, loads due to external forces, thrust forces, water hammer and vibrations to which the system may be subjected. Combination of these loads are to be checked.

7.7.1(b) The supports are to allow for relative movement between the pipes and the unit’s structure, having due regard to the difference in the coefficients of thermal expansion and deformations of the unit’s hull and its structure.

7.7.1(c) When calculating the thermal expansion, the system maximum working temperature and the temperature at which assembling is performed are to be taken into account.

7.7.2 External Loads (2012)
When installing the piping, allowance is to be made for temporary point loads, where applicable. Such allowances are to include at least the force exerted by a load (person) of 980 N (100 kgf, 220 lbf) at mid-span on any pipe more than 100 mm (4 in.) nominal diameter.

7.7.3 Shell Connections
Where plastic pipes are permitted in systems connected to the shell of the unit, the valves and the pipe connection to the shell are to be metallic. The side shell valves are to be arranged for remote control from outside of the space in which the valves are located. For further details of the shell valve installation, their connections and material, refer to 4-2-2/21.

7.7.4 Bulkhead and Deck Penetrations
7.7.4(a) The integrity of watertight bulkheads and decks is to be maintained where plastic pipes pass through them.

7.7.4(b) Where plastic pipes pass through "A" or "B" class divisions, arrangements are to be made to ensure that the fire endurance is not impaired. These arrangements are to be tested in accordance with IMO Resolution A 754 (18), Recommendation on Fire Resistance Tests for "A", "B" and "F" Class Divisions, as amended.

7.7.4(c) If the bulkhead or deck is also a fire division and destruction by fire of plastic pipes may cause inflow for liquid from tank, a metallic shut-off valve operable from above the bulkhead deck is to be fitted at the bulkhead or deck.

7.9 Manufacturing of Plastic Pipes (2012)
The manufacturer is to have a quality system and be certified in accordance with 1-1-A2/5.3 and 1-1-A2/5.5 of the ABS Rules for Conditions of Classification – Offshore Units and Structures (Part I) or ISO 9001 (or equivalent). The quality system is to consist of elements necessary to ensure that pipes and component are produced with consistent and uniform mechanical and physical properties in accordance with recognized standards, including testing to demonstrate the compliance of plastic pipes, fittings and joints with 4-2-2/7.5.1 through 4-2-2/7.5.8 and 4-2-2/7.19, as applicable.
Where the manufacturer does not have a certified quality system in accordance with 1-1-A2/5.3 and 1-1-A2/5.5 of the ABS
Rules for Conditions of Classification - Offshore Units and Structures (Part 1) or ISO 9001 (or equivalent), the tests in 4-2-2/7.5.1 through 4-2-2/7.5.8 and 4-2-2/7.19, as applicable, will be required using samples from each batch of pipes being supplied for use aboard the unit and are to be carried out in the presence of the Surveyor.

Each length of pipe and each fitting is to be tested at the manufacturer’s production facility to a hydrostatic pressure not less than 1.5 times the internal design pressure of the pipe in 4-2-2/7.5.1. Alternatively, for pipes and fittings not employing hand layup techniques, the hydrostatic pressure test may be carried out in accordance with the hydrostatic testing requirements stipulated in the recognized national or international standard to which the pipe or fittings are manufactured, provided that there is an effective quality system in place.

Depending upon the intended application, ABS reserves the right to require the hydrostatic pressure testing of each pipe and/or fitting.

If the facility does not have a certified quality system in accordance with 1-1-A2/5.3 and 1-1-A2/5.5 of the ABS Rules for Conditions of Classification – Offshore Units and Structures (Part 1) or ISO 9001 (or equivalent), then the production testing must be witnessed by the Surveyor.

The manufacturer is to provide documentation certifying that all piping and piping components supplied are in compliance with the requirements of 4-2-2/7.

7.11 Plastic Pipe Bonding Procedure Qualification

7.11.1 Procedure Qualification Requirements

7.11.1(a) To qualify joint bonding procedures, the tests and examinations specified herein are to be successfully completed. The procedure for making bonds is to include the following:

i) Materials used

ii) Tools and fixtures

iii) Environmental requirements

iv) Joint preparation requirements

v) Cure temperature

vi) Dimensional requirements and tolerances

vii) Test acceptance criteria for the completed assembly

7.11.1(b) Any change in the bonding procedure which will affect the physical and mechanical properties of the joint will require the procedure to be re-qualified.

7.11.2 Procedure Qualification Testing

7.11.2(a) A test assembly is to be fabricated in accordance with the procedure to be qualified and it is to consist of at least one pipe-to-pipe joint and one pipe-to-fitting joint. When the test assembly has been cured, it is to be subjected to a hydrostatic test pressure at a safety factor of 2.5 times the design pressure of the test assembly for not less than one hour. No leakage or separation of joints is to be allowed. The test is to be conducted so that the joint is loaded in both longitudinal and circumferential direction.

7.11.2(b) Selection of pipes used for test assembly is to be in accordance with the following:

i) When the largest size to be joined is 200 mm (8 in.) nominal outside diameter or smaller, the test assembly is to be the largest pipe size to be joined.
When the largest size to be joined is greater than 200 mm (8 in.) nominal outside diameter, the size of the test assembly is to be either 200 mm (8 in.) or 25% of the largest piping size to be joined, whichever is greater.

7.11.2(c) When conducting performance qualifications, each bonder and each bonding operator are to make up test assemblies, the size and number of which are to be as required above.

7.13 Tests by the Manufacturer – Fire Endurance Testing of Plastic Piping in the Dry Condition (For Level 1 and Level 2)

7.13.1 Test Method

7.13.1(a) The specimen is to be subjected to a furnace test with fast temperature increase similar to that likely to occur in a fully developed liquid hydrocarbon fire. The time/temperature is to be as follows:

<table>
<thead>
<tr>
<th>Time</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>At the end of 5 minutes</td>
<td>945</td>
</tr>
<tr>
<td>At the end of 10 minutes</td>
<td>1033</td>
</tr>
<tr>
<td>At the end of 15 minutes</td>
<td>1071</td>
</tr>
<tr>
<td>At the end of 30 minutes</td>
<td>1098</td>
</tr>
<tr>
<td>At the end of 60 minutes</td>
<td>1100</td>
</tr>
</tbody>
</table>

7.13.1(b) The accuracy of the furnace control is to be as follows:

i) During the first 10 minutes of the test, variation in the area under the curve of mean furnace temperature is to be within ±15% of the area under the standard curve.

ii) During the first 30 minutes of the test, variation in the area under the curve of mean furnace temperature is to be within ±10% of the area under the standard curve.

iii) For any period after the first 30 minutes of the test, variation in the area under the curve of mean furnace temperature is to be within ±5% of the area under the standard curve.

iv) At any time after the first 10 minutes of the test, the difference in the mean furnace temperature from the standard curve is to be within ±100°C (±180°F).

7.13.1(c) The locations where the temperatures are measured, the number of temperature measurements and the measurement techniques are to be approved by ABS.

7.13.2 Test Specimen

7.13.2(a) The test specimen is to be prepared with the joints and fittings intended for use in the proposed application.

7.13.2(b) The number of specimens is to be sufficient to test typical joints and fittings, including joints between non-metal and metal pipes and metal fittings to be used.

7.13.2(c) The ends of the specimen are to be closed. One of the ends is to allow pressurized nitrogen to be connected. The pipe ends and closures may be outside of the furnace.

7.13.2(d) The general orientation of the specimen is to be horizontal and is to be supported by one fixed support with the remaining supports allowing free movement. The free length between supports is not to be less than eight times the pipe diameter.
7.13.2(e) Most materials will require a thermal insulation to pass this test. The test procedure is to include the insulation and its covering.

7.13.2(f) If the insulation contains or is liable to absorb moisture, the specimen is not to be tested until the insulation has reached an air dry-condition defined as equilibrium with an ambient atmosphere of 50% relative humidity at 20 ± 5°C (68 ± 9°F). Accelerated conditioning is permissible, provided the method does not alter the properties of the component material. Special samples are to be used for moisture content determination and conditioned with the test specimen. These samples are to be so constructed as to represent the loss of water vapor from the specimen having similar thickness and exposed faces.

7.13.3 Test Condition
A nitrogen pressure inside the test specimen in to be maintained automatically at 0.7 ± 0.1 bar (0.7 ± 0.1 kgf/cm², 10 ± 1.5 psi) during the test. Means are to be provided to record the pressure inside of the pipe and the nitrogen flow into and out of the specimen in order to indicate leakage.

7.13.4 Acceptance Criteria
7.13.4(a) During the test, no nitrogen leakage from the sample is to occur.

7.13.4(b) (2015) After termination of the furnace test, the test specimen together with fire protective coating, if any, is to be allowed to cool in still air to ambient temperature and then tested to the design pressure of the pipes, as defined in 4-2-2/7.5.1 and 4-2-2/7.5.2. The pressure is to be held for a minimum of 15 minutes. Pipes without leakage qualify as Level 1 or 2 depending on the test duration. Pipes with negligible leakage (i.e., not exceeding 5% flow loss) qualify as Level 1W or Level 2W depending on the test duration. Where practicable, the hydrostatic test is to be conducted on bare pipe (i.e., coverings and insulation removed) so that any leakage will be apparent.

7.13.4(c) Alternative test methods and/or test procedures considered to be at least equivalent, including open pit testing method, may be accepted in cases where the pipes are too large for the test furnace.

7.15 Test by Manufacturer – Fire Endurance Testing of Water-Filled Plastic Piping (For Level 3)

7.15.1 Test Method
7.15.1(a) A propane multiple burner test with a fast temperature increase is to be used.

7.15.1(b) For piping up to and including 152 mm (6 in.) O.D., the fire source is to consist of two rows of five burners, as shown in 4-2-2/7.15.1 FIGURE 2. A constant heat flux averaging 113.6 kW/m² (36,000 BTU/hr-ft²) ± 10% is to be maintained 12.5 ± 1 cm (5 ± 0.4 in.) above the centerline of the burner array. This flux corresponds to a pre-mix flame of propane with a fuel flow rate of 5 kg/hr (11 lb/hr) for a total heat release of 65 kW (3700 BTU/min.). The gas consumption is to be measured with an accuracy of at least ± 3% in order to maintain a constant heat flux. Propane with a minimum purity of 95% is to be used.

7.15.1(c) For piping greater than 152 mm (6 in.) O.D., one additional row of burners is to be included for each 51 mm (2 in.) increase in pipe diameter. A constant heat flux averaging 113.6 kW/m² (36,000 BTU/hr-ft²) ± 10% is to be maintained 12.5 ± 1 cm (5 ± 0.4 in.) above the centerline of the burner array. This fuel flow is to be increased as required to maintain the designated heat flux.

7.15.1(d) The burners are to be type "Sievert No. 2942" or equivalent which produces an air mixed flame. The inner diameter of the burner heads is to be 29 mm (1.14 in.). See 4-2-2/7.15.1 FIGURE 1. The burner heads are to be mounted in the same plane and supplied with gas from a...
manifold. If necessary, each burner is to be equipped with a valve in order to adjust the flame height.

7.15.1(e) The height of the burner stand is also to be adjustable. It is to be mounted centrally below the test pipe with the rows of burners parallel to the pipe’s axis. The distance between the burner heads and the pipe is to be maintained at 12.5 ± 1 cm (5 ± 0.4 in.) during the test. The free length of the pipe between its supports is to be 0.8 ± 0.05 m (31.5 ± 2 in.). See 4-2-2/7.15.1 FIGURE 2.

**FIGURE 1**
Fire Endurance Test Burner Assembly
7.15.2 Test Specimen

7.15.2(a) Each pipe is to have a length of approximately 1.5 m (5 ft).

7.15.2(b) The test pipe is to be prepared with permanent joints and fittings intended to be used. Only valves and straight joints versus elbows and bends are to be tested as the adhesive in the joint is the primary point of failure.

7.15.2(c) The number of pipe specimens is to be sufficient to test all typical joints and fittings.

7.15.2(d) The ends of each pipe specimen are to be closed. One of the ends is to allow pressurized water to be connected.

7.15.2(e) If the insulation contains or is liable to absorb moisture, the specimen is not to be tested until the insulation has reached an air dry-condition defined as equilibrium with an ambient atmosphere of 50% relative humidity at 20 ± 5°C (68 ± 9°F). Accelerated conditioning is permissible, provided the method does not alter the properties of the component material. Special samples are to be used for moisture content determination and conditioned with the test specimen. These samples are to be so constructed as to represent the loss of water vapor from the specimen having similar thickness and exposed faces.

7.15.2(f) The pipe samples are to rest freely in a horizontal position on two V-shaped supports. The friction between pipe and supports is to be minimized. The supports may consist of two stands, as shown in 4-2-2/7.15.1 FIGURE 2.

7.15.2(g) A relief valve is to be connected to one of the end closures of each specimen.

7.15.3 Test Conditions

7.15.3(a) The test is to be carried out in a sheltered test site in order to prevent any draft influencing the test.

7.15.3(b) Each pipe specimen is to be completely filled with deaerated water to exclude air bubbles.

7.15.3(c) The water temperature is not to be less than 15°C (59°F) at the start and is to be measured continuously during the test. The water is to be stagnant and the pressure maintained at 3 ± 0.5 bar (3.1 ± 0.5 kgf/cm², 43.5 ± 7.25) during the test.

7.15.4 Acceptance Criteria

7.15.4(a) During the test, no leakage from the sample(s) is to occur, except that slight weeping through the pipe wall may be accepted.
After termination of the burner test, the test specimen together with fire protective coating, if any, is to be allowed to cool to ambient temperature and then tested to the design pressure of the pipes, as defined in 4-2-2/7.5.1 and 4-2-2/7.5.2. The pressure is to be held for a minimum of 15 minutes without significant leakage [i.e., not exceeding 0.2 1/min. (0.05 gpm)]. Where practicable, the hydrostatic test is to be conducted on bare pipe (i.e., coverings and insulation removed) so that any leakage will be apparent.

**7.17 Tests by Manufacturer – Flame Spread**

**7.17.1 Test Method**

Flame spread of plastic piping is to be determined by IMO Resolution A.653(16) entitled "Recommendation on Improved Fire Test Procedures for Surface Flammability of Bulkhead, Ceiling, and Deck Finish Materials" with the following modifications.

**7.17.1(a)** Tests are to be made for each pipe material and size.

**7.17.1(b)** The test sample is to be fabricated by cutting pipes lengthwise into individual sections and then assembling the sections into a test sample as representative as possible of a flat surface. A test sample is to consist of at least two sections. The test sample is to be at least 800 ± 5 mm (31.5 ± 0.2 in.) long. All cuts are to be made normal to the pipe wall.

**7.17.1(c)** The number of sections that must be assembled together to form a test sample is to be that which corresponds to the nearest integral number of sections which makes up a test sample with an equivalent linearized surface width between 155 mm (6 in.) and 180 mm (7 in.). The surface width is defined as the measured sum of the outer circumference of the assembled pipe sections that are exposed to the flux from the radiant panel.

**7.17.1(d)** The assembled test sample is to have no gaps between individual sections.

**7.17.1(e)** The assembled test sample is to be constructed in such a way that the edges of two adjacent sections coincide with the centerline of the test holder.

**7.17.1(f)** The individual test sections are to be attached to the backing calcium silicate board using wire (No. 18 recommended) inserted at 50 mm (2 in.) intervals through the board and tightened by twisting at the back.

**7.17.1(g)** The individual pipe sections are to be mounted so that the highest point of the exposed surface is in the same plane as the exposed flat surface of a normal surface.

**7.17.1(h)** The space between the concave unexposed surface of the test sample and the surface of the calcium silicate backing board is to be left void.

**7.17.1(i)** The void space between the top of the exposed test surface and the bottom edge of the sample holder frame is to be filled with a high temperature insulating wool if the width of the pipe segments extend under the side edges of the sample holding frame.


Testing is to demonstrate the compliance of plastic pipes, fittings and joints for which approval, in accordance with 4-2-2/7, is requested. These tests are to be in compliance with the requirements of relevant standards as per 4-2-2/Table 3 and 4-2-2/Table 4.
### TABLE 2
Fire Endurance Requirements Matrix *(2019)*

<table>
<thead>
<tr>
<th>PIPING SYSTEMS</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>FLAMMABLE LIQUIDS</td>
<td></td>
</tr>
<tr>
<td>1 Oil [flash point ≤ 60°C (140°F)]</td>
<td>NA</td>
</tr>
<tr>
<td>2 Fuel oil [flash point &gt; 60°C (140°F)]</td>
<td>X</td>
</tr>
<tr>
<td>3 Lubricating oil</td>
<td>X</td>
</tr>
<tr>
<td>4 Hydraulic oil</td>
<td>X</td>
</tr>
<tr>
<td>SEA WATER (See Note 1)</td>
<td></td>
</tr>
<tr>
<td>5 Bilge main and branches</td>
<td>L1</td>
</tr>
<tr>
<td>6 Fire main and water spray</td>
<td>L1</td>
</tr>
<tr>
<td>7 Foam system</td>
<td>L1W</td>
</tr>
<tr>
<td>8 Sprinkler system</td>
<td>L1W</td>
</tr>
<tr>
<td>9 Ballast</td>
<td>L3</td>
</tr>
<tr>
<td>10 Cooling water, essential services</td>
<td>L3</td>
</tr>
<tr>
<td>11 Non-essential systems</td>
<td>0</td>
</tr>
<tr>
<td>FRESH WATER</td>
<td></td>
</tr>
<tr>
<td>12 Cooling water, essential services</td>
<td>L3</td>
</tr>
<tr>
<td>13 Condensate return</td>
<td>L3</td>
</tr>
<tr>
<td>14 Non-essential systems</td>
<td>0</td>
</tr>
<tr>
<td>SANITARY/DRAINS/SCUPPERS</td>
<td></td>
</tr>
<tr>
<td>15 Deck drains (internal)</td>
<td>L1W (3)</td>
</tr>
<tr>
<td>16 Sanitary drains (internal)</td>
<td>0</td>
</tr>
<tr>
<td>17 Scuppers and discharges (overboard)</td>
<td>0 (1,5)</td>
</tr>
<tr>
<td>VENTS/SOUNDING</td>
<td></td>
</tr>
<tr>
<td>18 Water tanks/dry spaces</td>
<td>0</td>
</tr>
<tr>
<td>19 Oil tanks [flash point &gt; 60°C (140°F)]</td>
<td>X</td>
</tr>
<tr>
<td>20 Oil tanks [flash point ≤ 60°C (140°F)]</td>
<td>NA</td>
</tr>
<tr>
<td>MISCELLANEOUS</td>
<td></td>
</tr>
<tr>
<td>21 Control air</td>
<td>L1 (4)</td>
</tr>
<tr>
<td>22 Service air (non-essential)</td>
<td>0</td>
</tr>
<tr>
<td>23 Brine</td>
<td>0</td>
</tr>
</tbody>
</table>
TABLE 3

<table>
<thead>
<tr>
<th>Test</th>
<th>Typical Standard</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Internal pressure (1)</td>
<td>4-2-2/7.5.1, ASTM D 1599, ASTM D 2992, ISO 15493 or equivalent</td>
<td>Top, Middle, Bottom (of each pressure range) Tests are to be carried out on pipe spools made of different pipe sizes, fittings and pipe connections.</td>
</tr>
<tr>
<td>2 External pressure (1)</td>
<td>4-2-2/7.5.2, ISO 15493 or equivalent</td>
<td>As above, for straight pipes only.</td>
</tr>
<tr>
<td>3 Axial strength (1)</td>
<td>4-2-2/7.5.3</td>
<td>As above.</td>
</tr>
<tr>
<td>4 Load deformation</td>
<td>ASTM D 2412 or equivalent</td>
<td>Top, Middle, Bottom (of each pressure range)</td>
</tr>
</tbody>
</table>
### TABLE 4

**Standards for Plastic Pipes – Additional Requirements Depending on Service and/or Location of Piping (2007)**

<table>
<thead>
<tr>
<th>Test</th>
<th>Typical Standard</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Fire endurance&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>4-2-2/7.5.6</td>
<td>Representative samples of each type of construction and type of pipe connection.</td>
</tr>
<tr>
<td>2 Flame spread&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>4-2-2/7.5.7</td>
<td>Representative samples of each type of construction.</td>
</tr>
<tr>
<td>3 Smoke generation&lt;sup&gt;2&lt;/sup&gt;</td>
<td>IMO Fire Test Procedures Code</td>
<td>Representative samples of each type of construction.</td>
</tr>
<tr>
<td>4 Toxicity&lt;sup&gt;2&lt;/sup&gt;</td>
<td>IMO Fire Test Procedures Code</td>
<td>Representative samples of each type of construction.</td>
</tr>
<tr>
<td>5 Electrical conductivity&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>4-2-2/7.5.8 ASTM F1173-95 or ASTM D 257, NS 6126/ 11.2 or equivalent</td>
<td>Representative samples of each type of construction</td>
</tr>
</tbody>
</table>

**Notes:**

1. Where the manufacturer does not have a certified quality system, test to be witnessed by the Surveyor. See 4-2-2/7.9.
2. If applicable.
Notes:

1. Where the manufacturer does not have a certified quality system, test to be witnessed by the Surveyor. See 4-2-2/7.9.

2. If applicable.

Note: Test items 1, 2 and 5 in 4-2-2/7.19 TABLE 4 are optional. However, if not carried out, the range of approved applications for the pipes will be limited accordingly (see 4-2-2/7.19 TABLE 2).

9 Valves

9.1 General (1993)

9.1.1 Standard Valves

All valves constructed and tested in accordance with a recognized standard are acceptable to ABS, subject to compliance with 4-2-2/9.5.

9.1.2 Non-Standard Valves

All other valves not certified by the manufacturer in accordance with a recognized standard are subject to special consideration, and drawings of such valves showing details of construction and materials are to be submitted for review, as well as basis for valve pressure rating, such as design calculations or appropriate burst test data.

9.3 Construction (2016)

All valves are to close with a right hand (clockwise) motion of the handwheel when facing the end of the stem and are to be either of the rising stem type or fitted with an indicator to show whether the valve is open or closed.

All valves of Class I and II piping systems having nominal diameters exceeding 50 mm (2 in.) are to have bolted, pressure seal or breech lock bonnets and flanged or welding ends. Welding ends are to be butt welding type, except that socket welding ends may be used for valves having nominal diameters of 80 mm (3 in.) or less. See 4-2-1/11.11.

All cast iron valves are to have bolted bonnets or are to be of the union bonnet type. For cast iron valves of union bonnet type, the bonnet ring is to be of steel, bronze or malleable iron.

Stems, discs or disc faces, seats, and other wearing parts of valves are to be of corrosion-resistant materials suitable for intended service.

Valves are to be designed for the maximum working pressure to which they will be subjected. The design pressure is to be at least 3.4 bar (3.5 kgf/cm², 50 psi), except that valves used in open systems, such as vent and drain lines, and valves mounted on atmospheric tanks which are not part of the tank suction or discharge piping (for example, level gauge and drain cocks and valves in inert gas and vapor emission control systems) may be designed for a pressure below 3.4 bar (3.5 kgf/cm², 50 psi), subject to the requirements of 4-2-2/9.1. Large fabricated ballast manifolds which connect lines exceeding 200 mm (8 in.) nominal pipe size may be specially considered when the maximum working pressure to which they will be subjected does not exceed 1.7 bar (1.75 kgf/cm², 25 psi).

All valves for Class I and II piping systems and valves intended for use in steam or oil lines are to be constructed so that the stem is positively restrained from being screwed out of the body (bonnet). Plug cocks, butterfly valves and valves employing resilient material will be subject to special consideration. Valve operating systems for all valves which cannot be manually operated are to be submitted for approval.
9.5 Hydrostatic Test and Identification

All valves are to be subjected by the manufacturer to a hydrostatic test at a pressure equal to that stipulated by the American National Standards Institute or other recognized standard. They are to bear the trademark of the manufacturer legibly stamped or cast on the exterior of the valve and also the primary pressure rating at which the manufacturer guarantees the valve to meet the requirements of the standards.

11 Pipe Fittings

11.1 General (2016)

All fittings in Class I and II piping are to have flanged or welded ends in sizes over 89 mm O.D. (3 in. N.P.S). Screwed fittings may be used in Class I and II piping systems, provided the maximum working temperature does not exceed 496°C (925°F) and the maximum working pressure does not exceed the maximum pressure indicated below for the pipe size.

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Maximum Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm O.D. (in. N.P.S.)</td>
<td>bar (kgf/cm², psi)</td>
</tr>
<tr>
<td>above 89 (3)</td>
<td>not permitted in Class I and II piping service</td>
</tr>
<tr>
<td>above 60 (2) through 89 (3)</td>
<td>27.6 (28.10, 400)</td>
</tr>
<tr>
<td>above 33 (1) through 60 (2)</td>
<td>41.4 (42.20, 600)</td>
</tr>
<tr>
<td>above 27 (0.75) through 33 (1)</td>
<td>82.3 (84.4, 1200)</td>
</tr>
<tr>
<td>27 (0.75) and smaller</td>
<td>103 (105.5, 1500)</td>
</tr>
</tbody>
</table>

Flared, flareless and compression fittings may be used for tube sizes not exceeding 60 mm O.D. (2 in. N.P.S.) in Class I and II piping. In Class III piping, screwed fittings and flared, flareless and compression tube fittings will be accepted without size limitations. Flared fittings are to be used for flammable fluid systems, except that both flared and flareless fittings of the non-bite type may be used when the tubing system is of steel or nickel-copper or copper-nickel alloys. Only flared fittings are to be used when tubing for flammable fluid systems is of copper or copper-zinc alloys. See 4-2-6/3.7 for hydraulic systems. Bite type fittings are not to be used for flammable fluid systems, unless such fittings are in compliance with a recognized standard or design-approved by ABS. Refer to 4-6-2/Tables 10 and 11 of Marine Vessel Rules.

11.3 Hydrostatic Test and Identification

All fittings are to be subjected by the manufacturer to a hydrostatic test at a pressure equal to that stipulated by the American National Standards Institute or other recognized standard. They are to bear the trademark of the manufacturer legibly stamped or cast on the exterior of the fitting and also the primary pressure rating at which the manufacturer guarantees the fitting to meet the requirements of the standards.

11.5 Nonstandard Fittings (1993)

Fittings which are not certified by the manufacturer to a recognized standard will be subject to special consideration. Plans showing details of construction, material and design calculations or test results are to be submitted for review.

13 Welded Nonstandard Valves and Fittings (1993)

Nonstandard steel valves and fittings fabricated by means of fusion welding are to comply also with the requirements of Chapter 4 of the ABS Rules for Materials and Welding (Part 2). However, after a manufacturer’s procedure in the fabrication of equipment of this kind has been demonstrated by tests to the satisfaction of a Surveyor to ABS, subsequent tests on the product need not be witnessed, but the manufacturer’s guarantee that the Rules are complied with will be accepted as for other valves and fittings which conform to standards of the American National Standards Institute or other recognized standards.
15 Flanges (2012)

15.1 General
Flanges are to be designed and fabricated in accordance with a recognized national or international standard. Slip-on flanges from flat plate may be substituted for hubbed slip-on flanges in Group II piping systems.

15.3 Class I and II Piping Flanges
In Class I and II piping, flanges may be attached to the pipes by any of the following methods appropriate for the material involved.

15.3.1 Steel Pipe
Over 60 mm O.D. (2 in. N.P.S.) steel pipes are to be expanded into steel flanges, or they may be screwed into the flanges and seal-welded. They may in all cases be attached by fusion welding in compliance with the requirements of 2-4-4/5.7 of the ABS Rules for Materials and Welding (Part 2). Smaller pipes may be screwed without seal-welding, but in steam and oil lines are, in addition, to be expanded into the flanges in order to insure uniformly tight threads.

15.3.2 Nonferrous Pipe
In Class I and II, nonferrous pipes are to be brazed to composition or steel flanges, and in sizes of 60 mm O.D. (2 in. N.P.S.) and under, they may be screwed.

15.5 Class III Piping Flanges
Similar attachments are also to be used in Class III piping. However, modifications are permitted for welded flanges, as noted in 2-4-4/5.7 of the ABS Rules for Materials and Welding (Part 2), and screwed flanges of suitable material may be used in all sizes.

17 Material of Valves and Fittings

17.1 General
The physical characteristics of such material are to be in accordance with the applicable requirements of 2-3-1 of the ABS Rules for Materials and Welding (Part 2), or such other appropriate material specification as may be approved in connection with a particular design for the stresses and temperatures to which they may be exposed. Manufacturers are to make physical tests of each melt and, upon request, are to submit the results of such tests to ABS.

17.3 Forged or Cast Steel
In any system, forged or cast steel may be used in the construction of valves and fittings for all pressures and temperatures. Consideration is to be given to the possibility of graphite formation in the following steels: Carbon steel above 425°C (800°F); carbon-molybdenum steel above 468°C (875°F); chrome-molybdenum steel (with chromium under 0.60%) above 524°C (975°F).

17.5 Cast Iron
For temperatures not exceeding 232°C (450°F), cast iron of the physical characteristics specified in 2-3-11 of the ABS Rules for Materials and Welding (Part 2) may be used in the construction of valves and fittings, except as noted in 4-2-1/11.17, 4-2-2/21.5 and 4-2-5/3.9.

17.7 Nonferrous
Brass or bronze having the physical characteristics as specified in 2-3-1 of the ABS Rules for Materials and Welding (Part 2) may be used in the construction of valves and fittings intended for temperatures up to 208°C (406°F). For temperatures greater than 208°C (406°F), but not in excess of 288°C (550°F), high-temperature bronze is to be used and the chemical and physical characteristics are to be submitted for
approval. Valves, fittings and flanges made of nonferrous material may be attached to nonferrous pipe by an approved soldering method. For pressures up to 6.9 bar (7 kgf/cm², 100 psi) and temperatures not exceeding 93°C (200°F), ordinary solder may be used, but for higher pressures and temperatures, the method and the quality of solder to be used will be subject to special consideration in each case.

17.9 Ductile (Nodular) Iron

Nodular-iron applications for valves and fittings will be specially considered where the temperature does not exceed 343°C (650°F).

19 Fluid Power Cylinders *(1 July 2009)*

19.1 General *(2012)*

Fluid power cylinders subject to pressures or temperatures greater than those indicated below are to be designed, constructed and tested in accordance with a recognized standard for fluid power cylinders.

- **Hydraulic fluid – flammable:** 7 bar (7.1 kgf/cm², 101.5 psi) or 60°C (140°F)
- **Hydraulic fluid – non-flammable:** 16 bar (16.3 kgf/cm², 232 psi) or 200°C (392°F)
- **Air:** 16 bar (16.3 kgf/cm², 232 psi) or 200°C (392°F)

Acceptance will be based on the manufacturer’s certification of compliance and on verification of permanent identification on each cylinder bearing the manufacturer's name or trademark, standard of compliance and design pressure and temperature.

19.3 Non-compliance with a Recognized Standard *(2012)*

Cylinders subject to pressures or temperatures higher than those indicated above which are not constructed to a recognized standard may be accepted based on the following:

**i)** Regardless of diameter, the design of the cylinder is to be shown to comply with one of the following:

- A recognized pressure vessel code,
- 4-4-1 of the *Marine Vessel Rules*. For instance, the cylinder is to have a wall thickness not less than that given by equation 2 of 4-4-1-A1/3.1, and the cylinder ends are to meet the requirements of flat heads in 4-4-1-A1/5.7, or
- Verification through burst tests. Steel cylinders (other than cast steel) are to withstand not less than 4 times the design pressure, while cast steel, cast iron and nodular iron cylinders are to withstand not less than 5 times the maximum allowable working pressure.

Documentation in this regard is to be submitted for review.

**ii)** Each individual unit is to be hydrostatically tested to 1.5 times the design pressure (2 times, for cast iron and nodular iron cylinders) by the manufacturer. A test certificate is to be submitted.

**iii)** Each cylinder is to be affixed with a permanent nameplate or marking bearing the manufacturer’s name or trademark and the design pressure and temperature.

19.5 Materials

**i)** The materials of the cylinders are to comply with the requirements of the standard or code to which they are designed and constructed. Where the design is verified through burst tests, the materials of the cylinder are to comply with 4-4-1/3 of the *Marine Vessel Rules* or other acceptable standards.

**ii)** Ordinary cast iron having an elongation of less than 12% is not to be used for cylinders expected to be subjected to shock loading.
iii) Copies of certified mill test reports are to be made available to the Surveyor upon request.

19.7 **Rudder Actuators**
Rudder actuators are to be in accordance with the requirements of 4-3-4/7.3.1 of the *Marine Vessel Rules*.

19.9 **Cylinders Below Pressures or Temperatures Indicated in 4-2-2/19.1**
Cylinders subject to pressures and temperatures at or below those indicated in 4-2-2/19.1 may be used in accordance with the manufacturer’s rating and verification of suitable for the intended service.

19.11 **Exemptions (2012)**
Fluid power cylinders that do not form part of the unit's piping systems covered in Part 4 Chapter 2 and Part 6 Chapter 1 of these Rules are exempt from the requirements of 4-2-2/19. However, those fluid power cylinders which are integrated into piping systems associated with optional classification notations are to comply with the requirements of 4-2-2/19 and the applicable requirements specified in the pertinent ABS Rules and Guides.

21 **Sea Inlets and Overboard Discharges**

21.1 **Installation (2006)**
Piping connections bolted to the shell plating are to have the bolt heads countersunk on the outside and the bolts threaded through the plating. Where a reinforcing ring of sufficient thickness is riveted or welded to the inside of the shell, studs may be used.

Threaded connections outboard of the shell valves are not considered an acceptable method of connecting pipe to the shell.

21.3 **Valve Connections to Shell (2012)**
Pipe connections fitted between the shell and the valves are to have a minimum wall thickness not less than that specified below and be as short as possible. Wafer-type valves are not to be used for any connections to the unit’s shell unless specially approved.

<table>
<thead>
<tr>
<th>Nominal Size, d</th>
<th>Min. Wall Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>d ≤ 65 mm (2.5 in.)</td>
<td>7 mm (0.276 in.)</td>
</tr>
<tr>
<td>d = 150 mm (6 in.)</td>
<td>10 mm (0.394 in.)</td>
</tr>
<tr>
<td>d ≥ 200 mm (8 in.)</td>
<td>12.5 mm (0.492 in.)</td>
</tr>
</tbody>
</table>

For intermediate nominal pipe sizes, the wall thicknesses are to be obtained by linear interpolation as follows:

For $65 < d < 150$: $7 + 0.035 (d - 65)$ mm or $0.28 + 0.034 (d - 2.5)$ in.

For $150 < d < 200$: $10 + 0.05 (d - 150)$ mm or $0.39 + 0.05 (d - 6.0)$ in.

21.5 **Materials**
All shell fittings and the valves required by 4-2-2/21.9 and 4-2-2/23 are to be of steel, bronze or other approved ductile material. Valves of ordinary cast iron or similar material are not acceptable. The use of nodular iron, also known as ductile iron or spheroidal-graphite iron, will be accepted, provided the material has an elongation not less than 12%. All pipes to which this subsection refers are to be of steel or other equivalent material, subject to special approval.
21.7 **Shell Reinforcement**

Overboard discharges are to have spigots extending through the shell plate. Boiler and evaporator blow-off overboard discharges are to have doubling plates or heavy inserts fitted. The spigot is to extend through the doubling and the shell and the external doubling plate, when fitted, but the spigot need not project beyond the outside surface of the unit.

21.9 **Sea-Water Inlet and Discharge Valves (2012)**

Positive closing valves are to be fitted at the shell in inlet and discharging piping. The controls are to be readily accessible and are to be provided with indicators showing whether the valves are open or closed. Refer to 7-1-3/23.3 with regard to controls accessibility.

Materials readily rendered ineffective by heat are not to be used for connection to the shell where the failure of the material in the event of a fire would give rise to danger of flooding.

Power-operated valves are to meet the requirements in 4-2-1/11.25. Position indicating systems for sea-water inlet and discharge valves are to be independent of the valves’ control systems. Additionally, sea-water valves necessary for the operation of propulsion machinery or generation of power required in 4-3-2/3.1 are to be designed to remain in the last ordered position upon loss of control power.

Valves for sea-water inlets and discharges are also to be in accordance with the following, as applicable.

21.9.1 **Column-Stabilized Units**

Sea-water inlets and discharges below the assigned load line are to be provided with valves which can be remotely operated from an accessible position outside of the space.

21.9.2 **Self-Elevating and Surface-Type Units**

Sea-water inlets and discharges in spaces below the assigned load line which are not intended to be normally manned are to be provided with valves which can be remotely operated from an accessible position outside of the space. If the valves are readily accessible, the spaces containing the inlets and discharges may be provided with bilge alarms in lieu of remote operation of the valves.

21.9.3 **Self-Elevating Units**

Mud pit discharges are to be provided with valves which can be operated from an accessible position. These valves are to be normally closed and a sign to this effect is to be posted near the operating position. Non-return valves need not be provided.

21.11 **Sea Chests (1996)**

The locations of sea chests are to be such as to minimize the probability of blanking off the suction, and they are to be so arranged that the valves may be operated from the floors or gratings.

Sea chests are to be fitted with strainer plates at the shell. The strainers are to have a clear area of at least 1.5 times the area of the sea valves, and efficient means are to be provided for clearing the strainers.

23 **Scuppers and Drains on Surface-Type and Self-Elevating Units**

23.1 **Discharges through the Shell (2005)**

Discharges led through the shell either from spaces below the freeboard deck or from within superstructures and deckhouses on the freeboard deck, fitted with doors complying with the requirements of 3-2-11/5 of the Marine Vessel Rules, are to be fitted with efficient and accessible means for preventing water from passing inboard.

Normally, each separate discharge is to have one automatic non-return valve with a positive means of closing it from a position above the freeboard deck, or bulkhead deck, whichever is higher. Alternatively,
one non-return valve and one positive closing valve controlled from above the freeboard deck may be accepted.

23.1.1

Where, however, the vertical distance from the load water-line to the inboard end of the discharge pipe exceeds 0.01\(L\), the discharge may have two automatic non-return valves without positive means of closing, provided that the inboard valves are always accessible for examination under service conditions. The inboard valve is to be above the deepest load waterline. If this is not practicable, then, provided a locally controlled stop valve is interposed between the two non-return valves, the inboard valve need not be fitted above the deepest load waterline.

23.1.2

Where that vertical distance from the summer load waterline to the inboard end of the discharge pipe exceeds 0.02\(L\), a single automatic non-return valve without positive means of closing may be accepted provided it is located above the deepest load waterline. If this is impracticable, a locally operated positive closing valve may be provided below the single non-return valve in which case the non-return valve need not be located above the specified deepest load waterline. The means for operating the positive-action valve is to be readily accessible and provided with an indicator showing whether the valve is open or closed.

See 3-1-1/13 for definition of ‘freeboard deck’.

3-1-1/3 of the Marine Vessel Rules and 3-1-1/3 of the Barge Rules define \(L\).

23.1.3 (2005)

Where sanitary discharges and scuppers lead overboard through the shell in way of machinery spaces, the fitting to shell of a locally operated positive closing valve, together with a non-return valve inboard, will be acceptable.

23.3 Scuppers and Discharges below the Freeboard Deck – Shell Penetration (1996)

Scuppers and discharge pipes originating at any level and penetrating the shell either more than 450 mm (17.5 in.) below the freeboard deck or less than 600 mm (23.5 in.) above the summer load waterline are to be provided with a non-return valve at the shell. This valve, unless required by 4-2-2/23.1, may be omitted if the piping has a wall thickness at least equal to the thickness of the shell plating or extra-heavy pipe (see 4-2-1/3.9), whichever is less.

23.5 Scuppers from Superstructures or Deckhouses

Scuppers leading from superstructures or deckhouse not fitted with doors complying with the requirements of Section 3-2-11/5 of the Marine Vessel Rules are to be led overboard.

25 Cooler Installations External to the Hull

25.1 General (2019)

The inlet and discharge connections of external cooler installations are to be in accordance with 4-2-2/21.1, 4-2-2/21.3, 4-2-2/21.5 and 4-2-2/21.9, except that wafer type valves will be acceptable. If a flexible hose or joint is fitted, it should be fire rated when located within the Category A machinery space and located inboard of the isolation valve.

25.3 Integral Keel Cooler Installations

The positive closing valves required by 4-2-2/27.1 need not be provided if the keel (skin) cooler installation is integral with the hull. To be considered integral with the hull, the installation is to be constructed such that channels are welded to the hull with the hull structure forming part of the channel.
The channel material is to be at least of the same thickness and quality as that required for the hull, and the forward end of the cooler is to be faired to the hull with a slope of not greater than 4 to 1.

If positive closing valves are not required at the shell, all flexible hoses or joints are to be positioned above the deepest load waterline or be provided with an isolation valve.

25.5 Non-integral Keel Cooler Installations
Where non-integral keel coolers are used, if the shell penetrations are not fully welded, the penetration is to be encased in a watertight enclosure.

27 Penetrations through Watertight Boundaries
At the boundaries required to be maintained watertight for damage stability, valves or watertight closures may be required (see 3-3-2/5). Check valves and spring or gravity-actuated, non-return valves are not to be considered effective in preventing progressive flooding. Watertight closures or valves and their control and position-indicating systems are to be provided as follows:

27.1 Ventilating Systems (2017)
Non-watertight ducts passing through subdivision bulkheads and watertight ducts servicing more than one watertight compartment or which are within the extent of damage, (see 3-3-2/3.5), are to be provided with valves, or other approved positive means of closure such as watertight dampers, at the subdivision boundary.

Materials readily rendered ineffective by heat are not to be used in the construction of the valves or the closure mechanism to ensure effective closure facility in the event of fire. Electric cables, where used, are to be fire-resistant, meeting the requirements of IEC Publication 60331.

Valve operators are to be fitted with position indicators. Control of valves is to be from one of the following areas:

i) Ballast control room or other normally manned spaces.

ii) Readily accessible locations which are above the calculated immersion line in the damaged condition (see 3-3-2/1.3).

27.3 Internal Drain System
27.3.1 Where drain systems are led to a separate, watertight compartment fitted with a bilge suction, positive closing valves are to be provided with position indicators. Control of these valves is to be from locations listed in 4-2-2/27.1.

27.3.2 Where the installation of a remote valve operator is impractical, drain lines may be fitted with quick-acting, self-closing valves at the boundary of the space which is equipped with a bilge suction.
1.1 General (2011)

Except for comparatively small compartments that are not fitted with a fixed means of drainage, vent pipes are to be fitted to all tanks, cofferdams, voids, tunnels and compartments which are not fitted with other ventilation arrangements.

In all units, the structural arrangement in double-bottom and other tanks is to be such as to permit the free passage of air and gases from all parts of the tanks to the vent pipes. Tanks having a comparatively small surface, such as fuel-oil settling tanks, need to be fitted with only one vent pipe, while tanks having a comparatively large surface are to be fitted with at least two vent pipes, one of which is to be located at the highest part of the tank. Vent pipes are to be arranged to provide adequate drainage under normal conditions. No shutoff valve or a closing device that can prevent the venting from a tank is to be installed in vent piping.

All vent and overflow pipes terminating in the weather are to be fitted with return bends (gooseneck), or equivalent, and the vent outlet is to be provided with an automatic means of closure i.e., close automatically upon submergence (e.g., ball float or equivalent), complying with 4-2-3/1.9.5.

1.3 Progressive Flooding Consideration (1995)

Tank vents and overflows are to be located giving due regard to stability and the extent of watertight integrity provided in the plans submitted in accordance with 4-2-1/7.1. They are to terminate above the extent of watertight integrity. Those terminating within the extent of weathertight integrity are to be fitted with automatic means of closure such as a ball check valve or equivalent.

The vent of a permanently filled compartment may terminate within the extent of watertight integrity. Automatic means of closures are not required for vents of such compartments.

For the purpose of positioning vent and overflow ends, damage to the space from which they emanate need not be considered.

Progressive flooding through tank vents and overflows, regardless of the means of closure, is to be considered when tank vents and overflows from intact spaces terminate within a damaged compartment or vice versa.

1.5 Height and Wall Thickness of Vent Pipes (2010)

See 4-2-3/1.3 for damage stability requirements.

1.5.1 Vents Exposed to Weather

Vent pipes on decks exposed to the weather are to have the following heights:

i) 760 mm (30 in.) for those on the freeboard deck; and

ii) 450 mm (17.5 in.) for those on the superstructure deck.
The height is to be measured from the deck to the point where water may have access below. Where these heights may interfere with the working of the vessel, a lower height may be accepted, provided that ABS is satisfied that the closing arrangements and other circumstances justify a lower height.

The wall thicknesses of vent pipes where exposed to the weather are to be not less than that specified below.

<table>
<thead>
<tr>
<th>Nominal Size, (d)</th>
<th>Min. Wall Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>(d \leq 65) mm (2.5 in.)</td>
<td>6.0 mm (0.24 in.)</td>
</tr>
<tr>
<td>(65) mm (2.5 in.) &lt; (d) &lt; 150 mm (6 in.)</td>
<td>by interpolation(^{(1)})</td>
</tr>
<tr>
<td>(d \geq 150) mm (6 in.)</td>
<td>8.5 mm (0.33 in.)</td>
</tr>
</tbody>
</table>

Note:
1. \(6 + 0.029(d – 65)\) mm or \(0.24 + 0.026(d – 2.5)\) in.

1.5.2 Vents not Exposed to Weather
Vent pipes not exposed to the weather need not comply with the height and wall thickness required by 4-2-3/1.5.1.

1.7 Size
The diameter of each vent pipe is not to be less than 38 mm (1.5 in.) I.D. for fresh-water tanks, 51 mm (2 in.) I.D. for water-ballast tanks and 63 mm (2.5 in.) I.D. for oil tanks, unless specially approved otherwise. Where tanks are to be filled by pump pressure, the aggregate area of the vents in the tank is to be at least 125% of the effective area of the filling line, except that when overflows are fitted, the area of the overflow is to be at least 125% of the effective area of the filling line and the vents need not exceed the above minimum sizes. Notwithstanding the above, the pump capacity and pressure head are to be considered in the sizing of vents and overflows. When high capacity and/or high head pumps are used, calculations demonstrating the adequacy of the vent and overflows are to be submitted.

1.9 Termination of Vent Pipes (2007)

1.9.1 Termination on or Above Freeboard Deck
Vent pipes for all tanks, double bottoms and other compartments which extend to the shell of the unit are to be led above the freeboard deck. In addition, vents for ballast tanks and fuel oil tanks are to be led to the weather.

1.9.2 Termination in Machinery Spaces
Vents for other tanks not adjacent to the shell of the unit may terminate within the machinery space but are to be located so as to preclude the possibility of overflowing on electric equipment, engines or high temperature piping. For low flash point fuel oil, see 4-2-5/9.5.

1.9.3 Protection for Fuel Oil and Lubricating Oil Tanks (2018)
Vent pipes for fuel oil service tanks, fuel oil settling tanks and lubricating oil tanks which directly serve the engines for propulsion and auxiliary generator engines are to be so located and arranged that in the event of a broken vent pipe, this will not directly lead to the risk of ingress of sea water splashes or rain water into the above mentioned tanks.

1.9.4 Fuel Oil Tanks Vent Outlets
Vent outlets from fuel oil tanks are to be fitted with corrosion-resistant flame screens having clear area through the mesh of not less than the required area of the vent pipe and are to be located where the possibility of ignition of gases issuing from the vent outlets is remote. Either a single
screen of corrosion-resistant wire of at least 12 by 12 meshes per lineal cm (30 by 30 mesh per lineal inch), or two screens of at least 8 by 8 meshes per lineal cm (20 by 20 mesh per lineal inch) spaced not less than 13 mm (0.5 inch) nor more than 38 mm (1.5 inch) apart are acceptable.

See also 4-2-3/1.3 for progressive flooding considerations.

*Note:*

Mesh count is defined as a number of openings in a lineal cm (inch) counted from the center of any wire to the center of a parallel wire.

1.9.5 Vent Outlet Closing Devices (2010)

1.9.5(a) General.

Where vent outlets are required by 4-2-3/1.1 to be fitted with automatic closing devices, they are to comply with the following:

1.9.5(b) Design.

i) Vent outlet automatic closing devices are to be so designed that they will withstand both ambient and working conditions, and be suitable for use at inclinations up to and including ±40°.

ii) Vent outlet automatic closing devices are to be constructed to allow inspection of the closure and the inside of the casing, as well as changing the seals.

iii) Efficient ball or float seating arrangements are to be provided for the closures. Bars, cage or other devices are to be provided to prevent the ball or float from contacting the inner chamber in its normal state and made in such a way that the ball or float is not damaged when subjected to water impact due to a tank being overfilled.

iv) Vent outlet automatic closing devices are to be self-draining.

v) The clear area through a vent outlet closing device in the open position is to be at least equal to the area of the inlet.

vi) An automatic closing device is to:

- Prevent the free entry of water into the tanks,
- Allow the passage of air or liquid to prevent excessive pressure or vacuum developing in the tank.

vii) In the case of vent outlet closing devices of the float type, suitable guides are to be provided to ensure unobstructed operation under all working conditions of heel and trim [see 4-2-3/1.9.5.i].

viii) The maximum allowable tolerances for wall thickness of floats should not exceed ±10% of thickness.

ix) (2017) The inner and outer chambers of an automatic air pipe head is to be of a minimum thickness of 6 mm (0.24 inch). Where side covers are provided and their function is integral to providing functions of the closing device as outlined in 4-2-3/1.9.5.i, they are to have a minimum wall thickness of 6 mm (0.24 inch). If the air pipe head can meet the tightness test in 4-2-3/1.9.5.i without the side covers attached, then the side covers are not considered to be integral to the closing device, in which case a wall less than 6 mm may be acceptable for side covers.

1.9.5(c) Materials
Casings of vent outlet closing devices are to be of approved metallic materials adequately protected against corrosion.

For galvanized steel air pipe heads, the zinc coating is to be applied by the hot dip method and the thickness is to be 70 to 100 micrometers (2.756 to 3.937 mil).

For areas of the head susceptible to erosion (e.g. those parts directly subjected to ballast water impact when the tank is being pressed up, for example the inner chamber area above the air pipe, plus an overlap of 10° or more to either side) an additional harder coating should be applied. This is to be an aluminum bearing epoxy, or other equivalent coating, applied over the zinc.

Closures and seats made of non-metallic materials are to be compatible with the media intended to be carried in the tank and to seawater, and suitable for operating at ambient temperatures between -25°C and 85°C (-13°F and 185°F).

1.9.5(d) Type Testing

i) Testing of Vent Outlet Automatic Closing Devices. Each type and size of vent outlet automatic closing device is to be type tested at the manufacturer’s works or other acceptable location.

The minimum test requirements for a vent outlet automatic closing device are to include the determination of the flow characteristics of the vent outlet closing device, the measurement of the pressure drop versus the rate of volume flow using water and with any intended flame or insect screens in place and also tightness tests during immersion/emerging in water, whereby the automatic closing device is to be subjected to a series of tightness tests involving not less than two (2) immersion cycles under each of the following conditions:

- The automatic closing device is to be submerged slightly below the water surface at a velocity of approximately 4 m/min (13.12 ft/min) and then returned to the original position immediately. The quantity of leakage is to be recorded.
- The automatic closing device is to be submerged to a point slightly below the surface of the water. The submerging velocity is to be approximately 8 m/min (26.24 ft/min) and the air pipe vent head is to remain submerged for not less than 5 minutes. The quantity of leakage is to be recorded.
- (2014) Each of the above tightness tests are to be carried out in the normal position as well as at an inclination of 40 degrees under the strictest conditions for the device. In cases where such strictest conditions are not clear, tests shall be carried out at an inclination of 40 degrees with the device opening facing in three different directions: upward, downward, sideways (left or right). See 4-2-3/Figures 1 to 4.

The maximum allowable leakage per cycle is not to exceed 2 ml/mm (1.312 × 10^-2 gal/inch) of nominal diameter of inlet pipe during any individual test.

ii) Discharge/Reverse Flow Test (2014). The air pipe head shall allow the passage of air to prevent excessive vacuum developing in the tank. A reverse flow test shall be performed. A vacuum pump or another suitable device shall be connected to the opening of the air pipe leading to the tank. The flow velocity shall be applied gradually at a constant rate until the float gets sucked and blocks the flow. The velocity at the point of blocking shall be recorded. 80% of the value recorded will be stated in the certificate. Each type and size of vent outlet automatic closing device is to be surveyed and type tested at the manufacturer’s works or other acceptable location.

iii) Testing of Nonmetallic Floats. Impact and compression loading tests are to be carried out on the floats before and after pre-conditioning as follows:
Test temperature °C (°F):

<table>
<thead>
<tr>
<th>Test conditions</th>
<th>-25°C (-13°F)</th>
<th>20°C (68°F)</th>
<th>85°C (185°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>After immersing in water</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>After immersing in fuel oil</td>
<td>NA</td>
<td>Yes</td>
<td>NA</td>
</tr>
</tbody>
</table>

Immersing in water and fuel oil is to be for at least 48 hours.

**Impact Test.** The test may be conducted on a pendulum type testing machine. The floats are to be subjected to 5 impacts of 2.5 N-m (1.844 lbf-ft) each and are not to suffer permanent deformation, cracking or surface deterioration at this impact loading.

Subsequently, the floats are to be subjected to 5 impacts of 25 N-m (18.44 lbf-ft) each. At this impact energy level some localized surface damage at the impact point may occur. No permanent deformation or cracking of the floats is to appear.

**Compression Loading Test.** Compression tests are to be conducted with the floats mounted on a supporting ring of a diameter and bearing area corresponding to those of the float seating with which it is intended that the float shall be used. For a ball type float, loads are to be applied through a concave cap of the same internal radius as the test float and bearing on an area of the same diameter as the seating. For a disc type float, loads are to be applied through a disc of equal diameter as the float.

A load of 3430 N (350 kgf, 770 lbf) is to be applied over one minute and maintained for 60 minutes. The deflection is to be measured at intervals of 10 minutes after attachment of the full load.

The record of deflection against time is to show no continuing increase in deflection and, after release of the load, there is to be no permanent deflection.

**iv) Testing of Metallic Floats.** The above described impact tests are to be carried out at room temperature and in the dry condition.
FIGURE 1
Example of Normal Position (2014)

FIGURE 2
Example of Inclination 40 degrees Opening Facing Upward (2014)
FIGURE 3
Example of Inclination 40 degrees Opening Facing Downward (2014)
1.11 **Overflow Pipes (1998)**

Overflow pipes discharging through the unit’s side are to be located as far above the deepest load line as practicable and are to be provided with non-return valves located on the unit’s side. Where the overflow does not extend above the freeboard deck, there is to be provided in addition an efficient and accessible means for preventing water from passing inboard. Such means may consist of another non-return valve located in an accessible position above the deepest load line. Where it is impracticable to locate the inner valve in an accessible position, one non-return valve with positive means for closing from an accessible position above the freeboard or bulkhead deck will be acceptable, provided there are suitable arrangements to insure the valve not being closed by unauthorized persons and provided a notice is posted in a conspicuous place at the operating station to the effect that the valve is never to be closed, except as may be required in an emergency.

Overflow pipes where provided from combustible and flammable liquid tanks are to be led to an overflow tank of adequate capacity or to a storage tank having space reserved for overflow purposes. An alarm device is to be provided to give warning when the liquid reaches a predetermined level in the overflow tank. If a sight flow glass is also provided in the overflow pipe, then such sight glasses are to be fitted only in vertical sections of overflow pipes and be in readily visible positions.

### 3 Sounding Arrangements

#### 3.1 General

All tanks, except as noted below, are to be provided with separate sounding pipes or with approved tank-level indicating apparatus. Where a tank-level indicating system is used, a supplementary manual means of sounding is to be provided, where practicable, for tanks which are not always accessible.
In general, void compartments adjacent to the sea or to tanks containing liquids, and void compartments through which piping carrying liquids pass are to be fitted with separate sounding pipes, approved tank liquid level indicating apparatus, or be fitted with means to determine if the void tanks contain liquids. Voids as defined above which do not comply with this requirement are to be accounted for in the unit’s stability analysis. See 3-3-2/1.3.4.

3.3 **Sounding Pipes (1993)**

Sounding pipes are not to be less than 38 mm (1.5 in.) inside diameter. Where a sounding pipe exceeds 20 m (65.6 ft) in length, the internal diameter is to be at least 50 mm (2 in.). They are to be led as straight as possible from the lowest part of the tank or compartment to the bulkhead deck or to a position which is always accessible. If sounding pipes terminate below the freeboard deck, they are to be provided with means for closing in the following manner.

3.3.1 **Oil Tanks (2019)**

For oil tanks, with quick-acting, self-closing valves.

3.3.2 **Other Tanks**

For tanks other than oil tanks, with gate valves or a screw cap secured to the pipe with a chain.

Provision is to be made to prevent injuring the unit’s plating by the striking of the sounding rod. In general, sounding pipes are not to pass through bilge wells, but if this is not practicable, the pipe is to be at least Extra Heavy in the bilge well. (See 4-2-1/3.9). Sounding pipes for combustible or flammable fluids are not to terminate in accommodation spaces.

3.3.3 **Ignition of Spillage**

3.3.3(a) **Fuel Oil Tanks (2019)**

Sounding pipes for fuel oil tanks are not to terminate in any space where the risk of ignition of spillage may exist. In particular, they shall not terminate in machinery spaces or in close proximity to internal combustion engines, generators, major electric equipment or surfaces with temperatures in excess of 220°C (428°F) in other spaces. Where it is impracticable to do otherwise, sounding pipes from fuel oil tanks may terminate in machinery spaces, provided the following are met:

i) The sounding pipes terminate in locations remote from ignition hazards or effective precautions such as shielding are taken to prevent fuel oil spillage from coming into contact with a source of ignition;

ii) The terminations of sounding pipes are fitted with quick-acting, self-closing valves and with a small-diameter self-closing test cock or equivalent located below the valve for the purpose of ascertaining that fuel oil is not present before the valve is opened. Provisions are to be made so as to prevent spillage of fuel oil through the test cock from creating an ignition hazard.

iii) (2005) An oil level gauge is provided. However, short sounding pipes may be used for tanks other than double bottom tanks without the additional closed level gauge, provided an overflow system is fitted, see 4-2-3/1.11.

3.3.3(b) **Lubricating Oil Tanks (2019)**

Sounding pipes from lubricating oil tanks may terminate in machinery spaces provided that the following are met:

i) The sounding pipes are to terminate in locations remote from the ignition hazards, or effective precautions, such as shielding, are taken to prevent oil spillage from coming into contact with a source of ignition.
The termination of sounding pipes is fitted with a quick-acting self-closing valve. Alternatively, for lubricating oil tanks that cannot be filled by a pump, the sounding pipes may be fitted with an appropriate means of closure such as a shut-off valve or a screw cap attached by chain to the pipe.

3.5 **Gauge Glasses**

Tanks may be fitted with suitable gauge glasses, provided the gauge glasses are fitted with a valve at each end and adequately protected from mechanical damage.

Tanks containing flammable or combustible fluids are to be fitted with gauge glasses of the flat glass type having approved self-closing valves at each end. For hydraulic oil tanks located in spaces other than Category A machinery spaces, cylindrical gauge glasses with approved self-closing valves at each end will be acceptable, provided such spaces do not contain internal combustion engines, generators, major electrical equipment or piping having a surface temperature in excess of 220°C (428°F).

Tanks integral with the shell which are located below the deepest load waterline may be fitted with gauge glasses, provided they are of the flat glass type having approved self-closing valves at each end.

See 5-1-1/3.9.2.6 for the definition of Category A machinery spaces.

3.7 **Level Indicating Device (1 July 2019)**

Where a level-indicating device or system is provided for determining the level in a tank containing flammable or combustible liquid, failure of the device/system is not to result in the release of the content of the tank through the device. Penetrations for level switches may be used below the tank top provided they are contained in a steel enclosure or other enclosures not being capable of being destroyed by fire. However, level switches are not to be used in place of required level indicating devices. If an overflow is not fitted, means are also to be provided to prevent overfilling of the tank in the event of malfunctioning of the indicating device/system.
1. General Arrangement of Bilge Systems for Surface-Type Units

1.1 General (2012)
A satisfactory pumping plant is to be provided in all units capable of pumping from and draining any compartment when the unit is on an even keel and either upright or listed 5 degrees. For this purpose, wing suction will often be necessary, except in narrow compartments at the ends of the unit. Arrangements are to be made whereby water in the compartment will drain to the suction pipes. Efficient means are to be provided for draining water from all tank tops and other watertight flats. Peak tanks and comparatively small compartments, such as chain lockers, echo sounder spaces and decks over peak tanks, etc., may be drained by ejectors or hand pumps. Where ejectors are used for this purpose, the overboard discharge arrangements are to comply with 4-2-2/23. See also 3-2-4/17.3 of the Marine Vessel Rules. For cases where a suction line is led through the forepeak bulkhead, see 4-2-1/11.17.

Notes:
For the purpose of this Section, comparatively small compartments are those which comply with the following criteria:

a  The volume of the compartment is not to exceed

\[
\frac{(LBD)}{1000}
\]

where \(L, B\) and \(D\) as defined in 4-2-4/9.1.2; and

b  The wetted surface of the compartment, excluding stiffening members, when its volume is half-filled with water is not to exceed 100 m\(^2\) (1076 ft\(^2\))

1.3 Number of Bilge Pumps
At least two power-driven bilge pumps are to be provided, one of which may be attached to the propulsion unit.

1.5 Direct Bilge Suctions (2011)
One of the independent power pumps is to be fitted with a suction led directly from the main machinery-space bilge to the suction valve chest of the pump so arranged that it can be operated independently of the bilge system. The size of this line is to be such that the pump will deliver its full capacity. If watertight bulkheads separate the main machinery space into compartments, such a direct suction is to be fitted to each compartment unless the pumps available for bilge service are distributed throughout these compartments, in which case, at least one pump in each such compartment is to be fitted with a direct suction in its compartment. The direct bilge suction is to be controlled by a stop-check valve.

1.7 Emergency Bilge Suctions (2016)
In addition to the direct bilge suction required by 4-2-4/1.5, emergency bilge suction is to be fitted for the main machinery space for ship-type units 55 m (180 ft) or more in length. The emergency bilge suction is to be directly connected to the largest independently driven pump in the main machinery space, other than the required bilge pumps. Where this pump is not suitable, the second largest suitable pump in the main
machinery space may be used for this service, provided that the selected pump is not one of the required bilge pumps and its capacity is not less than that of the required bilge pump.

The emergency bilge line is to be provided with a suction stop-check valve, which is to be so located as to enable rapid operation and a suitable overboard discharge line. For the emergency bilge inlet, the distance between the open end of the suction inlet and the tank top is to be adequate to allow a full flow of water. The hand wheel of emergency bilge suction valve is to be positioned not less than 460 mm (18 in.) above the floor plates.

In addition, the following arrangements are also to be complied with, as applicable:

i) For internal-combustion-engine propulsion machinery spaces, the area of the emergency bilge suction pipe is to be equal to the full suction inlet of the pump selected.

ii) For steam propulsion machinery spaces, the main cooling water circulating pump is to be the first choice for the emergency bilge suction, in which case, the diameter of the emergency bilge suction is to be at least two-thirds the diameter of the cooling water pump suction.

3 General Arrangement of Bilge Systems for Column-Stabilized Units and Self-Elevating Units

3.1 Permanent Systems
Except as indicated below, all compartments are to have a permanently installed bilge or drainage system. Compartments below the bulkhead deck containing essential equipment for operation and safety of the unit are to be capable of being pumped out by at least two power-driven bilge pumps or equivalent. For column stabilized units, the bilge system in each pump room is to be operable from the central ballast control station.

3.3 Void Compartments
In general, void compartments adjacent to the sea or to tanks containing liquids, and void compartments through which piping conveying liquids pass, are to be drained by permanently installed bilge or drainage systems or by portable means. If portable pumps are used, two are to be provided and both pumps and arrangements for pumping are to be readily accessible. Void compartments as defined above which are not provided with bilge or drainage systems complying with the above are to be accounted for in the unit’s stability analysis. See 3-3-2/1.3.4 and 4-2-2/27.3.

3.5 Chain Lockers
Chain lockers are to be drained by permanently installed bilge or drainage systems or by portable means. Means are to be provided for removal of mud and debris.

3.7 Bilge Alarm
Propulsion rooms and pump rooms in lower hulls of column-stabilized units are to be provided with two independent systems of high bilge water level detection, giving an audible and visual alarm at the central ballast control station.

5 Bilge Piping (All Units)

5.1 General
The arrangement of the bilge pumping system is to be such as to prevent the possibility of water or oil passing into the machinery spaces, or from one compartment to another, whether from the sea, water ballast or oil tanks. The bilge mains are to have separate control valves at the pumps.
5.3 **Installation (2017)**

Bilge pipes passing through compartments intended for the carriage of oil are to be of either steel or wrought iron. Where bilge pipes pass through deep tanks, means are to be provided to prevent the flooding of other spaces in the event of a pipe breaking or joint leaking in the tanks. Such means may consist of an oiltight or watertight tunnel, or making the lines of Extra-Heavy steel pipe (see 4-2-1/3.9) properly installed to take care of expansion and having all joints within the tank welded or extra-heavy flanged joints (e.g., one pressure rating higher). The number of flanged joints is to be kept to a minimum. When a tunnel is not employed and the line runs through a deep tank, bilge pipes are to have non-return valves fitted at the open ends.

5.5 **Manifolds, Cocks and Valves (2012)**

All manifolds, cocks and manually operated valves in connection with the bilge pumping arrangement are to be in positions which are accessible at all times under ordinary circumstances. Where such valves are located in normally unmanned spaces below the assigned load line and which are not provided with high bilge water level alarms, then the valves are to be operable from outside such spaces.

All valves in the machinery space controlling the bilge suctions from the various compartments are to be of the stop-check type. If valves are fitted in the open ends of bilge pipes, they are to be of the non-return type.

Remote control of bilge valves is to be clearly marked at the control station and means are to be provided to indicate whether the valves are open or closed. The indicator is to rely on movement of the valve spindle, or be otherwise arranged with equivalent reliability.

5.7 **Common-main-type Bilge Systems**

Where permitted, this type of system is to have the fore-and-aft piping installed inboard of the assumed penetration zone, as defined in 3-3-2/3.5. The control valves required in the branches from the bilge main are to be accessible at all times and are to be of the stop-check type with an approved type of remote operator. Remote operators may be located in a manned machinery space, or from an accessible position above the freeboard deck, or from underdeck walkways. Remote operators may be of the hydraulic, pneumatic or reach-rod type.

5.9 **Strainers**

Bilge lines in machinery spaces other than emergency suctions are to be fitted with strainers easily accessible from the floor plates and are to have straight tail pipes to the bilges. The ends of bilge lines in other compartments are to be fitted with suitable strainers having an open area of not less than three times the area of the suction pipe. In addition, strainers are to be fitted in accessible positions between the bilge manifolds and the pumps.

5.11 **Gravity Drains**

Gravity drains that penetrate the main machinery space watertight bulkheads below the freeboard deck and terminate within the main machinery space are to be fitted with a valve operable from above the freeboard deck or with quick-acting, self-closing valves. The valve should preferably be located in the main machinery space. When gravity drains from other spaces are terminated in cargo holds, the cargo hold bilge well is to be fitted with a high level alarm. Gravity drains which terminate in spaces which are protected by fixed gas extinguishing systems are to be fitted with means to prevent the escape of extinguishing medium.

5.13 **Bilge Suctions from Hazardous Areas**

Hazardous and non-hazardous areas are to be provided with separate drainage or pumping arrangements.
5.15 **Exceptions**

The bilge arrangements of units intended for restricted or special services will be specially considered in each case.

7 **Bilge Pumps (All Units)**

7.1 **General (2007)**

Sanitary, ballast and general-service pumps may be accepted as independent power bilge pumps, provided they are of the required capacity and are fitted with stop valves so that when a pump is used for one service, the other services can be isolated. Where centrifugal pumps are installed, suitable means for priming are to be provided.

7.3 **Arrangement and Capacity**

Each bilge pump is to be capable of giving a speed of water through the bilge main, required by 4-2-4/9.1 or 4-2-4/9.3, as applicable, of not less than 2 m (6.6 ft) per second. The pump capacity, $Q$, in this case may be determined from the following equation.

\[
Q = \frac{5.66d^2}{10^3} \text{ m}^3/\text{hr}
\]

\[
Q = 16.1d^2 \text{ gpm}
\]

where

\[d = \text{diameter of main-bilge-line suction, mm (in.), required by 4-2-4/9.}\]

When more than two pumps are connected to the bilge system, their arrangement and aggregate capacity are not to be less effective.

9 **Size of Bilge Suctions**

9.1 **Surface-Type Units**

The least internal diameter of bilge suction pipes is to be that of the nearest commercial size within 6 mm (0.25 in.) of the diameter determined by the following equations.

9.1.1 **Main Line**

For the diameter of main-bilge-line suctions and direct bilge suctions to the pumps:

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

\[
d = 1 + \sqrt{L(B + D)/2500} \text{ in.}
\]

9.1.2 **Branch Lines (2012)**

For the equivalent diameter of the combined branch suctions to a compartment:

\[
d = 25 + 2.16\sqrt{c(B + D)} \text{ mm}
\]

\[
d = 1 + \sqrt{c(B + D)/1500} \text{ in.}
\]

where

\[d = \text{internal diameter of pipe, in mm (in.)}
\]

\[L = \text{length of unit, in m (ft)}\]


\[ B = \text{breadth of unit, in m (ft)} \]
\[ D = \text{molded depth to bulkhead or freeboard deck, in m (ft)} \]
\[ c = \text{length of compartment, in m (ft)} \]

\( L, B, \) and \( D \) are defined in Section 3-1-1 of the Marine Vessel Rules for ship-type units and Section 3-1-1 of the Barge Rules for barge-type units.

Note:
For comparatively small compartments as defined in 4-2-4/1.1, the equation in 4-2-4/9.3.2 may be used as an alternative in the calculation of the required size of branch lines.

9.1.3 Main Line Reductions
In units where engine room bilge pumps are fitted primarily for drainage within the engine room, \( L \) may be reduced by the combined length of the tanks. In such cases, the cross sectional area of the bilge main is not to be less than twice the required cross sectional area of the engine room branch lines.

9.1.4 Size Limits
No main suction piping is to be less than 63 mm (2.5 in.) internal diameter. No branch piping need be more than 100 mm (4 in.) I.D., nor is it to be less than 51 mm (2 in.) I.D. in diameter, except that for drainage of small pockets or spaces 38 mm (1.5 in.) I.D. pipe may be used.

9.3 Column-Stabilized Units and Self-Elevating Units
9.3.1 Main Line (2018)
The cross sectional area of the bilge main is not to be less than the combined areas of the two largest required branch suctions.

9.3.2 Branch Lines
The size of branch suctions and drains from each compartment is not to be less than that determined from the following equation:

\[ d = [2.15\sqrt{A} + 25] \text{ mm} \]

\[ d = [\sqrt{A}/1500 + 1] \text{ in.} \]

where

\( d = \text{internal diameter of the branch suction to the nearest 5 mm (0.20 in.)} \)
\( A = \text{wetted surface in m}^2 \text{ (ft}^2) \text{ of} \)

\( i) \) Single compartment drained by the branch suction, excluding stiffening members, when the compartment is half-filled.

\( ii) \) The two largest compartments, excluding stiffening members, when the compartments are half-filled where multiple compartments are drained together.

9.3.3 Size Limits
The internal diameter of any bilge line is not to be less than 50 mm (2 in.).
11 Ballast Piping (All Units)

11.1 General
The arrangement of the ballast pumping system is to be such as to prevent the possibility of water or oil passing into the machinery spaces, or from one compartment to another, whether from the sea, water ballast or oil tanks. The ballast mains are to have separate control valves at the pumps.

11.3 Installation (2017)
Ballast pipes passing through compartments intended for the carriage of oil are to be either steel or wrought iron. Where ballast pipes pass through deep tanks, means are to be provided to prevent the flooding of other spaces in the event of a pipe breaking or joint leaking in the tanks.

Such means may consist of an oiltight or watertight tunnel, or making the lines of Extra-Heavy steel pipe (see 4-2-1/3.9) properly installed to take care of expansion and having all joints within the tank welded or extra-heavy flanged joints (e.g., one pressure rating higher). The number of flanged joints is to be kept to a minimum.

11.5 Controls for Ballast Tank Valves
Ballast tank valves are to be arranged so that they will remain closed at all times, except when ballasting. For this purpose, manual screw thread operated valves or positive holding arrangements for butterfly type valves or other approved arrangement will be accepted. Where installed, remote controlled valves are to be either arranged so that they will close and remain closed upon loss of control power or arranged so they will remain in their last position and are provided with a readily accessible manual means of closing in case of loss of power to the valve control system. Remote control of ballast valves is to be clearly marked at the control station and means are to be provided to indicate whether the valve is open or closed.

11.7 Exceptions
The ballast arrangements of units intended for restricted or special services will be specially considered in each case.

11.9 Ballast Water Treatment Systems (1 July 2012)
Where a ballast water treatment system is to be installed, it is to comply with the requirements in 5 of the ABS Guide for Ballast Water Treatment and the same is to be verified by ABS.

13 Ballasting Systems for Column-Stabilized Units

13.1 General
The ballast system is to be designed and arranged such that the system can take suction from and deballast any ballast tank under normal operating and transit conditions. The system is to be capable of restoring the unit to a normal operating or transit draft and a level trim condition, when subject separately to each of the following:

\[ i) \] The assumed damaged conditions as specified in 3-3-2/1.3.2(a) with any one pump inoperable.

\[ ii) \] The flooding specified in 3-3-2/1.3.2(b).

In addition, the system is to be capable of raising the unit, starting from a level trim condition at deepest normal operating draft, either a distance of 4.6 m (15 ft) or to the severe storm draft, whichever distance is greater, within three hours (calculations are to be submitted). The ballasting procedure is to be submitted for information and is to be provided to the unit’s operating personnel.
13.3 Manifolds

Ballast suctions are to be led from readily accessible manifolds unless independent pumps are provided for each tank. Ballast systems are to be arranged to prevent the inadvertent transfer of ballast water from one quadrant to any other quadrant of the unit.

13.5 Pumps

13.5.1 Number

In general, at least two independent ballast pumps are to be capable of taking suction on each ballast tank. In the case of units with two lower hulls, each hull is to be provided with at least two independently driven ballast pumps. Units with more than two lower hulls or of unusual configuration will be subject to special consideration.

13.5.2 Pump Performance (2012)

At least two pumps are to be capable of effectively emptying each intact tank at maximum normal operating draft when the unit is subject to the assumed damage conditions specified in 3-3-2/1.3.2. [Note: Loss of a pump(s) due to flooding of a pump room is to be considered in meeting this requirement.] Each of the pumps utilized in meeting the above requirement is to have adequate head/capacity characteristics and available net positive suction head (NPSHa) to operate at the angles of heel and trim associated with the conditions specified in 3-3-2/1.3.2 at a capacity of not less than 50% of the capacity required from that pump to meet the criteria of 4-2-4/13.1. Counterflooding is not to be considered as a means to improve the suction head available to the ballast pumps.

Pump data and calculations substantiating compliance with this requirement are to be submitted. The use of submersible pumps will be subject to special consideration.

13.7 Ballast Control Features (1995)

13.7.1 Centralized Control Station (1995)

13.7.1(a) Location.

A centralized control station is to be provided. It is to be located above the worst damage waterline and in a space clear of the assumed extent of damage specified in 3-3-2/3.5.2, protected from weather and readily accessible when the unit is subjected to the severe storm and damage, as defined in 3-3-2/1.3.1 and 3-3-2/1.3.2.

13.7.1(b) Controls and Indications (2012).

The central ballast control station is to be fitted with the following control and indicating systems, having appropriate audible and visual alarms.

i) Ballast pump control system
ii) Ballast pump status indicating system
iii) Ballast valve control system
iv) Ballast valve position indicating system
v) Draft indicating system
vi) Tank level indicating system
vii) Heel and trim indicators
viii) Electric power availability system (main and emergency)
ix) Ballast control hydraulic or pneumatic pressure indicating system, where applicable.
x) Bilge system in each pump room. See 4-2-4/3.1
Bilge alarms of propulsion and pump rooms in lower hulls. See 4-2-4/3.7.

13.7.1(c) Communication.

A means of communication, which is independent of the unit’s service electrical system, is to be provided between the central ballast control station and those spaces containing the local controls for ballast pumps and associated ballast valves.

13.7.1(d) Back-up Station.

Back-up station is not required but if fitted, it is to comply with the requirements in 4-2-4/13.7.1(a) and 4-2-4/13.7.1(c), except that the back-up station need not be located above the worst damaged waterline.

13.7.2 Independent Local Control (1995)

All ballast pumps and valves are to be fitted with independent local control operable in the event of failure of the remote control from the central ballast control station. These independent local controls need not be power operated. The independent local controls for each ballast pump and its associated valves are to be from the same location. For communication, see 4-2-4/13.7.1(c).

13.7.3 Safety Features (1995)

13.7.3(a) Independency

i) All Systems. The systems listed in 4-2-4/13.7.1(b) are to function independently of one another or have sufficient redundancy so that a failure in one system does not jeopardize the operation of any of the other systems.

ii) Pump/Valve Control Systems. The ballast pump and ballast valve control systems are to be arranged such that loss of any one component will not cause loss of operation of the other pumps or valves. This requirement will not apply to those parts of a control system dedicated to a single ballast valve nor will it apply to manifolds serving exclusively those dedicated systems.

13.7.3(b) Dual Power Source.

For those systems listed in 4-3-2/5.3.10(a), the source of any electrical power is to comply with the requirements in 4-3-2/5.3. Where the power source is pneumatic or hydraulic, there are to be at least two power units designed to function at the inclination angles in 4-3-2/5.5.1.

13.7.3(c) Disconnects (2012).

Means are to be provided at the central ballast control station to isolate or disconnect the ballast pump control and ballast valve control systems from their sources of electrical, pneumatic or hydraulic power.

13.7.3(d) Electronic Systems.

Where microprocessor, computer-operated or multiplex type systems form part of the control system, they are to have back-up capability for continued operation upon loss of any single major component.

13.7.3(e) Valve Controls.

The ballast valve control system is to be designed and arranged so that there is not continuing transfer of ballast upon loss of power. See also 4-2-4/13.3. Ballast tank valves are to close automatically upon loss of power. They are to remain closed upon reactivation of control power until they are intentionally opened.
13.7.4 Valve Position Indicating Systems (2012)

A means to indicate whether a valve is open or closed is to be provided at each location from which the valve may be controlled. The indicators are to rely on movement of the valve spindle or be otherwise arranged with equivalent reliability.

13.7.5 Draft Indicating System (1995)

The draft indicating system is to indicate the draft at each corner of the unit.

13.7.6 Tank Level Indicating System (1995)

The tank level indicating system is to indicate the liquid levels in all ballast tanks and in other tanks, such as fuel oil, fresh water, drilling water or liquid storage tanks, the filling of which could affect the stability of the unit. Tank level sensors are not to be located in the tank suction lines.

A secondary means of determining levels in ballast tanks, which may be a sounding pipe, is also to be provided.
Fuel Oil System – General

1.1 Arrangement (1994)

1.1.1 Tanks (2011)

1.1.1(a) Structural Tanks (1 July 2019)

As far as practicable, fuel-oil tanks are to be part of the structure and located outside of machinery spaces of Category A. Where fuel-oil tanks, other than double bottom tanks, are necessarily located adjacent to or within machinery spaces of Category A, the arrangements are to reduce the area of the tank boundary common with the machinery space of category A to not more than two sides and to comply with the following:

i) Fuel tanks having boundaries common with machinery spaces of category A are not to contain fuel oils having flash point of 60°C (140°F) or less.

ii) At least one of their vertical sides is to be contiguous to the machinery space boundary. The arrangements in 4-2-5/1.1.1.iii Figure 1 are acceptable for structural tanks provided the requirements of 4-2-5/11 are complied with. (The side shell is not being included in contiguous boundary of the category A machinery space.)

iii) The bottom of the fuel oil tank is not to be so exposed that it will be in direct contact with flame should there be a fire in a Category A machinery space. The fuel tank is to extend to the double bottom. Alternatively, the bottom of the fuel oil tank is to be fitted with a cofferdam. The cofferdam is to be fitted with suitable drainage arrangements to prevent accumulation of oil in the event of oil leakage from the tank.

FIGURE 1
Acceptable Fuel Oil Tanks Arrangements Inside Category A Machinery Spaces (2013)
1.1.1(b) Free Standing Tanks.

In general, the use of free standing fuel oil tanks is to be avoided. Where permitted, they are to be placed in an oil-tight spill tray of ample size with adequate means of drainage, in accordance with 4-2-1/11.33.1.

1.1.2 Spillage (2011)

No fuel oil tank is to be situated where spillage or leakage therefrom can constitute a hazard by falling on heated surfaces or electrical equipment. Precautions are to be taken to prevent any oil that may escape under pressure from any pump, filter or heater from coming into contact with heated surfaces.

1.1.3 Sounding Arrangements

See 4-2-3/3, as applicable.

1.1.4 Service and Settling Tanks (2012)

At least two fuel oil service tanks are to be provided for propulsion and essential services. The capacity, with one service tank unavailable, is to be sufficient for at least eight hours operation of the propulsion plant, if any, at maximum continuous rating and the generator plant (excluding emergency generator) at the normal sea load. See also 4-2-3/1.9.3.

Where the propulsion plant and auxiliary machinery are supplied by different service tanks, or where more than one type of fuel is used onboard the unit, the number and capacity of the fuel oil service tanks is to be sufficient such that the propulsion plant, including all auxiliary machinery vital for propulsion, and the generator plant have both a main fuel oil supply and a back-up fuel oil supply. The capacity of the tanks, with one service tank unavailable, is to be sufficient to provide the machinery it serves with enough fuel oil for at least eight hours operation, as required above.

Alternatives equivalent to the above arrangements will be considered.

A service tank is a fuel tank which contains only fuel of a quality ready for use, that is, fuel of a grade and quality that meets the specification required by the equipment manufacturer. A service tank is to be declared as such and is not to be used for any other purpose.

1.3 Piping, Valves and Fittings

Fuel oil pipes, valves and fittings are to be of steel or other approved materials.

1.5 Oil Heating Arrangements (1994)

1.5.1 Oil Heaters

Where steam heaters or heaters using other heating media are provided in fuel oil systems they are to be fitted with a temperature control and either a high temperature alarm or a low flow alarm, except where the maximum temperature of the heating medium does not exceed 220°C (428°F).

Where electric heaters are fitted, they are to be arranged to de-energize automatically when the oil level falls to a predetermined level to ensure that the heating elements are permanently submerged during operation. In addition, a safety temperature switch with a manual reset independent from the automatic control sensor is to be provided to cut off the electric power supply in order to avoid a surface temperature in excess of 220°C (428°F).

1.5.2 Tanks

Unless specially approved otherwise, fuel oil in storage tanks is not to be heated to temperatures within 10°C (18°F) below the flash point of the fuel oil.
Where heating arrangements are provided, the control and alarm requirements of 4-2-5/1.5.1 are applicable.

1.7 Fuel Oil Purifiers (1997)
Where fuel oil purifiers for heated oil are installed, the arrangement is to be in accordance with 5-3-1/11.

# Fuel-oil Transfer and Filling

3.1 General
The fuel-oil pumping arrangements are to be distinct from the other pumping systems as far as practicable, and the means provided for preventing dangerous interconnection in service are to be thoroughly effective.

3.3 Heating Coils
When heating coils are fitted, and oil leakage into the returns could contaminate the boiler feed water, provision is to be made to detect this leakage by running the returns from the heating coils to an inspection tank or other approved oil detector before being led to the boiler feed system.

3.5 Pipes in Oil Tanks
Oil pipes and other pipes, where passing through oil tanks, are to be of steel, except that other materials may be considered where it is demonstrated that the material is suitable for the intended service. All packing is to be of a composition not affected by oil.

3.7 Control Valves or Cocks
Valves or cocks controlling the various suctions are to be located close to the bulkhead where the suctions enter the machinery spaces and, wherever practicable, directly over the gutterway in way of deep and settling tanks. Pumps, strainers, etc., requiring occasional examination are to have drip pans.

3.9 Valves on Oil Tanks (2015)
3.9.1 Required Valves
Where pipe lines emanate from fuel oil tanks at such a level that they will be subjected to a static head of oil from the tank, they are to be fitted with positive closing valves. The valves are to be secured at the tank. A short length of Extra Strong pipe connecting the valve to the tank is also acceptable. Where the fuel oil piping passes through adjacent tanks, the valve required above may be located where the pipe run exits the adjacent tank(s) provided the piping in the adjacent tanks is Extra-Heavy and has all welded connections. However, if the adjacent tank is a fuel oil tank, the pipe run within the fuel oil tank is to be at least Standard thickness.

If the valves are installed on the outside of the tank, they are not to be of cast iron. The use of nodular iron, also known as ductile iron or spheroidal-graphite iron, will be accepted, provided the material has an elongation not less than 12%. Arrangements are to be provided for closing them at the valve and for tanks having a capacity of 500 liters (132 U.S. gal.) or greater, from a readily accessible and safe location outside of the compartment in which the valve is located. If the positive closing valve required above is situated in a shaft tunnel or pipe tunnel or similar space, arrangements for closing may be effected by means of an additional valve on the pipe or pipes outside of the tunnel or similar space. If such an additional valve is fitted in the machinery space it is to be operated from a position outside of this space. Where independent filling lines are fitted, they are to enter at or near the top of the tank, but if this would be impracticable, they are to be fitted with non-return valves at the tank. Also see 5-3-1/7.5.

3.9.2 Remote Means of Closure
The valves required above may be remotely operated by reach rods or by electric, hydraulic or pneumatic means. The source of power to operate these valves is to be located outside of the space
in which the valves are located. The positioning of the valve by either local or remote means is not to interfere with the ability of the other means to close the valve. This remote means of closure is to override all other means of valve control.

The controls for the remote means of closure of the valves of the emergency generator fuel tank and the emergency fire pump fuel tank, as applicable, are to be grouped separately from those for other fuel oil tanks.

Remote operation of readily accessible normally closed tank valves in open ended service such as sampling or drains, is not required if the valves are fitted with blind, plug, or cap.

Where tanks are supplying fuel to diesel engines of essential or emergency services, the use of an electric, hydraulic or pneumatic system to keep the valve directly in the open position is not acceptable. Materials readily rendered in effective by heat are not to be used in the construction of the valves or the closure mechanism within the space unless adequately protected to ensure effective closure facility in the event of fire. If electric cables are utilized, they are to be fire-resistant, meeting the requirements of IEC 60331. See 4-3-4/7.

Hydraulic systems are to be in accordance with 4-2-6/3 for both Class I and II piping systems. For a pneumatic system, the air supply may be from a source from within the space, provided a separate receiver complying with the following is located outside of the space.

1) Sufficient capacity to close all connected valves twice
2) Fitted with low air pressure alarm
3) Air supply line is fitted with a non-return valve adjacent to the receiver

5 Fuel-oil Service System for Boilers

Where boilers are located in machinery spaces, they are to be fitted with guard plates and drip pans in way of furnaces. Boilers installed for the purpose of providing power for auxiliaries are to have at least two means of feeding and two fuel-oil service pumps. The construction of all boilers is to comply with the requirements of Section 4-4-1 and Appendix 4-4-1-A1 of the Marine Vessel Rules.

7 Fuel-oil Service System for Internal Combustion Engines

7.1 Fuel-oil Pumps and Oil Heaters

7.1.1 Transfer Pumps
Two fuel-oil transfer pumps are to be provided and one of them is to be independent of the main engine.

7.1.2 Booster Pumps
A standby fuel-oil booster pump is to be provided for main engines having independently driven booster pumps. For main engines having attached booster pumps, a complete pump may be carried as a spare in lieu of the standby pump.

7.1.3 Heaters
When fuel-oil heaters are required for main engine operation, at least two heaters of approximately equal size are to be installed. The combined capacity of the heaters is to be not less than that required to supply the main engine(s) at full power.

7.3 Oil Tanks and Drains for Fuel Oil Systems (1994)

Drain tanks for waste oil, fuel oil overflows, drains from fuel and lube oil drip pans, and fuel injection piping, etc. are to be fitted with air and sounding pipes. Non-return valves are to be fitted in drain lines
entering the drain tanks, except where backflow would not present a hazard. Suitable means are to be provided for pumping out these drain tanks.

Oil tanks not forming a part of the unit’s structure, where permitted by 4-2-5/1.1.1, are to have suitable drip pans with adequate means of drainage, in accordance with 4-2-1/11.33.1.

7.5 Fuel-oil Pressure Piping

Pipes from booster pumps to injection systems are to be at least Standard seamless steel (see 4-2-1/3.9). Pipes conveying heated oil are to be at least Standard seamless or electric resistance welded steel. ERW pipe is to be straight seam and fabricated with no filler metal (e.g., ABS Grade 2 or 3 ERW). Valves and fittings may be screwed in sizes up to and including 60 mm O.D. (2 in. N.P.S.), but screwed unions are not to be used on pressure lines in sizes 33 mm O.D. (1 in. N.P.S.) and over. Valves are to be so constructed as to permit packing under pressure.

7.7 Fuel-oil Injection System (1994)

7.7.1 General

Strainers are to be provided in the fuel-oil injection-pump suction line. For main propulsion engines, the arrangement is to be such that the strainers may be cleaned without interrupting the fuel supply to the engine. For auxiliary engines, the arrangement is to be such that the strainers may be cleaned without undue interruption of power necessary for propulsion. Multiple auxiliary engines, each fitted with a separate strainer and arranged such that changeover to a standby unit can be accomplished without loss of propulsion capability, will be acceptable for this purpose.

Where strainers are fitted in parallel to enable cleaning without disrupting the oil supply, means are to be provided to minimize the possibility of a strainer under pressure being opened inadvertently. Strainers are to be provided with suitable means for venting when being put in operation and being depressurized before being opened. Valves or cocks with drain pipes led to a safe location are to be used for this purpose. Strainers are to be so located that in the event of leakage, oil cannot be sprayed onto the exhaust manifold or surfaces with temperatures in excess of 220°C (428°F).

Cut-out valves are to be located at the service tanks and be so arranged as to be operable from the engine-room floor plates and, where considered necessary, from outside the engine compartment. See also 4-2-5/3.9. The injection line is to be of seamless drain pipe and fittings are to be extra heavy. The material used may be either steel or nonferrous, as approved in connection with the design.

7.7.2 Piping Between Injection Pump and Injectors (2012)

See 6-1-3/3.1.

7.9 Piping Between Booster Pump and Injection Pumps (2005)

Spray shields are to be fitted around flanged joints, flanged bonnets and any other flanged or threaded connections in fuel oil piping systems under pressure exceeding 1.8 bar (1.84 kgf/cm², 26 psi) which are located above or near units of high temperature, including boilers, steam pipes, exhaust manifolds, silencers or other equipment required to be insulated by 5-3-1/11.i, and to avoid, as far as practicable, oil spray or oil leakage into machinery air intakes or other sources of ignition. The number of joints in such piping systems is to be kept to a minimum.

7.10 Isolating Valves in Fuel Supply and Spill Piping (2015)

In multi-engine installations which are supplied from the same fuel source, a means of isolating the fuel supply and spill (return) piping to individual engines is to be provided. The means of isolation is not to affect the operation of the other engines and is to be operable from a position not rendered inaccessible by a fire on any of the engines.
9 Low Flash Point Fuels *(1994)*

### 9.1 General

Fuel oils with a flash point of 60°C (140°F) closed cup or below may be accepted for the following:

9.1.1 Units classed for restricted service within areas having a climate ensuring that ambient temperatures of spaces where such fuel oil is stored will not rise within 10°C (18°F) below its flash point may use fuel oil with flash point of 60°C (140°F) or below, but not less than 43°C (110°F).

9.1.2 Installations complying with the ABS Guide for Burning Crude Oil and Slops in Main and Auxiliary Boilers, regarding the use of crude oil as fuel.

9.1.3 *(2012)*

For emergency generators or emergency fire pump prime movers, fuel oil with a flash point of not less than 43°C (110°F) may be used, subject to the following:

i) Fuel oil tanks except those arranged in double bottom compartments are located outside of machinery spaces of category A.

ii) Provisions for measurement of oil temperature are provided on the suction pipe of oil fuel pump.

iii) Stop valves and/or cocks are provided on the inlet side and outlet side of the fuel oil strainers.

iv) Pipe joints of welded construction or of circular cone type or spherical type union joint are applied as much as possible.

See 4-3-2/5.5.2.iii

### 9.3 Fuel Heating

For oil heating arrangements, see 4-2-5/1.5.2.

### 9.5 Fuel-tank Vents

Vent pipes are to extend at least 1 m (3 ft) above the operating deck unless otherwise required by damage stability considerations or the International Convention on Load Lines.

11 Additional Measures for Oil Pollution Prevention *(2010)*

#### 11.1 General

11.1.1 Application

The requirements of 4-2-5/11 provide the arrangement of fuel oil tanks location for compliance with MARPOL 73/78, as amended. They are to be applied to all types of mobile offshore units classed with ABS.

11.1.2 Submission of Plans

Plans showing compliance with the applicable requirements in 4-2-5/11.3 are to be submitted for review.
11.3 Tank Protection Requirements

11.3.1 General (2014)

The requirements of 4-2-5/11 apply to mobile offshore units having an aggregate fuel oil capacity (including tanks of 30 m$^3$ (1060 ft$^3$) or less) of 600 m$^3$ (21190 ft$^3$) and above. However, the requirements need not be applied to individual fuel oil tanks with a capacity not greater than 30 m$^3$ (1060 ft$^3$), provided that the aggregate capacity of such excluded tanks is not greater than 600 m$^3$ (21190 ft$^3$). Further, individual fuel oil tanks are not to have capacity greater than 2500 m$^3$ (88290 ft$^3$).

Fuel oil tanks of any volume are not to be used for ballast water.

Fuel oil tank means a tank in which fuel oil is carried, but excludes those tanks which would not contain fuel oil in normal operation, such as overflow tanks. Fuel oil capacity means the volume of a tank in cubic meters (cubic feet) at 98% tank filling.

Fuel oil means any oil used as fuel in connection with the propulsion and auxiliary machinery of the unit in which such oil is carried.

11.3.2 Protective Location of Tanks

The protective locations for the tanks specified in 4-2-5/11.3.1 above are to be as follows:

11.3.2(a) Deterministic Approach.

All applicable tanks are to be located not less than the distance as specified in 4-2-5/11.3.2(a)i), ii) and iii), as relevant, from the unit’s bottom or side shell plating. Small suction wells may extend below fuel oil tank’s bottom if they are as small as possible and the distance between the unit’s bottom plate and the suction well bottom is not reduced by more than half of the distance required by 4-2-5/11.3.2(a)i.

i) For all mobile offshore units, except of the self-elevating type, having an aggregate fuel oil capacity of 600 m$^3$ (21190 ft$^3$) and above, all tanks, including those in the unit’s pontoons, are to be arranged above the unit’s molded line of bottom shell plating at the distance $h$ as specified below:

$$h = B/20 \text{ m (ft)},$$

$$h = 2.0 \text{ m (6.6 ft), whichever is smaller}$$

where

$B$ is the breadth of the unit or, if applicable, the pontoon, in m (ft).

$h$ is in no case to be less than 0.76 m (2.5 ft).

ii) For all mobile offshore units having an aggregate fuel oil capacity greater than or equal to 600 m$^3$ (21190 ft$^3$) but less than 5000 m$^3$ (176570 ft$^3$), tanks are to be arranged inboard of the molded line of side plating not less than the distance $w$ as specified below:

$$w = 0.4 + 2.4C/20000 \text{ m}$$

$$w = 1.31 + 7.87C/706290 \text{ ft}$$

where
For all mobile offshore units having an aggregate fuel oil capacity of 5000 m³ (176570 ft³) and above, tanks are to be arranged inboard of the molded line of side plating not less than the distance \( w \), as specified below:

\[
\begin{align*}
  \text{iii) } \quad w &= 0.5 + \frac{C}{20000} \text{ m} \\
  \quad w &= 1.64 + \frac{C}{706290} \text{ ft}, \text{ or} \\
  \quad w &= 2.0 \text{ m (6.6 ft), whichever is smaller}
\end{align*}
\]

where \( C \) is the unit’s total volume of fuel oil (including tanks of 30 m³ or less) in m³ (ft³) at 98% tank filling.

The minimum value of \( w = 1.0 \text{ m (3.3 ft)} \).

iv) When applying 4-2-5/11.3.2(a) to column-stabilized units, the tank protection specified by paragraphs 4-2-5/11.3.2(a).ii and by 4-2-5/11.3.2(a).iii applies only to those areas subject to damage as per 3-3-2/3.5.2.

11.3.2(b) Probabilistic Approach.

As an alternative to the deterministic approach of 4-2-5/11.3.2(a), arrangements complying with the level of protection for both side and bottom damage in accordance with the accidental oil fuel outflow performance standard of Regulation 12A, Annex I, MARPOL 73/78, as amended, are acceptable.

13 Class Notation – POT (2018)

In addition to the requirements for fuel oil tank protection as specified in 4-2-5/11.1 utilizing the deterministic approach of 4-2-5/11.3.2(a), where lubricating oil tanks with a capacity greater than 30 m³ (1060 ft³) (other than tanks for lubricating oil under main engines) are also arranged in the same manner as required by the deterministic approach [4-2-5/11.3.2(a)] for fuel oil tanks, mobile offshore units are to be eligible for the optional Class notation, POT – Protection of Fuel and Lubricating Oil Tanks. Further, the following exemptions are applicable to lubrication oil tanks:

i) In application of equation in 4-2-5/11.3.2(a).ii or 4-2-5/11.3.2(a).iii, total volume of lubricating oil tanks need not be accounted for \( C \) (unit’s total volume of oil fuel in m³ (ft³) at 98% tank filling).

ii) Tanks used as propulsion engine lubricating oil drain tanks need not be located in a protected location away from the vessel’s side or bottom plates.
PART 4
CHAPTER 2  Pumps and Piping Systems
SECTION 6  Other Piping Systems and Tanks

1  Lubricating-oil Systems

1.1 General (2011)

The lubricating-oil piping is to be entirely separated from other piping systems. In addition, the requirements of 4-2-5/1.1.2, 4-2-5/1.3, and 4-2-5/1.5 are applicable.

Normally opened valves on lubricating oil tanks are to comply with the same requirements as those for fuel oil tanks given in 4-2-5/3.9. However, arrangements for remotely closing the valve from a position outside of the compartment need not be provided if inadvertent valve closure could result in damage to the running machinery due to lack of lubricating-oil. Where the machinery is arranged for automatic shutdown upon loss of lubricating-oil, the valve required by 4-2-5/3.9 is to be provided with means to close it from a readily accessible and safe location outside of the compartment in which the valve is located.

For ship-type units, the lubricating systems are to be so arranged that they will function satisfactorily under the conditions specified in 4-1-1/7.

1.3 Sight Flow Glasses (2018)

Sight flow glasses may be fitted only in the vertical sections of lubricating oil overflow pipes, provided that it is in a readily visible position.

1.5 Turbines and Reduction Gears

For turbines and their reduction gears, see 4-6-6/9.7.1 and 4-6-6/9.3.1 of the Marine Vessel Rules.

1.7 Internal Combustion Engines and Reduction Gears

Lubricating-oil systems for internal-combustion engines and their reduction gears are to be in accordance with the following.

1.7.1 Lubricating-oil Pumps (1993)

In cases where forced lubrication is used for propulsion engines and reduction gears, one independently driven stand-by pump is to be provided in addition to the necessary pumps for normal operation. Two separate means are to be provided for water circulation where oil coolers are fitted (see 4-2-6/11.7). Where the size and design of an engine is such that lubrication before starting is not necessary and an attached pump is normally used, an independently driven stand-by pump is not required if a complete duplicate of the attached pump is carried as a spare. The above requirements are applicable to diesel propulsion engines and for reduction gears associated with single diesel propulsion engines with a maximum operating speed above 400 RPM driving a single shaft (single and multiple screw). For reduction gears associated with diesel propulsion engines with a maximum operating speed of 400 RPM and below and reduction gears associated with multiple diesel engines driving a single shaft (single and multiple screw), see 4-6-5/5.3.1 of the Marine Vessel Rules.
1.7.2 Filters (1998)

Oil filters are to be provided. In the case of main propulsion engines which are equipped with full-flow-type filters, the arrangements are to be such that the filters may be cleaned without interrupting the oil supply. For auxiliary engines, the arrangement is to be such that the filters may be cleaned without undue interruption of power necessary for propulsion. Multiple auxiliary engines, each fitted with a separate filter and arranged such that change over to a standby unit can be accomplished without loss of propulsion capability, will be acceptable for this purpose. The arrangement of the valving is to be such as to avoid release of debris into the lubricating-oil system upon activation of the relieving mechanism.

Where filters are fitted in parallel to enable cleaning without disrupting the oil supply, means are to be provided to minimize the possibility of a filter under pressure being opened inadvertently. Filters are to be provided with suitable means for venting when being put in operation and being depressurized before being opened. Valves and cocks with drain pipes led to a safe location are to be used for this purpose. Filters are to be so arranged as to prevent, in the event of leakage, spraying of oil onto the exhaust manifold and surfaces with temperatures in excess of 220°C (428°F).

1.7.3 Low-oil-pressure Alarm (2017)

An alarm device with audible and visual signals for failure of the lubricating-oil system is to be fitted for propulsion and auxiliary engines having a rated power greater than 37 kW (50 hp).

1.7.4 Drain Pipes (1997)

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

No interconnection is to be made between the drain pipes from the crankcases of two or more engines.

1.9 Electrical Machinery

For electrical machinery, see also 4-3-3/3.3, 4-3-3/3.5.1 and 4-3-3/3.13.

3 Hydraulic Systems

3.1 General (2012)

The arrangements for Class I and II hydraulic piping systems are to be in accordance with the requirements of this section, except that hydraulic systems which form part of an independent device or equipment not covered by these Rules and which does not form part of the unit’s piping system (such as a crane) are not covered by this Section, unless it is relevant to an optional notation or certification requested for the unit. Plans showing clearly the arrangements and details are to be submitted for review. The requirements for fuel oil tanks contained in 4-2-5/1.1.2 and 4-2-5/1.3 are also applicable for tanks containing hydraulic fluid.

3.3 Valves

3.3.1 General

In general, valves are to comply with the requirements of 4-2-2/9 and 4-2-2/17.

3.3.2 Relief Valves

Relief valves are to be provided for the protection of the hydraulic system. Each relief valve is to be capable of relieving not less than full pump flow with a maximum pressure rise of not more than 10% of the relief valve setting.
3.5 **Piping**

Piping is to meet the requirements of 4-2-1/9 and 4-2-2/5, except that mill tests need not be witnessed by the Surveyor. In such cases, mill certificates are to be provided.

3.7 **Pipe Fittings**

Fittings and flanges are to meet the requirements of 4-2-2/11 and 4-2-2/15, except as follows.

3.7.1 **Non-standard Fittings**

Fittings which are not constructed to a recognized standard will be subject to special consideration. Plans showing details of construction, material and design calculations or test results are to be submitted for review.

3.7.2 **Split Flanges (2004)**

Split flanges are not to be used in steering gear systems and certified thruster systems for propulsion or station keeping service. The use of split flanges for all other applications will be specially considered.

3.7.3 **Straight Thread O Ring Connections**

Straight thread O ring type connections may be used for connections to equipment such as pumps, valves, cylinders, accumulators, gauges and hoses. Such connections are not to be used for joining sections of pipe.

3.7.4 **Tapered Threaded Connections**

Tapered threaded connections up to and including 89 mm O.D. (3 in. N.P.S.) may be used without limitation for connections to equipment such as pumps, valves, cylinders, accumulators, gauges and hoses.

Such connections are not to be used for joining sections of pipe, except where permitted by 4-2-2/11.1.

3.9 **Flexible Hoses**

Hose assemblies are to be in accordance with 4-2-1/11.29.

3.11 **Accumulators (2018)**

Accumulators are to meet the requirements of 4-6-7/3 of the Marine Vessel Rules. Each accumulator which may be isolated is to be protected by suitable relief valves. Where a gas charging system is used, a relief valve is to be provided on the gas side of the accumulator.

3.13 **Fluid Power Cylinders**

Fluid power cylinders are to meet the requirements of 4-2-2/19.

3.15 **Design Pressure**

The pressure used for determining the strength and design of piping and components is not to be less than the relief valve setting.

3.17 **Segregation of High Pressure Hydraulic Units (2012)**

Hydraulic units with maximum working pressures above 15.5 bar (15.8 kgf/cm², 225 psi) installed within machinery spaces are to be placed in separate room or rooms or shielded as necessary to prevent any oil or oil mist that may escape under pressure from coming into contact with surfaces with temperatures in excess of 220°C (428°F), electrical equipment or other sources of ignition. For the purposes of this requirement, a hydraulic unit includes the power pack and all components of the hydraulic piping system.
5 Fixed Oxygen-Acetylene Installations

5.1 Application (2005)
Provisions of 4-2-6/3 apply to fixed oxygen-acetylene installations that have two or more cylinders of oxygen and acetylene, respectively. Spare cylinders of gases need not be counted for this purpose. Provisions of 4-2-6/5.5 and 7-1-4/41.9, as applicable, are to be complied with for fixed installations regardless of the number of cylinders.

5.3 Gas Storage
5.3.1 Storage of Gas Cylinders
5.3.1(a) Storage room.
The gas cylinders are to be stored in rooms dedicated for this purpose only. A separate room is to be provided for each gas. The rooms are to be on or above the upper-most continuous deck and are to be constructed of steel. Access to the rooms is to be from the open deck and the door is to open outwards. The boundaries between the rooms and other enclosed spaces are to be gastight. Suitable drainage of the storage room is to be provided.

5.3.1(b) Open area.
Where no storage room is provided, the gas cylinders may be placed in an open storage area. In such cases, they are to be provided with weather protection (particularly from heavy seas and heat) and effectively protected from mechanical damage. Suitable drainage of the open storage area is to be provided.

5.3.1(c) Piping passing through storage room or area.
Piping systems containing flammable fluids are not to run through the storage room or open storage area.

5.3.2 Ventilation of Storage Room (2018)
Acetylene cylinder storage rooms are to be fitted with ventilation systems capable of providing at least six air changes per hour based on the gross volume of the room. The ventilation system is to be independent of ventilation systems of other spaces. The space within 3 m (10 ft) from the power ventilation exhaust or 1 m (3 ft) from the natural ventilation exhaust is to be considered a hazardous area. The fan is to be of the non-sparking construction. See 4-3-3/9.7. Small storage spaces provided with sufficiently large openings for natural ventilation need not be fitted with mechanical ventilation.

5.3.3 Electrical Installation in Storage Room (2018)
Electrical equipment installed within the acetylene storage room, including the ventilation fan motor, is to be of the certified safe type. Electrical equipment installed within the storage room may be any of the types indicated in 4-3-3/9.1.2(b) and is to be IEC Publication 60079-20-1 group IIC class T2.

In explosive gas atmospheres containing acetylene, equipment protection by flameproof (explosion proof) enclosures “Ex d” for external mounting, where constructed of copper or copper alloys, is to be:

i) Coated with tin, nickel, or other coating; or

ii) Alternatively the maximum copper content of the alloy is to be limited to 60%.

Flameproof entry devices are not considered an enclosure surface requiring coating or copper content restriction.
5.5  **Piping System Components**

5.5.1  **Pipe and Fittings**

5.5.1(a)  **General (2013).**

In general, all oxygen and acetylene pipes, pipe fittings, pipe joints and valves are to be in accordance with the provisions of Section 4-2-1 and Section 4-2-2, except as modified below.

5.5.1(b)  **Piping materials (2010).**

Materials for acetylene on the high-pressure side between the cylinders and the regulator are to be steel. Copper or copper alloys containing more than 65% copper are not to be used in acetylene piping (high or low pressure). Materials for oxygen on the high-pressure side are to be steel or copper. All pipes, both high- and low-pressure sides, are to be seamless.

5.5.1(c)  **Design pressure (2006).**

Pipes, pipe fittings and valves on the oxygen high-pressure side are to be designed for not less than 207 bar (211 kgf/cm², 3000 psi). Pipes used on the low-pressure side are to be at least of standard wall thickness.

5.5.1(d)  **Pipe joints.**

All pipe joints outside of the storage room or open storage area are to be welded.

5.5.1(e)  **Flexible hoses (2009).**

Flexible hoses used to connect oxygen or acetylene gas cylinders to a fixed piping system or manifold are to comply with an acceptable standard and be suitable for the intended pressure and service. Further, the internal surface of a hose used to connect an acetylene tank is to be of a material that is resistant to acetone and dimethylformamide decomposition.*

Where a flexible hose is connected from an oxygen cylinder to the piping system or manifold directly (i.e., no intervening pressure regulator), the internal liner of the oxygen hose is to be of a material that has an autoignition temperature of not less than 400°C (752°F) in oxygen.*

* Criteria based on ISO 14113:1997 Gas welding equipment - rubber and plastic hoses assembled for compressed or liquefied gases up to a maximum design pressure of 450 bar.

5.5.2  **Pressure Relief Devices (2012).**

Pressure relief devices are to be provided in the gas piping if the maximum allowable working pressure of the piping system can be exceeded. These devices are to be set to discharge at not more than the maximum allowable working pressure of the piping system to a location in the weather remote from sources of vapor ignition or openings to spaces or tanks. The area within 3 m (10 ft) of the pressure relief device discharge outlet is to be regarded as a hazardous area. The pressure relief devices may be either a relief valve or a rupture disc.

5.5.3  **System Arrangements**

Where two or more gas cylinders are connected to a manifold, high pressure piping between each gas cylinder and the manifold is to be fitted with a non-return valve. The piping is not to run through unventilated spaces or accommodation spaces. Outlet stations are to be fitted with shut-off valves. Outlet stations are to be provided with suitable protective devices to prevent back flow of gas and the passage of flame into the supply lines.
5.5.4 Gas Cylinders (2018)
Gas cylinders are to be designed, constructed and certified in accordance with the provisions of 4-4-1/1.11.4 of the Marine Vessel Rules. Each cylinder is to be fitted with a suitable pressure relief device such as a fusible plug or a rupture disc.

The area within 3 m (10 ft) of the pressure relief device discharge outlet from an acetylene gas cylinder is to be regarded as a hazardous area.

7 Fuel Storage for Helicopter Facilities

7.1 General (2007)
Fixed fuel storage and transfer facilities are to comply with the following:

7.1.1 Isolation
Fuel storage and transfer facilities are to be remote or suitably isolated from areas which contain a source of vapor ignition and are not to be located on landing areas. The storage and transfer area is to be permanently marked as an area where smoking and open flames are not permitted.

7.1.2 Hazardous Areas (2016)
The requirements for hazardous areas are applicable for fuel with a flash point at or below 60°C (140°F) close cup test. Open spaces within 3 m (10 ft) of the refueling equipment and within 3 m (10 ft) of the storage tank vent outlets are to be regarded as hazardous areas. The first 1.5 m (5 ft) is to be regarded a Zone 1 hazardous area and the second 1.5 m (5 ft) is to be regarded a Zone 2 hazardous area.

Enclosed spaces containing refueling equipment or storage tank vents are to be regarded as Zone 1 hazardous areas. See 4-3-3/9 for acceptable certified safe equipment and is to be IEC Publication 60079-20-1 group II A class T3. Enclosed spaces are to meet the following provisions.

7.1.2(a) Ventilation Capacity.
The enclosed space is to be provided with an effective power ventilation system sufficient to provide at least six air changes per hour.

7.1.2(b) Exhaust Ventilation Duct and Fan.
The exhaust duct is to be regarded as a Zone 1 hazardous area and the outlet from any exhaust duct is to be sited in a safe location, having regard to other possible sources of ignition. See 4-3-6/5.3.ii and 4-3-6/5.5.iv. Exhaust fans are to be of non-sparking construction complying with 4-3-3/9.7.

7.1.2(c) Dewatering System.
Where a gravity drain system is fitted, the system is to comply with the provisions of 4-2-2/23. Where a bilge pumping system is fitted, the system is to comply with the provisions of 4-2-4/1 through 4-2-4/7 as applicable.

7.1.3 Fuel Storage Tank Construction
Fixed fuel storage tanks are to be of approved metal construction. Special attention is to be given to the design, mounting, securing arrangement and electrical bonding of the storage tank and the fuel transfer system.
7.1.4 Fuel Storage Tank Vents

Tank vents are to be sized in accordance with 4-2-3/1.7, API Standard 2000, “Venting Atmospheric and Low-Pressure Storage Tanks”, or other approved criteria. Vent outlets are to be located such that vapors will disperse freely.

7.1.5 Fuel Storage Tank Valves

Storage tank outlet valves are to be provided with a means of remote closure in the event of fire. Means are also to be provided for remote shutdown of the fuel transfer unit.

7.3 Spill Containment (2015)

To contain spillage and retain fire extinguishing agents, a coaming at least 150 mm (6 in.) in height is to be provided. The coaming is to surround the fuel storage area, which consists of the fuel tank, associated piping and any pumping unit adjacent to the storage tank. Where the pumping unit or any other unit such as dispenser/coalescer unit is remote from the tank, a separate coaming around each unit is to be provided. A coaming will not be required around the fuel storage tank where the installation is such that the tank is cantilevered from the platform and arranged to be jettisoned.

Drainage is to be provided for the area enclosed by the coaming complying with the following:

7.3.1

The area within the coaming is to be sloped toward the drain line.

7.3.2

Drainage from the area within the coaming is to be led through a valve designed for selective output (e.g., three-way valve) either to a holding tank complying with 4-2-6/7.1.2 and 4-2-6/7.1.3 or directly overboard. No other valves may be fitted in the drain line.

7.3.3

The cross sectional area of the drain line from the fuel tank coaming is to be at least twice that of the fuel storage tank outlet connection.

Fuel tank coamings not provided with drainage arrangements in accordance with the above are to be sized to contain the full volume of the fuel storage tank plus 150 mm (6 in.) of foam.

9 Starting-air Systems

9.1 Design and Construction (2013)

The design and construction of all air reservoirs and piping systems are to be in accordance with the applicable requirements of Section 4-4-1 and Appendix 4-4-1-A1 of the Marine Vessel Rules. The piping system is to be in accordance with the applicable requirements of 4-2-2 of these Rules. The air reservoirs are to be so installed as to make the drain connections effective under extreme conditions of trim. Compressed-air systems are to be fitted with relief valves and each air reservoir which can be isolated from a relief valve is to be provided with its own safety valves or equivalent. Connections are also to be provided for cleaning the air reservoir and pipe lines.

All discharge pipes from starting air compressors are to be led directly to the starting air reservoirs, and all starting pipes from the air reservoirs to main or auxiliary engines are to be entirely separate from the compressor discharge piping system.

9.3 Starting-air Capacity (2013)

Units having internal combustion engines arranged for air starting are to be provided with at least two starting-air reservoirs of approximately equal size. The total capacity of the starting-air reservoirs is to be sufficient to provide, without recharging the air reservoirs, at least the number of consecutive starts stated below. If other compressed air systems, such as control air, are supplied from starting-air reservoirs, the...
aggregate capacity of the air reservoirs is to be sufficient for continued operation of these systems after the air necessary for the required number of starts has been used.

9.3.1 Diesel Propulsion

The minimum number of consecutive starts (total) required to be provided from the starting-air reservoirs is to be based upon the arrangement of the engines and shafting systems as indicated in the following table.

<table>
<thead>
<tr>
<th></th>
<th>Single Screw Unit</th>
<th>Multiple Screw Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>One engine coupled</td>
<td>Two or more engines</td>
</tr>
<tr>
<td></td>
<td>to shaft directly</td>
<td>coupled to shaft</td>
</tr>
<tr>
<td></td>
<td>or through reduction gear</td>
<td>through clutch and reduction gear</td>
</tr>
<tr>
<td>Reversible Engines</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>Non-reversible Engines</td>
<td>6</td>
<td>8</td>
</tr>
</tbody>
</table>

For arrangements of engines and shafting systems which differ from those indicated in the table, the capacity of the starting-air reservoirs will be specially considered based on an equivalent number of starts.

9.3.2 Diesel-electric Propulsion

The minimum number of consecutive starts required to be provided from the starting-air reservoirs is to be determined from the following equation.

\[ S = 6 + G(G - 1) \]

where

\[ S \] = total number of consecutive starts

\[ G \] = number of engines necessary to maintain sufficient electrical load to permit vessel transit at full seagoing power and maneuvering. The value of \( G \) need not exceed 3.

9.3.3 Non Self-Propelled Units

The minimum number of consecutive starts required to be provided from the starting-air reservoirs is three (3) per auxiliary engine, but the total capacity of the starting-air reservoirs dedicated to the auxiliary engines need not exceed eight (8) consecutive starts.

9.5 Protective Devices for Starting-air Mains (2011)

Where engine starting is by direct injection of air into engine cylinders, in order to protect starting-air mains against explosions arising from improper functioning of starting valves, an isolation non-return valve or equivalent is to be installed at the starting-air supply connection to each engine. Where engine bores exceed 230 mm (9 in.), a bursting disc or flame arrester is to be fitted in way of the starting valve of each cylinder for direct reversing engines having a main starting manifold or at the supply inlet to the starting-air manifold for non-reversing engines.

The above requirement is not intended to apply to engines utilizing air starting motors.
Cooling-water Systems for Internal Combustion Engines

11.1 General
Means are to be provided to ascertain the temperature of the circulating water at the return from each engine and to indicate that the proper circulation is being maintained. Drain cocks are to be provided at the lowest point of all jackets. For relief valves, see 4-2-1/11.21.

11.3 Sea Suctions
At least two independent sea suctions are to be provided for supplying water to the engine jackets or to the heat exchangers.

11.5 Strainers
Where sea water is used for direct cooling of the engine, unless other equivalent arrangement is specially approved by ABS, suitable strainers are to be fitted between the sea valves and the pump suctions and are to be either of the duplex type or otherwise so arranged that they can be cleaned without interrupting the cooling-water supply. This applies also to the emergency circulating water to the engine.

11.7 Circulating Water Pumps (1993)
There are to be at least two means for supplying cooling water to main and auxiliary engines, compressors, coolers, reduction gears, etc. One of these means is to be independently driven and may consist of a connection from a suitable pump of adequate size normally used for other purposes, such as a general service pump, or in the case of fresh-water circulation, one of the unit’s fresh-water pumps. Where, due to the design of the engine, the connection of an independent pump is impracticable, the independently driven stand-by pump will not be required if a complete duplicate of the attached pump is carried as a spare. Multiple auxiliary engine installations utilizing attached pumps need not be provided with spare pumps.

13 Exhaust System

13.1 Exhaust Lines
The exhaust pipes are to be water-jacketed or effectively insulated. Exhaust pipes of several engines are not to be connected together, but are to be run separately to the atmosphere unless arranged to prevent the return of gases to an idle engine. Exhaust lines which are led overboard near the waterline are to be protected against the possibility of water finding its way inboard. Boiler uptakes and engine-exhaust lines are not to be connected, except when specially approved, as in cases where the boilers are arranged to utilize the waste heat from the engines.

13.3 Exhaust Gas Temperature
Propulsion engines with bores exceeding 200 mm (8 in.) are to be fitted with a means to display the exhaust gas temperature of each cylinder.

13.5 Exhaust Emission Abatement Systems (1 July 2018)
Where a vessel is fitted with an exhaust emission abatement system and the optional vessel notations detailed under 1/9.3 through 1/9.9 of the ABS Guide for Exhaust Emission Abatement are not requested, the installed exhaust emission abatement system is to comply with the minimum requirements prescribed in 1/15 TABLE 1 of the Guide and is to be verified by an ABS Surveyor during installation. This is applicable to new construction and existing vessel conversions.

Where a Selective Catalytic Reduction (SCR) system is to be installed as a NOx Reducing Device using urea based ammonia (e.g., 40%/60% urea/water solution), it is to comply with the requirements in 3/11.3 of the ABS Guide for Exhaust Emission Abatement and the same is to be verified by ABS.
15 **Valves in Atomizing Lines**

Where air or steam is used to atomize well bore fluids prior to flaring, a non-return valve is to be fitted in the line. This valve is to be part of the permanently installed piping, readily accessible and as close as possible to the burner boom. Alternative arrangements shown to provide an equivalent level of safety will be considered.

17 **Helicopter Deck Drainage Arrangements (2018)**

Helicopter decks are to be arranged and provided with means to prevent collection of liquids and to prevent liquids from spreading to or falling on other parts of the unit. Drainage facilities in way of helidecks are to be lead directly overboard independent of any other system.

19 **Boilers and Associated Piping**

Boilers and their associated steam, exhaust and feed systems are to be in accordance with the applicable requirements of Part 4, Chapters 4 and 6 of the *Marine Vessel Rules*.

21 **Steering Gear Piping**

Piping systems associated with steering gear systems are to be in accordance with Section 4-3-4 of the *Marine Vessel Rules*.

23 **Gas Turbine Piping**

Piping systems associated with gas turbines are to be in accordance with 4-2-3/9 of the *Marine Vessel Rules*.


Raw water systems supplying seawater to essential services on a self-elevating unit in elevated condition are to be approved by ABS. Raw water towers, leg well suctions and hose reels may be considered an acceptable arrangement for raw water systems.

25.1 **General**

At least two means of supplying water to essential services, such as cooling water system for main power generation or fire main system, are to be provided. Pump capacity, system pressure and piping installation are to be as required for the specific system or systems supplied. The pumps are to be sized to provide their full required water demand with one pump out of service. See 4-2-6/11 and 5-2-2/1.1.

In general, the use of hoses from the discharge of the submersible pump to the connection to the fixed seawater system on board the unit is permitted, provided that the hose is suitable for the intended service. The hoses are to be fire resistant, except when they are adequately separated such that a single incident (fire, blast, etc.) would not damage all the raw water hoses.

25.3 **Raw Water Tower**

The strength of the raw water tower and its components to withstand the maximum design environmental conditions for the unit in elevated condition is to be assessed and calculations in this regard are to be submitted for review.

25.5 **Leg Well Suction**

The raw water system is to be suitably supported to the unit’s leg and adequately protected against mechanical damage due to the operation of the legs.
25.7 **Hose Reel**

In lieu of utilizing either raw water towers or leg well suctions, submersible pumps installed on a hose reel and lowered into the sea may be considered as an acceptable means of water supply onboard a self-elevating unit, subject to the following conditions:

25.7.1 **Arrangement**

There are to be at least two hose reels provided. The hose reel units are to be adequately separated by either distance or primary structure such that a single incident (fire, blast, etc.) would not render both pumping systems inoperable.

25.7.2 **Pump Power**

Each hose reel pump unit is to be powered independently, such that a single failure in the power distribution system would not render both units inoperable.

25.7.3 **Design**

The design of the hose reel/pump skid is to be submitted for review, including verification of the skid and reel strength and component suitability (piping and electrical). In particular, details of the hoses, including type, standard, material and capability to withstand the maximum design environmental loads, are to be submitted for review. In principle, collapsible type hoses are not considered acceptable for this service.

25.7.4 **Isolation**

In order to isolate a damaged pump/hose from the rest of the sea water system, a suitable isolation valve is to be provided, capable of being operated during or immediately after the incident (fire, blast, etc.) in such a way that the water supply is not interrupted.

25.7.5 **Location**

The reels are not to be located in a hazardous zone and each reel is to be positioned directly next to the deck edge or opening utilized to lower the pumps overboard.

25.7.6 **Operation**

All hose reels provided are to be deployed at all times the unit is in the elevated condition. Instructions in this regard are to be included in the Operating Manual.
PART 4

CHAPTER 3 Electrical Installations

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1 Applications

Electrical apparatus and wiring systems are to be constructed and installed in accordance with the requirements of this Section.

3 Definitions

The following definitions apply for the purpose of this Section.

3.1 Earth (2014)

A large conducting body, such as the metal hull of the ship, used as an arbitrary zero of potential.

3.3 Earthed Distribution System

A system in which one pole of a single phase system or the neutral point of a three phase system is earthed but the earthing connection does not normally carry current.

3.5 Essential Services (2012)

For definition of essential services, see 4-1-1/3.5.

3.7 Explosion-proof (Flameproof) Equipment (2016)

Explosion-proof equipment is equipment:

\[i\) Having an enclosure capable of:

- withstanding an explosion within it of a specified flammable gas or vapor, and
- preventing the ignition of the specified flammable gas or vapor in the atmosphere surrounding the enclosure by sparks, flashes or explosions of the gas or vapor within, and

\[ii\) Operates at such an external temperature that a surrounding flammable atmosphere will not be ignited.

Where explosion-proof equipment is required by these Rules, equipment certified as being flameproof as defined in IEC Publication 60079 series or other recognized standard may be accepted.

3.9 Hazardous Area (Hazardous Location)

An area where flammable or explosive vapor, gas, or dust, or explosives may normally be expected to accumulate.

3.11 Hull-return System

A system in which insulated conductors are provided for connection to one pole or phase of the supply, the hull of the unit or other permanently earthed structure being used for effecting connections to the other pole or phase.
3.13 **Inhomogeneous Field (2014)**
An electric field which does not have a constant voltage gradient between electrodes.

3.15 **Intrinsically safe**
A circuit or part of a circuit is intrinsically safe when any spark or any thermal effect produced in the test conditions prescribed in a recognized standard (such as IEC 60079-11) is incapable of causing ignition of the prescribed explosive gas atmosphere.

3.15.1 **Category “ia” (2016)**
Apparatus which is incapable of causing ignition in normal operation, or with a single fault, or with any combination of two faults applied, with the following safety factors:

- In normal operation: 1.5
- With one fault: 1.5
- With two faults: 1.0

Above safety factors are applied to the current, voltage or their combination, as specified in 5.2 of IEC 60079-11.

3.17 **Increased Safety**
Type of protection applied to electrical apparatus that does not produce arcs or sparks in normal service, in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and of the occurrence of arc and sparks. See IEC 60079-7.

3.19 **Nominal Voltage (2014)**
*Nominal Voltage* \((U_0)\) – The nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (as 120/240 V, 480/277 V, 600 V). The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.

*U_0* (as relates to cable voltage rating) – The rated power frequency voltage between conductor and earth or metallic screen for which the cable is designed.

3.21 **Non-Periodic Duty Rating**
A rating at which the machine is operated continuously or intermittently with varying the load and speed within the permissible operating range. The load and speed variations include the overloads applied frequently, which may greatly exceed the full load rating of the machine.

3.23 **Non-sparking Fan**
A fan consisting of a combination of impeller and housing which are unlikely to produce sparks by static electricity or by entry of foreign objects in both normal and abnormal conditions. See also 4-3-3/9.7.

3.25 **Overvoltage Category (2014)**
*Overvoltage Category* (of a circuit or within an electrical system) – Conventional number based on limiting the values of prospective transient overvoltages occurring in a circuit and depending on the means employed to influence the overvoltages.

3.27 **Overvoltage Withstand Test (2014)**
*Overvoltage Withstand Test* (layer test) – Test intended to verify the power-frequency withstand strength along the winding under test and between its phase (strength between turns and between layers in the windings).
3.29 **Periodic Duty Rating**

A rating at which the machine is operated repeatedly on cycle of sequential loading with starting, electric braking, no-load running, rest and de-energized periods, where applicable. The time for the duration of operating cycle (duty cycle) is to be 10 minutes and the ratio (i.e., cyclic duration factor) between the period of loading (including starting and electric braking) and the duty cycle is to be one of the values of 15%, 25%, 40% or 60%.

3.31 **Pollution Degree (2014)**

*Pollution Degree* (of environmental conditions) – A conventional number based on the amount of conductive or hygroscopic dust, ionized gas or salt, and on the relative humidity and its frequency of occurrence resulting in hygroscopic absorption or condensation of moisture leading to reduction in dielectric strength and/or surface resistivity of the insulating materials of devices and components.

3.33 **Portable Apparatus**

Portable apparatus is any apparatus served by a flexible cord.

3.35 **Pressurized Equipment (1997)**

Equipment having an enclosure in which positive pressure is maintained to prevent against the ingress of external atmosphere and complying with the requirements in 4-3-3/9.3.3.

3.37 **Semi-enclosed Space**

A space limited by decks and/or bulkheads in such a manner that the natural conditions of ventilation in the space are notably different from those obtained on open deck.

3.39 **Separate Circuit**

A circuit which is independently protected by a circuit protection device at the final subcircuit and is dedicated to a single load.

3.41 **Short Circuit**

A short circuit is an abnormal connection through a negligible impedance, whether made accidentally or intentionally, between two points of different potential in a circuit.

3.43 **Short-time Rating**

A rating at which the machine is operated for a limited period which is less than that required to reach the steady temperature condition, followed by a rest and de-energized period of sufficient duration to re-establish the machine temperature within 2°C (3.6°F) of the coolant.

5 **Plans and Data to Be Submitted (2012)**

See 4-3-2/1, 4-3-3/1, 4-3-4/1 and 4-3-5/3.1.2, and 4-3-6/3. Refer to 6-1-7/3 for electrical equipment certification.

7 **Standard Distribution System (2014)**

The following are recognized as standard systems of distribution. Distribution systems differing from these will be specially considered.

- Two-wire direct current
- Three-wire direct current
- Two-wire single-phase alternating current
- Three-wire three-phase alternating current*
- Four-wire three-phase alternating current with solidly earthed neutral but not with hull return
*Three-wire single-phase AC may be used in conjunction with this system for lighting.

9 **Voltage and Frequency Variations (2008)**

Electrical appliances supplied from the main or emergency systems, are to be so designed and manufactured that they are capable of being operated satisfactorily under the normally occurring variations in voltage and frequency. Unless otherwise stated in national or international standards, the variations from the rated value may be taken from 4-3-1/19 TABLE 1. Any special system, such as electronic circuits, which cannot operate satisfactorily within the limit shown in 4-3-1/19 TABLE 1, is not to be supplied directly from the system but by alternative means, such as through a stabilized supply.

For generators, see 6-1-3/3.1, 6-1-3/3.5.1, and 6-1-7/5.17.2.

11 **Materials**

All electrical equipment is to be constructed of durable and flame-retardant materials. Materials are to be resistant to corrosion, moisture, high and low temperatures, and are to have other qualities necessary to prevent deterioration in the ambient conditions that the equipment may be expected to encounter.

13 **Grounding Arrangements**

Where not obtained through normal construction, arrangements are to be provided to effectively ground metal structures of derricks, masts and helicopter decks. See also 4-2-6/7.1.3 for fuel storage for helicopter facilities. Grounding arrangements are also to be provided for tending vessels.

15 **Degree of Protection for Enclosure (2014)**

The designation to indicate the degree of protection consists of the characteristic letters IP followed by two numerals (the “characteristic numerals”) indicating conformity with conditions stated in 4-3-1/19 TABLE 2 and 4-3-1/19 TABLE 3. The test and inspection for determining the degree of protection may be carried out in accordance with IEC Publication 60529 by the manufacturer whose certificate of tests will be acceptable and is to be submitted upon request from ABS. Type of enclosure required for protection of equipment is to be suitable for the intended location. See 4-3-3/3.1.1 for selection of protective enclosure for electrical equipment based on location condition. Equipment in compliance with recognized national standards will also be considered. For high voltage equipment see 4-3-5/7.1 TABLE 1.

17 **Temperature Ratings**

17.1 **General (2014)**

For purposes of rating of equipment a maximum ambient air temperature of 45°C (113°F) is to be assumed.

Where ambient temperatures in excess of 45°C (113°F) are expected the rating of equipment is to be based on the actual maximum ambient air temperature.

The use of lower ambient temperatures may be considered provided the total rated temperature of the equipment is not exceeded and where the lower values can be demonstrated. The use of a value for ambient temperature less than 40°C (104°F) is only permitted in spaces that are environmentally controlled.

17.3 **Reduced Ambient Temperature (2005)**

17.3.1 **Environmentally Controlled Spaces**

Where electrical equipment is installed within environmentally-controlled spaces, the ambient temperature for which the equipment is to be rated may be reduced from 45°C and maintained at a value not less than 35°C, provided:

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**Part 4  Machinery and Systems**

**Chapter 3  Electrical Installations**

**Section 1  General**
The equipment is not to be used for emergency services.

Temperature control is achieved by at least two independent cooling systems so arranged that in the event of loss of one cooling system for any reason, the remaining system(s) is capable of satisfactorily maintaining the design temperature. The cooling equipment is to be rated for a 45°C ambient temperature.

The equipment is to be able to initially start to work safely at a 45°C ambient temperature until such a time that the lesser ambient temperature may be achieved.

Audible and visual alarms are provided, at a continually-manned control station, to indicate any malfunction of the cooling systems.

17.3.2 Rating of Cables
In accepting a lesser ambient temperature than 45°C, it is to be ensured that electrical cables for their entire length are adequately rated for the maximum ambient temperature to which they are exposed along their length.

17.3.3 Ambient Temperature Control Equipment
The equipment used for cooling and maintaining the lesser ambient temperature is to be classified as a secondary essential service, in accordance with 4-3-1/3.5, and the capability of cooling is to be witnessed by the Surveyor at sea trial.

19 Clearances and Creepage Distances
The distances between live parts of different potential and between live parts and the case or other earthed metal, whether across surfaces or in air, are to be adequate for working voltage, having regard to the nature of the insulating material and the conditions of service. See 4-3-5/1.1.3 and 6-1-7/9.9.6 for additional requirements for switchboard and high voltage systems.

### TABLE 1
Voltage and Frequency Variations [See 4-3-1/9] (2008)

<table>
<thead>
<tr>
<th>Quantity in Operation</th>
<th>Permanent Variation</th>
<th>Transient Variation (Recovery Time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>±5%</td>
<td>±10% (5 s)</td>
</tr>
<tr>
<td>Voltage</td>
<td>+6%, -10%</td>
<td>±20% (1.5 s)</td>
</tr>
</tbody>
</table>

Voltage Variations for DC Distribution Systems
(such as systems supplied by DC generators or rectifiers)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Variations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage tolerance (continuous)</td>
<td>±10%</td>
</tr>
<tr>
<td>Voltage cyclic variation deviation</td>
<td>5%</td>
</tr>
<tr>
<td>Voltage ripple (AC rms over steady DC voltage)</td>
<td>10%</td>
</tr>
</tbody>
</table>

Voltage Variations for Battery Systems

<table>
<thead>
<tr>
<th>Type of System</th>
<th>Variations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components connected to the battery during charging (see Note)</td>
<td>+30%, -25%</td>
</tr>
<tr>
<td>Components not connected to the battery during charging</td>
<td>+20%, -25%</td>
</tr>
</tbody>
</table>
**Note:**
Different voltage variations as determined by the charging/discharging characteristics, including the ripple voltage from the charging device, may be considered.

### TABLE 2
Degree of Protection – Indicated by the First Characteristic Numeral

[See 4-3-1/15]

<table>
<thead>
<tr>
<th>First Characteristic Numeral</th>
<th>Short Description</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Non-protected</td>
<td>No special protection</td>
</tr>
<tr>
<td>1</td>
<td>Protected against solid objects greater than 50 mm (2 in.)</td>
<td>A large surfacing of the body, such as a hand (but no protection against deliberate access). Solid object exceeding 50 mm (2 in.) in diameter.</td>
</tr>
<tr>
<td>2</td>
<td>Protected against solid objects greater than 12 mm (0.5 in.)</td>
<td>Fingers or similar objects not exceeding 80 mm (3.15 in.) in length. Solid objects exceeding 12 mm (0.5 in.) in diameter.</td>
</tr>
<tr>
<td>3</td>
<td>Protected against solid objects greater than 2.5 mm (0.1 in.)</td>
<td>Tools, wires, etc., of diameter or thickness greater than 2.5 mm (0.1 in.). Solid objects exceeding 2.5 mm (0.1 in.) in diameter.</td>
</tr>
<tr>
<td>4</td>
<td>Protected against solid objects greater than 1 mm (0.04 in.)</td>
<td>Wires or strips of thickness greater than 1 mm (0.04 in.). Solid objects exceeding 1 mm (0.04 in.) in diameter.</td>
</tr>
<tr>
<td>5</td>
<td>Dust protected</td>
<td>Ingress of dust is not totally prevented, but dust does not enter in sufficient quantity to interfere with satisfactory operation of the equipment.</td>
</tr>
<tr>
<td>6</td>
<td>Dust-tight</td>
<td>No ingress of dust</td>
</tr>
</tbody>
</table>

[Designation]

The degree of protection is designated as shown in the following examples:

When it is required to indicate the degree of protection by only one characteristic numeral which shows either degree of protection against foreign bodies and electrical shock or against liquid, the omitted numeral is to be replaced by the letter X.

**Examples:**

1. **IP56** The first characteristic numeral of "5".
   The second characteristic numeral of "6".
2. **IPX5** Degree of protection against only liquid.
3. **IP2X** Degree of protection against foreign bodies and electrical shock.
### TABLE 3
Degree of Protection – Indicated by the Second Characteristic Numeral [See 4-3-1/15] (2016)

<table>
<thead>
<tr>
<th>Second Characteristic Numeral</th>
<th>Short Description</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Non-protected</td>
<td>No special protection</td>
</tr>
<tr>
<td>1</td>
<td>Protected against dripping water</td>
<td>Dripping water (vertically falling drops) is to have no harmful effect.</td>
</tr>
<tr>
<td>2</td>
<td>Protected against dripping water when tilted up to 15 deg.</td>
<td>Vertically dripping water is to have no harmful effect when the enclosure is tilted at any angle up to 15 deg. from its normal position.</td>
</tr>
<tr>
<td>3</td>
<td>Protected against spraying water</td>
<td>Water falling as spray at an angle up to 60 deg. from the vertical is to have no harmful effect.</td>
</tr>
<tr>
<td>4</td>
<td>Protected against splashing water</td>
<td>Water splashed against the enclosure from any direction is to have no harmful effect.</td>
</tr>
<tr>
<td>5</td>
<td>Protected against water jets</td>
<td>Water projected by a nozzle against the enclosure from any direction is to have no harmful effect.</td>
</tr>
<tr>
<td>6</td>
<td>Protected against heavy seas</td>
<td>Water from heavy seas or water projected in powerful jets is not to enter the enclosure in harmful quantities.</td>
</tr>
<tr>
<td>7</td>
<td>Protected against the effects of immersion</td>
<td>Ingress of water in a harmful quantity is not to be possible when the enclosure is immersed in water under defined conditions of pressure and time.</td>
</tr>
</tbody>
</table>
| 8                             | Protected against submerision              | The equipment is suitable for continuous submersion in water under conditions which are to be specified by the manufacturer.  
**Note:** Normally, this will mean that the equipment is hermetically sealed. However, with certain types of equipment, it can mean that water can enter but only in such a manner that it produces no harmful effects. |
| 9 (2016)                      | Protected against high pressure and high temperature water jets | Water projected at high pressure and high temperature against the enclosure from any direction is to have no harmful effect. |

See Designation and examples in 4-3-1/19 TABLE 2.
Chapter 3  Electrical Installations

Section 2  Electrical Systems

1  Plans and Data to be Submitted

1.1  Wiring

1.1.1  Systems

One line diagrams for the following electrical systems are to be submitted for review.

- Power Supply and Distribution
- Lighting including Navigation Light
- Internal Communication
- General Emergency Alarm
- Fire Detection and Alarm
- Steering Gear Control (for self-propelled unit)
- Intrinsically-safe Equipment
- Emergency Generator Starting

1.1.2  Data for Wiring Systems

The one line diagrams are to show the circuit designation, type and size of cables, cable grouping and banking, trip setting and rating of the circuit protection devices, the location of electrical equipment accompanied by list of components, complete feeder list, rated load current for each branch circuit, and voltage drop for longest run of each size cable. The one line diagram for power supply and distribution systems is to indicate the following component details.

- Generator:  kW rating, voltage, rated current, frequency, number of phases, power factor
- Batteries:  type, voltage, capacity, conductor protection (when required)
- Motors:  kW rating, remote stops (when required)
- Transformers:  kVA rating, rated voltage and current on primary and secondary side, connection method

The one line diagram for power supply and distribution systems is also to include a list of sequential start of motors and equipment having emergency tripping or preferential tripping features.

1.3  Short-circuit Data (2016)

In order to establish that the protective devices on the main and emergency switchboards have sufficient short-circuit breaking and making capacities, data are to be submitted giving the maximum calculated short-circuit current in symmetrical rms and asymmetrical peak values available at the main bus bars together with the maximum allowable breaking and making capacities of the protective device. Similar
calculations are to be made at other points in the distribution system where necessary to determine the adequacy of the interrupting capacities of protective devices.

Reference may be made to IEC Publication 61363-1 Electrical Installations of Ships and Mobile and Fixed Offshore Units – Part 1: Procedures for Calculating Short-Circuit Currents in Three-Phase A.C.

1.5 Protective Device Coordination

A protective device coordination study is to be submitted for review. This protective device coordination study is to consist of an organized time-current study of all protective devices in series from the utilization equipment to the source for all circuit protection devices having different setting or time-current characteristics for long-time delay tripping, short-time delay tripping and instantaneous tripping, where applicable. Where an overcurrent relay is provided in series and adjacent to the circuit protection device, the operating and time-current characteristics of the relay are to be considered for coordination. See 4-3-2/9.1.5.

1.7 Load Analysis (2002)

An electric-plant load analysis is to be submitted for review. The electric-plant (including high voltage unit main service transformers or converters, where applicable per 4-3-2/7.1.6) load analysis is to cover all operating conditions of the unit, including normal seagoing (if applicable) and emergency operations.

1.9 High Voltage Systems (2014)

1.9.1 Documents
High Voltage Design Operating Philosophy Document (See 4-3-5/1.13)

1.9.2 Analysis
Arc-flash hazard analyses [See 6-1-7/15.3.2(f)]

1.9.3 Operating Manual
Preliminary Operation Manual for the high voltage system and equipment (See 4-3-5/1.15)

1.9.4 General Arrangement
General Arrangement of the switchboards and distribution boards

1.9.5 Spaces
General Arrangement of spaces containing high voltage switchboards showing the location of:

i) Access and operating locations

ii) The equipment in 4-3-2/1.9.4 above, with equipment access doors closed, open, maximum extent of withdrawable circuit breakers and associated cradles/dollies

iii) Doors to the room

iv) Location of work areas associated with the activities described in 4-3-5/1.13 and 4-3-5/1.15

v) Location and inventory of personal protective equipment (PPE) and safety equipment

vi) First aid equipment

1.9.6 Analysis and Data
An analysis or data for the estimated voltage transients to show that the insulation of power transformers is capable of withstanding the estimated voltage transients.
1.9.7 Standards
The applicable standard of construction and the rated withstand voltage of the insulation for power transformers. (This information is in addition to the information required in 6-1-7/11.)

3 Main Service Source of Power

3.1 Power Supply by Generators

3.1.1 Number of Generators
Units are to be provided with at least two main generator sets with combined capacity sufficient to maintain the unit in normal operations (including the drilling mode) and habitable conditions to include at least adequate services for cooking, heating, domestic refrigeration, mechanical ventilation, sanitary and fresh water.

3.1.2 Capacity of Generators (2019)
In addition to 4-3-2/3.1.1, the capacity of the generator sets is to be sufficient to maintain the unit in normal operational and habitable conditions, excluding drilling equipment, with any one main generator in reserve. The capacity of main generators is to be determined without recourse to the emergency source of power. See 4-3-2/5 for emergency power source requirements. Also, for self-propelled units, the generating sets are to be such that with any one generator or its primary source of power out of operation, the remaining generating sets are capable of providing the electrical services necessary to start the main propulsion plant in conjunction with other machinery, as appropriate, from a dead ship condition within 30 minutes, as defined in 4-1-1/3.9 See also 4-3-2/3.1.4.

3.1.3 Multiple Generators
For units having multiple generating sets providing power for both propulsion and auxiliary services, the propulsion loads considered for normal operation need only include those necessary to propel the unit at 3.6 m/s (7 kn) or one-half the design speed in calm water, whichever is the lesser. See 6-1-3/3.7 and 6-1-7/17.3.1 for details of propulsion generator.

3.1.4 Starting from "Dead Ship" Condition (2019)
In restoring the propulsion from a dead ship condition (see 4-1-1/3.9) for self-propelled units, no stored energy is to be assumed available for starting the propulsion plant, the main source of electrical power and other essential auxiliaries. It is assumed that means are available to start the emergency generator at all times.

The emergency source of electrical power may be used to restore the propulsion, provided its capacity either alone or combined with that of any other available source of electrical power is sufficient to provide at the same time those services required to be supplied by 4-3-2/5.3.1 through 4-3-2/5.3.7.

The emergency source of electrical power and other means needed to restore the propulsion are to have a capacity such that the necessary propulsion starting energy is available within 30 minutes from a dead ship condition, as defined in 4-1-1/3.9. Emergency generator stored starting energy is not to be directly used for starting the propulsion plant, the main source of electrical power and/or other essential auxiliaries (emergency generator excluded).

See also 4-3-2/3.1.2 above.

3.1.5 Fuel Capacity for Generator Prime Mover
For self-propelled units where the fuel for any unit’s main service generator prime mover differs from the fuel for the main propulsion plant, adequate fuel capacity for that unit’s service generator prime mover with adequate margins is to be provided for the longest anticipated run of the unit between fueling ports.
3.1.6 System Arrangement (2004)

3.1.6(a) General.

For self-propelled units where the main source of electrical power is necessary for propulsion and steering and the safety of the unit, the system is to be so arranged that the electrical supply to equipment necessary for these services is maintained or is capable of being restored in the case of loss of any one of the generators in service in accordance with the provision in 4-3-2/3.1.6(b) or 4-3-2/3.1.6(c).

Load shedding of nonessential services, and where necessary, secondary essential services (see 4-1-1/3.5) or other arrangements, as may be necessary, are to be provided to protect the generators against the sustained overload. For main bus bar subdivision, see 6-1-7/9.13.2.

3.1.6(b) Single Generator Operation.

Where the electrical power is normally supplied by a single generator, provision is to be made upon loss of power for automatic starting and connecting to the main switchboard of a stand-by generator(s) of sufficient capacity with automatic restarting of the essential auxiliaries in sequential operation, if necessary, to permit propulsion and steering and to ensure the safety of the unit. Starting and connection to the main switchboard of the standby generator is to be preferably within 30 seconds after loss of the electrical power supply but in no case in more than 45 seconds.

3.1.6(c) Multiple Generator Operation.

Where the electrical power is normally supplied by more than one generator set simultaneously in parallel operation, the system is to be so arranged that in the event of the loss of any one of the generators in service, the electrical supply to equipment necessary for propulsion and steering and to ensure the safety of the unit will be maintained by the remaining generator(s) in service. See also 4-3-2/3.1.3.

3.3 Generator Driven by Propulsion Unit (2004)

3.3.1 Constant Speed Drive

A generator driven by a main propulsion unit (shaft generator) capable of operating continuously at a constant speed, e.g., a system where the unit speed and direction are controlled only by varying propeller pitch, may be considered to be one of the generators required by 4-3-2/3.1.1, provided that the arrangements stated in (i) to (iii) below are complied with:

(i) The generator and the generating systems are capable of maintaining the voltage and frequency variation within the limits specified in 6-1-7/5.17.2 and 4-3-1/19 TABLE 1 under all weather conditions during sailing or maneuvering and also while the unit is stopped.

(ii) The rated capacity of the generator and the generating systems is safeguarded during all operations given under (i), and is such that the services required by 4-3-2/3.1.2 can be maintained upon loss of any generator in service.

(iii) An arrangement is made for starting a standby generator and connecting it to the switchboard, in accordance with 4-3-2/3.1.6.

3.3.2 Variable Speed Drive

Shaft generator installations not capable of operating continuously at a constant speed may be used for normal operational and habitable conditions of the unit, provided that the arrangements stated in (i) to (v) below are complied with. This type of generator will not be counted as one of the generators required by 4-3-2/3.1.2.

(i) In addition to this type of generator, generators of sufficient and adequate rating are provided, which constitute the main source of electrical power required by 4-3-2/3.1.2.
ii) When the frequency variations at the main bus bar exceed the following limits due to the speed variation of the propulsion machinery which drives the generator, arrangements are made to comply with 4-3-2/3.1.6.

- Permanent frequency variation: ±5.5%
- Transient frequency variation: ±11% (5 sec)

iii) The generators and the generating systems are capable of maintaining the voltage and frequency variation within the limits specified in 6-1-7/5.17.2 and 4-3-1/19 TABLE 1.

iv) Where load-shedding arrangements are provided, they are fitted in accordance with 4-3-2/9.3.3.

v) Where the propulsion machinery is capable of being operated from the navigation bridge, means are provided or procedures are in place to ensure that power supply to essential services is maintained during maneuvering conditions in order to avoid a blackout situation.

3.5 Sizing of AC Generator

In selecting the capacity of an alternating-current generating plant, particular attention is to be given to the starting current of motors forming part of the system. Under normal operating conditions of the unit with one generator held in reserve as a standby, the remaining generator sets operating in parallel and initially carrying the minimum load necessary for operating the unit are to have sufficient capacity with respect to the largest idle motor on the unit so that the motor can be started and the voltage drop occasioned by its starting current will not cause any already running motor to stall or control equipment to drop out.

5 Emergency Source of Power

5.1 General

5.1.1 Basic Requirement (2015)

A self-contained emergency source of electrical power – together with its associated power transformer, if any, transitional source of emergency power, emergency switchboard, and emergency lighting switchboard, and the fuel oil tank for emergency generator prime mover – is to be installed in a non-hazardous space and is to be located above the worst damage waterline (see 3-3-2/1.3.2), aft of the collision bulkhead, if any, and in a space which is not within the assumed extent of damage defined in 3-3-2/3.5. The space is to contain only machinery and equipment supporting the normal operation of the emergency power source. Its location is to be readily accessible from the open deck. The arrangement is to be such as to insure that a fire, flooding or other failure in a space containing the main source of electrical power, or in any space containing internal combustion machinery for propulsion, any oil-fired or oil-fuel unit, or internal combustion machinery with an aggregate total power of 375 kW (500 hp) or more, will not interfere with the supply or distribution of emergency power.

5.1.2 Boundary (2012)

Where the "boundaries" of spaces containing the emergency sources of electrical power, associated power transformer, transitional source of emergency power, emergency switchboard, emergency lighting switchboard, and the fuel oil tank for emergency generator prime mover are contiguous to boundaries of internal combustion machinery for propulsion, an oil-fired, or oil-fuel unit, or internal combustion machinery with an aggregate total power of 375 kW (500 hp) or more, or to spaces of Zone 1 or Zone 2, the contiguous boundaries are to be in compliance with Section 5-1-1.

5.1.3 Alternate Arrangements

Where the main source of electrical power is located in two or more spaces which have their own systems, including power distribution and control systems, completely independent of the systems.
in other spaces and such that a fire or other casualty in any other of the spaces will not affect the power distribution from the others, or to the services required in 4-3-2/5.3, the requirements for self-contained emergency source of power may be considered satisfied without an additional emergency source of electrical power, provided that:

i) There are at least two generating sets meeting the inclination design requirements of 4-3-2/5.5.1;

ii) Each set is of sufficient capacity to meet the requirements of 4-3-2/5.3;

iii) The generating sets are located in each of at least two spaces;

iv) The arrangements required by 4-3-2/5.1.3 in each such space are equivalent to those required by 4-3-2/5.5.2, 4-3-2/5.9 and 4-3-2/5.15 so that a source of electrical power is available at all times for the services required by 4-3-2/5.3; and

v) The location of each of the spaces referred to in 4-3-2/5.1.3.iii is in compliance with 4-3-2/5.1.1 and the boundaries meet the requirements of 4-3-2/5.1.2, except that contiguous boundaries should consist of an “A-60” bulkhead and a cofferdam, or a steel bulkhead insulated to class “A-60” on both sides.

5.1.4 Units with Dynamic Positioning Systems Notation (DPS 2 and 3) (2019)
For Units with DPS notation, an emergency source of power is required in accordance with 4-3-2/5.1.1 and 5.1.2. Alternate arrangements without a dedicated emergency source of power, in accordance with 4-3-2/5.1.3, will not be considered, provided the unit also meets the requirements of EHS-P notation in accordance with 8/3.1 of ABS Guide for Dynamic Positioning Systems.

5.3 Emergency Power Supply (2009)
(2012) The electrical power available is to be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously. Where the sum of the loads on the emergency generator switchboard exceeds the power available, an analysis demonstrating that the power required to operate the services simultaneously is to be produced. The analysis is to be submitted for review in support of the sizing of the emergency generator. Having regard to starting currents and the transitory nature of certain loads, the emergency source of electrical power is to be capable of supplying simultaneously at least the services listed in 4-3-2/5.3.1 through 4-3-2/5.3.12 for the period specified, if they depend upon an electrical source for their operation.

5.3.1 Emergency Lighting
For a period of 18 hours, emergency lighting:

5.3.1(a)
At every survival craft embarkation station, on deck, at the launching appliances and over the side to illuminate the surface of the water where the survival craft will enter the water. If fixed metal ladders or stairways are provided from the deck to the surface of the water for embarkation purposes, emergency lighting is to be provided for the fixed metal ladder and sea areas in their vicinity.

5.3.1(b) In all service and accommodation alleyways, stairways and exits, personnel elevators and their trunks.

5.3.1(c) In the machinery spaces and main generating stations, including their control positions.

5.3.1(d) In all control stations, machinery control rooms, and at each main and emergency switchboard.
5.3.1(e) In all spaces from which control of the drilling process is performed and where controls of machinery essential for the performance of this process, or devices for emergency switching-off of the power plant are located.

5.3.1(f) (2012) At all stowage positions for fire-fighters' outfits.

5.3.1(g) At the sprinkler pump, if any, at one of the fire pumps, if dependent upon emergency generator for its source of power, at the emergency bilge pump, if any, and at the starting positions of their motors.

5.3.1(h) (2012) On helideck, to include perimeter and helideck status lights, wind direction indicators illumination, and related obstruction lights, if any.

5.3.1(i) (2014) At every location where an abandonment system is deployed or operated and onto the water where personnel leaving the abandonment system will reach the water level.

5.3.2 Navigation Lights and Signals (1999)
For a period of 18 hours, the navigation lights, other lights and sound signals required by the International Regulations for the Prevention of Collisions at Sea in force.

5.3.3 Marking of Offshore Structures (2012)
For a period of four days, signaling lights and sound signals required for marking of offshore structures.

5.3.4 Internal Communications
For a period of 18 hours, all internal communication systems required in an emergency (see Note 1 below).

5.3.5 Fire and Gas Detection and Alarm Systems (1999)
For a period of 18 hours, the required fire and gas detection and alarm systems (see Note 1 below).

5.3.6 Emergency Signals
For a period of 18 hours, intermittent operation of the manually operated call points and all internal signals that are required in an emergency (see Note 1 below).

5.3.7 Blow-Out Preventer (BOP) and Well Disconnection
For a period of 18 hours, blow-out preventer control systems and means for disconnecting the unit from the well-head arrangement, if electrically controlled (see Note 1 below).

5.3.8 Fire Pump and Fire Extinguishing Systems
For a period of 18 hours, one of the fire pumps and other fire extinguishing systems, if dependent upon the emergency generator for its source of power.

5.3.9 Diving Equipment
Permanently installed diving equipment necessary for safe conduct of diving operations, if dependent on the unit’s electrical power.

5.3.10 Column Stabilized Units
On column stabilized units, for a period of 18 hours:

5.3.10(a) Ballast valve control system, ballast valve position indicating system, draft level indicating system and tank level indicating system.

5.3.10(b) The largest single ballast pump required by 4-2-4/13.5.1. See also 4-3-2/5.11.
5.3.11 Self-propelled Units

On self-propelled units:

5.3.11(a) For a period of 18 hours, emergency lighting at the steering gear.

5.3.11(b) For a period of 18 hours, navigational aids as required by Chapter V of the 1974 SOLAS Convention, as amended (see Note 1 below).

5.3.11(c) For a period of 18 hours, intermittent operation of the daylight signaling lamp and the unit's whistle (see Note 1 below).

5.3.11(d) For a period of at least 10 minutes continuous operation of the steering gear (see 4-3-2/11.5).

5.3.11(e) (2013) For a period of 18 hours, the radio communication equipment as required by Chapter IV of the 1974 SOLAS Convention, as amended (see Note 1 below).

5.3.12 Other Emergency Services

5.3.12(a) For a period of 30 minutes, operation of watertight doors referred to in 3-3-2/5.3 (but not necessarily all of them simultaneously), including their controls and indicators, unless an independent temporary source of stored energy is provided.

5.3.12(b) (2005) For a period of 30 minutes, free-fall lifeboat secondary launching appliance, if the secondary launching appliance is not dependent on gravity, stored mechanical power or other manual means.

5.3.12(c) For a period of 18 hours, intermittent operation of the general emergency alarm system and other manually operated alarms required in 4-3-2/17.

Note:

1 Unless they have an independent supply from an accumulator battery suitably located for use in an emergency and sufficient for the period of 18 hours.

5.5 Emergency Sources

5.5.1 General (2012)

The emergency source of electrical power may be either a generator or an accumulator battery in accordance with 4-3-2/5.5.2 or 5.5.3. The emergency generator and its prime mover and any emergency accumulator battery are to be designed to function at full rated power when upright and when inclined in static condition up to a maximum angle of heel in the intact and damaged condition, as determined in accordance with Section 3-3-2. In no case need the equipment be designed to operate when inclined in static condition more than:

- 25° in any direction on a column-stabilized unit;
- 15° in any direction on a self-elevating unit, and
- 22.5° about the longitudinal axis and/or when inclined 10°about the transverse axis on a surface unit.

In all cases, the emergency source of electrical power is to be designed to operate as a minimum under the angles of inclination defined in 4-1-1/7.1.

5.5.2 Generator (2012)

Where the emergency source of electrical power is a generator, it is to be:

i) Driven by a prime mover with all necessary auxiliary systems independent from the main source of electrical power systems. The auxiliary systems, which may include fuel oil
system, starting equipment, cooling system, lubricating oil system and air supply, are to be installed as near as is practicable to the generator prime mover, preferably located in the same space as the generator prime mover unless the operation of the generator prime mover would be thereby impaired; and

ii) Started automatically upon failure of the main source of electrical power supply and connected automatically to the emergency switchboard—then, those services referred to in 4-3-2/5.7 are to be connected automatically to the emergency generator as quickly as is safe and practicable subject to a maximum of 45 seconds, or

Provided with a transitional source of emergency electrical power as specified in 4-3-2/5.7 unless an emergency generator is provided capable both of supplying the services referred to in 4-3-2/5.7 of being automatically started and supplying the required load as quickly as is safe and practicable subject to a maximum of 45 seconds, and

iii) An adequate capacity of fuel oil for the emergency generator prime mover, having a flashpoint (closed cup test) of not less than 43°C (110°F), is to be provided. The use of fuel oil having a flashpoint of less than 60°C (140°F) but not less than 43°C (110°F) is to be subject to the provisions of 4-2-5/9.1.3.

5.5.3 Accumulator Battery
Where the emergency source of electrical power is an accumulator battery, it is to be capable of:

i) Carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage,

ii) Automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and

iii) Immediately supplying at least those services specified in 4-3-2/5.7.

5.5.4 Emergency Generator for Non-emergency Services (2008)
Provided that suitable measures are taken for safeguarding independent emergency operations under all circumstances, the emergency generator may be used, exceptionally, and for short periods, to supply non-emergency circuits during the blackout situation (see 4-1-1/3.11), dead ship condition (see 4-1-1/3.9), and routine use for testing (see 4-3-2/5.13). The generator is to be safeguarded against overload by automatically shedding such non-emergency services so that supply to the required emergency loads is always available. See also 4-3-2/5.9.5.

5.7 Transitional Source of Power (2009)
The transitional source of emergency electrical power, where required by 4-3-2/5.5.2.ii, is to consist of an accumulator battery which is to operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage, and be of sufficient capacity and is to be so arranged as to supply automatically in the event of failure of either the main or the emergency source of electrical power for half an hour at least the following services if they depend upon an electrical source for their operation:

i) The lighting required by 4-3-2/5.3.1 and 4-3-2/5.3.2. For this transitional phase, the required emergency electric lighting, in respect of the machinery space and accommodation and service spaces, may be provided by permanently fixed, individual, automatically charged, relay operated accumulator lamps; and

ii) All services required by 4-3-2/5.3.4 through 4-3-2/5.3.7 unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency.
5.9 Emergency Switchboard

5.9.1 General
The emergency switchboard is to be installed as near as is practicable to the emergency source of electrical power.

5.9.2 Emergency Switchboard for Generator
Where the emergency source of electrical power is a generator, the emergency switchboard is to be located in the same space unless the operation of the emergency switchboard would thereby be impaired.

5.9.3 Accumulator Battery
No accumulator battery fitted in accordance with 4-3-2/5.5.3 or 4-3-2/5.7 is to be installed in the same space as the emergency switchboard. An indicator is to be mounted on the main switchboard or in the machinery control room to indicate when these batteries are being discharged.

5.9.4 Interconnector Feeder Between Emergency and Main Switchboards (2014)
The emergency switchboard is to be supplied during normal operation from the main switchboard by an interconnector feeder which is to be protected at the main switchboard against overload and short circuit. The interconnector feeder is to be disconnected automatically at the emergency switchboard upon failure of the main source of electrical power. Where the system is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard against short circuit. In addition, the circuit protection device at the emergency switchboard on the interconnector feeder is to trip to prevent overloading of the emergency generator.

In designs where the main switchboard voltage is different from that of the emergency switchboard the power to the emergency switchboard is to be supplied from the main vessel service switchboard.

As far as practicable, the circuit coordination is to be arranged such that the outgoing circuits from the main vessel service switchboard will coordinate with the transformer circuit breakers to prevent the supply to the emergency switchboard from being unavailable due to a fault on one of the other outgoing circuits from the main vessel service switchboard.

Note:
For the purpose of this Rule, the main vessel service switchboard is a switchboard which is connected to the secondary of step-down transformer producing the required voltage.

5.9.5 Disconnection of Non-emergency Circuits
For ready availability of the emergency source of electrical power, arrangements are to be made where necessary to disconnect automatically non-emergency circuits from the emergency switchboard so that electrical power is to be automatically available to the emergency circuits.

5.11 Ballast Pumps
On column-stabilized units, it is to be possible to supply each ballast pump required by 4-2-4/13.5.1 from the emergency source of power. The arrangement is to be such that one of the pumps is connected directly to the main switchboard and the other pump is connected directly to the emergency switchboard. For systems utilizing independent pumps in each tank, all pumps are to be capable of being supplied from an emergency source of power. When sizing the emergency source of power in accordance with 4-3-2/5.3, the largest ballast pump capable of being supplied from this source is to be assumed to be operating simultaneously with the loads specified in 4-3-2/5.3, allowing for suitable load and diversity factors.

5.13 Arrangements for Periodic Testing
Provision is to be made to enable the periodic testing of the complete emergency system, and is to include the testing of automatic starting arrangements.
5.15 Starting Arrangements for Emergency Generator Sets

5.15.1 Cold Conditions
Emergency generating sets are to be capable of being readily started in their cold condition at a temperature of 0°C (32°F). If this is impracticable or if lower temperatures are likely to be encountered, heating arrangements are to be provided for ready starting of the generating sets.

5.15.2 Number of Starts
Each emergency generator that is arranged to be automatically started is to be equipped with approved starting devices with a stored energy capability of at least three consecutive starts. Unless a second independent means of starting is provided, the source of stored energy is to be protected to preclude critical depletion by automatic starting system, i.e., the automatic starting system is only allowable for consumption of the stored energy source to a level that would still provide the capability for starting the emergency generator upon intervention by personnel. In addition, a second source of energy is to be provided for an additional three starts within 30 minutes unless manual starting can be demonstrated to be effective to the Surveyor.

5.15.3 Charging of Stored Energy
The stored energy is to be maintained at all times, as follows:

5.15.3(a) Electrical and hydraulic starting systems are to be maintained from the emergency switchboard;

5.15.3(b) Compressed air starting systems may be maintained by the main or auxiliary compressed air receivers through a suitable non-return valve or by an emergency air compressor which, if electrically driven, is supplied from the emergency switchboard;

5.15.3(c) All of these starting, charging and energy storing devices are to be located in the emergency generator space. These devices are not to be used for any purpose other than the operation of the emergency generating set. This does not preclude the supply to the air receiver of the emergency generating set from the main or auxiliary compressed air system through the non-return valve fitted in the emergency generator space.

5.15.4 Manual Starting
Where automatic starting is not required, manual (hand) starting is permissible, such as manual cranking, inertia starters, manually charged hydraulic accumulators or power charge cartridges, where they can be demonstrated as being effective to the Surveyor.

When manual (hand) starting is not practicable, the requirements of 4-3-2/5.15.2 and 4-3-2/5.15.3 are to be complied with, except that starting may be manually initiated.

5.17 Alarms and Safeguards for Emergency Diesel Engines (2006)

5.17.1 Information to be Submitted
Information demonstrating compliance with these requirements is to be submitted for review. The information is to include instructions to test the alarm and safety systems.

5.17.2 Alarms and Safeguards
5.17.2(a) Alarms and safeguards are to be fitted in accordance with 4-3-2/5.17.2 TABLE 1.

5.17.2(b) The safety and alarm systems are to be designed to ‘fail safe’. The characteristics of the ‘fail safe’ operation are to be evaluated on the basis not only of the system and its associated machinery, but also the complete installation, as well as the unit.

5.17.2(c) Regardless of the engine output, if shutdowns additional to those specified in 4-3-2/5.17.2 TABLE 1 are provided, except for the overspeed shutdown, they are to be automatically overridden when the engine is in automatic or remote control mode.
5.17.2(d) The alarm system is to function in accordance with 4-9-2/3.1.2 and 4-9-2/7 of the Marine Vessel Rules, with additional requirements that grouped alarms are to be arranged on the bridge. For units that are not self-propelled, the grouped alarms are to be arranged at an emergency control station (see 8-2-1/11.7

5.17.2(e) In addition to the fuel oil control from outside the space, a local means of engine shutdown is to be provided.

5.17.2(f) Local indications of at least those parameters listed in 4-3-2/5.17.2 TABLE 1 are to be provided within the same space as the diesel engines and are to remain operational in the event of failure of the alarm and safety systems.

**TABLE 1**

<table>
<thead>
<tr>
<th>Systems</th>
<th>Monitored Parameters</th>
<th>A</th>
<th>Auto Shut Down</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel oil</td>
<td>Leakage from pressure pipes</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lubricating oil</td>
<td>Temperature –high</td>
<td>x</td>
<td></td>
<td>For engines having a power of 220 kW or more.</td>
</tr>
<tr>
<td></td>
<td>Lubricating oil pressure – low</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3</td>
<td>(2009) Oil mist in crankcase, mist concentration – high; or Bearing temperature - high; or Alternative arrangements</td>
<td>x</td>
<td>(2009) For engines having a power of 2250 kW (3000 hp) and above or having a cylinder bore of more than 300 mm (11.8 in.). See 4-2-1/7.2 of the Marine Vessel Rules.</td>
<td></td>
</tr>
<tr>
<td>Cooling medium</td>
<td>Pressure or flow –low</td>
<td>x</td>
<td></td>
<td>For engines having a power of 220 kW or more.</td>
</tr>
<tr>
<td></td>
<td>Temperature –high</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine</td>
<td>Overspeed activated</td>
<td>x</td>
<td>x</td>
<td>For engines having a power of 220 kW or more.</td>
</tr>
</tbody>
</table>

5.19 Requirements by the Governmental Authority

Attention is directed to the requirements of the governmental authority of the country whose flag the unit flies for the emergency services and the accumulator batteries required in various types of units.

7 Distribution System

7.1 Main Service Distribution System

7.1.1 General

Current-carrying parts with potential to earth are to be protected against accidental contact.

For recognized standard distribution systems, see 4-3-1/7. Separate feeders are to be provided for essential and emergency services.
7.1.2 Method of Distribution

The output of the unit’s service generators may be supplied to the current consumers by way of either branch system, meshed network system or ring main system. The cables of a ring-main or other looped circuit (e.g., interconnecting section boards in a continuous circuit) are to be formed of conductors having sufficient current-carrying and short-circuit capacity for any possible load and supply configuration.

7.1.3 Through-feed Arrangements

The size of feeder conductors is to be uniform for the total length, but may be reduced beyond any intermediate section board and distribution board, provided that the reduced size section of the feeder is protected by an overload device.

7.1.4 Motor Control Center (2006)

Feeder cables from the main switchboard or any section board to the motor control centers are to have a continuous current-carrying capacity not less than 100% of the sum of the nameplate ratings of all the motors supplied. Feeder cables of lesser current capacity are permitted, where the design is such that connected consumers are not operated simultaneously, under any operating mode.

7.1.5 Motor Branch Circuit

A separate circuit is to be provided for each fixed motor having a full-load current rating of 6 amperes or more and the conductors are to have a carrying capacity of not less than 100% of the motor full-load current rating. No branch circuit is to have conductors less than 1.5 mm² wire. Circuit-disconnecting devices are to be provided for each motor branch circuit and are to be in accordance with 4-3-3/3.13.2 and 6-1-7/9.15.2.

7.1.6 Power Supply Through Transformers and Converters

7.1.6(a) Continuity of Supply (2014).

Where transformers and/or converters form a part of the unit’s main service electrical system supplying essential services and services necessary for minimum comfortable conditions of habitability, the number and capacity of the transformers and/or converters are to be such that with any one transformer or converter or any one single phase of a transformer out of service, the remaining transformers and/or converters or remaining phases of the transformer are capable of supplying power to these loads under normal seagoing conditions.

See 4-3-5/1.3.6 for the additional requirements applicable for high voltage transformers.

7.1.6(b) Arrangements (2002).

Each required transformer is to be located as a separate unit with separate enclosure or equivalent, and is to be served by separate circuits on the primary and secondary sides. Each of the secondary circuits is to be provided with a multipole isolating switch. This multipole isolating switch is not to be installed on the transformer casing or its vicinity (in so far as practicable) in order to preclude its damage by fire or other incident at the transformer. A circuit breaker provided in the secondary circuit in accordance with 4-3-2/9.15.1 will be acceptable in lieu of the multipole isolating switch.
7.1.6(b) Arrangements (2020). Each required transformer is to be located in a separate enclosure or equivalent, and is to be served by separate circuits on the primary and secondary sides. When installed in the same space, the transformers are to be adequately separated to suitably protect and preclude damage by fire or other incident at one of the transformers. Each of the secondary circuits is to be provided with a multipole isolating switch. This multipole isolating switch is not to be installed on the transformer casing or its vicinity (in so far as practicable) in order to preclude its damage by fire or other incident at the transformer. A circuit breaker provided in the secondary circuit in accordance with 4-3-2/9.15.1, will be acceptable in lieu of a multipole isolating switch.

7.1.6(c) Transformers and Converters for Battery Charger (2004).

Where batteries connected to a single battery charger are the sole means of supplying DC power to equipment for essential services, as defined in 4-3-1/3.5, failure of the single battery charger under normal operating conditions should not result in total loss of these services once the batteries are depleted. In order to ensure continuity of the power supply to such equipment, one of the following arrangements is to be provided:

i) Duplicate battery chargers; or

ii) A single battery charger and a transformer/rectifier (or switching converter) which is independent of the battery charger, provided with a change-over switch; or

iii) Duplicate transformer/rectifier (or switching converter) units within a single battery charger, provided with a change-over switch.

The above requirements are not applicable for the following:

- The equipment for the essential services, which contains a single transformer/rectifier with a single AC power supply feeder to such equipment.
- The services which are not used continuously, such as battery chargers for engine starting batteries, etc.

7.1.6(d) Automatic Bus Transfer (2020). Where an Automatic Bus Transfer (ABT) is provided between the secondary side of the transformers and the load center panel connected directly without a multipole isolating switch or protective device, the ABT may be considered as the multipole isolating switch if it is provided with manual transfer operation lockable in either position. Details of the ABT is to be submitted for reference upon request.

7.1.7 Heating Appliances

Each heater is to be connected to a separate final subcircuit. However, a group of up to 10 heaters whose total current does not exceed 16A may be connected to a single final subcircuit.

7.1.8 Transformer Cable Sizing (2019)

Cables provided for primary and secondary circuits of transformers are to have current carrying capacities not less than the rated primary and secondary currents, respectively.

7.1.9 Generator Cable Sizing (2019)

Generator cable is to have a current carrying capacity of not less than the rated current or the rated continuous overload current of the generator.

7.3 Hull Return System

7.3.1 General

The hull return system is not to be used for power, heating or lighting, except that the following systems may be used:
i) Impressed current cathodic protective systems;

ii) Limited and locally earthed systems, provided that any possible resulting current does not flow directly through any hazardous areas; or

iii) Insulation level monitoring devices, provided the circulation current does not exceed 30 mA under all possible conditions.

Current-carrying parts with potential to earth are to be protected against accidental contact.

7.3.2 Final Subcircuits and Earth Wires
Where the hull return system is used, all final subcircuits (i.e., all circuits fitted after the last protective device) are to consist of two insulated wires, the hull return being achieved by connecting to the hull one of the bus bars of the distribution board from which they originate. The earth wires are to be in accessible locations to permit their ready examination and to enable their disconnection for testing of insulation.

7.5 Earthed Distribution Systems
System earthing is to be effected by means independent of any earthing arrangements of the non-current-carrying parts. Means of disconnection is to be provided in the neutral earthing connection of each generator so that the generator may be disconnected for maintenance. In distribution systems with neutral earthed or for generators intended to be run with neutrals interconnected, the machines are to be designed to avoid circulating currents exceeding the prescribed value. Transformer neutral is not to be earthed unless all corresponding generator neutrals are disconnected from the system (e.g., during shore supply). See 4-3-3/7.5.2.

7.7 External or Shore Power Supply Connection

7.7.1 General
Where arrangements are made for the supply of electricity from a source on shore or other external source, a termination point is to be provided on the unit for the reception of the flexible cable from the external source. Fixed cables of adequate rating are to be provided between the termination point and the main or emergency switchboard. Means for disconnecting the external or shore power supply are to be provided at the receiving switchboard. See 4-3-2/9.11 for the protection of external or shore power supply circuit.

7.7.2 Earthing Terminal
An earth terminal is to be provided for connecting the hull to an external earth.

7.7.3 Indicators
The external connection supply or shore connection is to be provided with a pilot lamp and a voltmeter (and frequency meter for AC) at main or emergency switchboard to show energized status of the cable.

7.7.4 Polarity or Phase Sequence
Means are to be provided for checking the polarity (for DC) or the phase sequence (for three-phase AC) of the incoming supply in relation to the unit’s system.

7.7.5 Information Plate (2012)
Refer to 7-1-6/7.7.1.

7.9 Harmonics (1 July 2017)
The total harmonic distortion (THD) in the voltage waveform in the distribution systems is not to exceed 8% and any single order harmonics not to exceed 5%. Other higher values may be accepted provided the distribution equipment and consumers are designed to operate at the higher limits. This relaxation on THD limits is to be documented (harmonic distortion calculation report) and made available on board as a
reference for the surveyor at each periodical survey. Where higher values of harmonic distortion are expected, any other possible effects, such as additional heat losses in machines, network resonances, errors in control and monitoring systems are to be considered. See also 9.18 and 9.19.

9 Circuit Protection System

9.1 System Design

9.1.1 General (1998)

Electrical installations are to be protected against accidental overload and short circuit, except

1) As permitted by 4-3-2/11.3,
2) Where it is impracticable to do so, such as engine starting battery circuit, and
3) Where by design, the installation is incapable of developing overload, in which case it may be protected against short circuit only.

The protection is to be by automatic protective devices for:

1) Continued supply to remaining essential circuits in the event of a fault, and
2) Minimizing the possibility of damage to the system and fire.

Three-phase, three-wire alternating current circuits are to be protected by a triple-pole circuit breaker with three overload trips or by a triple-pole switch with a fuse in each phase. All branch circuits are to be protected at distribution boards only and any reduction in conductor sizes is to be protected. Dual-voltage systems having an earthed neutral are not to have fuses in the neutral conductor, but a circuit breaker which simultaneously opens all conductors may be installed when desired. In no case is the dual-voltage system to extend beyond the last distribution board.

9.1.2 Protection Against Short-circuit

9.1.2(a) Protective Devices.

Protection against short-circuit is to be provided for each non-earthed conductor by means of circuit breakers or fuses.

9.1.2(b) Rated Short-circuit Breaking Capacity.

The rated short-circuit breaking capacity of every protective device is not to be less than the maximum available fault current at that point. For alternating current (AC), the rated short-circuit breaking capacity is not to be less than the root mean square (rms) value of the AC component of the prospective short-circuit current at the point of application. The circuit breaker is to be able to break any current having an AC component not exceeding its rated breaking capacity, whatever the inherent direct current (DC) component may be at the beginning of the interruption.

9.1.2(c) Rated Short-circuit Making Capacity.

The rated short-circuit making capacity of every switching device is to be adequate for maximum peak value of the prospective short-circuit current at the point of installation. The circuit breaker is to be able to make the current corresponding to its making capacity without opening within a time corresponding to the maximum time delay required.

9.1.3 Protection Against Overload

9.1.3(a) Circuit Breakers.
Circuit breakers or other mechanical switching devices for overload protection are to have a tripping characteristic (overload-trip time) adequate for the overload capacity of all elements in the system to be protected and for any discrimination requirements.

9.1.3(b) Fuses.

The fuse of greater than 320 amperes is not to be used for overload protection.

9.1.3(c) Rating (2005).

Fuse ratings and rating (or settings, if adjustable) of time-delay trip elements of circuit breakers are not to exceed the rated current capacity of the conductor to be protected as listed in 4-3-4/7.5 TABLE 2, except as otherwise permitted for generator, motor and transformer circuit protection in 4-3-2/9.3, 4-3-2/9.13 and 4-3-2/9.15. If the standard ratings or settings of overload devices do not correspond to the rating or the setting allowed for conductors, the next higher standard rating or setting may be used, provided it does not exceed 150% of the allowable current carrying capacity of the conductor, where permitted by the Standard to which the feeder cables have been constructed. Except as otherwise permitted for motor and transformer branch-circuit protection, adjustable-trip circuit breakers of the time-delay or instantaneous type are to be set to operate at not more than 150% of the rated capacity of the conductor to be protected.

9.1.3(d) Indication.

The rating or setting of the overload protective device for each circuit is to be permanently indicated at the location of the protective device.

9.1.4 Back-up Protection (2011)

9.1.4(a) Back-up Fuse Arrangements.

Circuit breakers having breaking and/or making capacities less than the prospective short-circuit current at the point of application will be permitted, provided that such circuit breakers are backed-up by fuses which have sufficient short-circuit capacity for that application. The fuse is to be specifically designed for back-up combinations with the circuit breaker and the maximum fault rating for the combination is to be provided.

9.1.4(b) Cascade Protection.

Cascade protection may be permitted, subject to special consideration. Such special consideration is not intended for new construction units, however may be granted when modifications are performed to existing units. The cascade protection is to be arranged such that the combination of circuit protective devices has sufficient short-circuit breaking capacity at the point of application (see 4-3-2/9.1.2(b)). All circuit protective devices are to comply with the requirements for making capacity (see 4-3-2/9.1.2(c)). Cascade protection is not to be used for circuits of primary essential services. Where cascade protection is used for circuits of secondary essential services, such services are to be duplicated, provided with means of automatic transfer and the automatic transfer is to alarm at a manned location. Cascade protection may be used for circuits of non-essential services.

9.1.5 Coordinated Tripping

Coordinated tripping is to be provided between generator, bus tie, bus feeder and feeder protective devices. See also 4-3-2/9.3.2 and 4-3-2/9.7.1. Except for cascade system (backup protection) in 4-3-2/9.1.4, the coordinated tripping is also to be provided between feeder and branch-circuit protective devices for essential services. Continuity of service to essential circuits under short-circuit conditions is to be achieved by discrimination of the protective devices as follows:

9.1.5(a) The tripping characteristics of protective devices in series are to be coordinated.
9.1.5(b) Only the protective device nearest to the fault is to open the circuit, except for cascade system (back-up protection) as specified in 4-3-2/9.1.4(a).

9.1.5(c) The protective devices are to be capable of carrying, without opening, a current not less than the short-circuit current at the point of application for a time corresponding to the opening of the breaker, increased by the time delay required for discrimination.

9.3 Protection for Generators

9.3.1 General

Generators of less than 25 kW not arranged for parallel operation may be protected by fuses. Any generators arranged for parallel operation and all generators of 25 kW and over are to be protected by a trip-free circuit breaker whose trip settings are not to exceed the thermal withstand capacity of the generator. The long-time over-current protection is not to exceed 15% above either the full-load rating of continuous-rated machines or the overload rating of special-rated machines. The shutting down of the prime mover is to cause the tripping of the unit main service generator circuit breaker.

9.3.2 Trip Setting for Coordination

The instantaneous and short-time overcurrent trips of the generators are to be set at the lowest values of current and time which will coordinate with the trip settings of feeder circuit breakers. See also 4-3-2/9.1.5, 4-3-2/9.5.1, and 4-3-2/9.5.2(a).

9.3.3 Load Shedding Arrangements (2004)

9.3.3(a) Provision for Load Shedding Arrangements.

In order to safeguard continuity of the electrical power supply, automatic load-shedding arrangements or other equivalent arrangements are to be provided:

i) Where only one generating set is normally used to supply power for propulsion and steering of the unit, and a possibility exists that due to the switching on of additional loads, whether manually or automatically initiated, the total load exceeds the rated generator capacity of the running generator, or

ii) Where electrical power is normally supplied by more than one generator set simultaneously in parallel operation for propulsion and steering of the unit, upon the failure of one of the parallel running generators, the total connected load exceeds the total capacity of the remaining generator(s).

9.3.3(b) Services not Allowed for Shedding.

Automatic load-shedding arrangements or other equivalent arrangements are not to automatically disconnect the following services. See 4-1-1/3.5 for the definition of essential services.

i) Primary essential services that, when disconnected, will cause immediate disruption to propulsion and maneuvering of the unit,

ii) Emergency services as listed in 4-3-2/5.3, and

iii) Secondary essential services that, when disconnected, will:

- Cause immediate disruption of systems required for safety and navigation of the unit, such as:
  - Lighting systems,
  - Navigation lights, aids and signals,
- Internal communication systems required by 4-3-2/15, etc.
- Prevent services necessary for safety from being immediately reconnected when the power supply is restored to its normal operating conditions, such as:
  - Fire pumps, and other fire extinguishing medium pumps,
  - Bilge pumps,
  - Ventilation fans for engine and boiler rooms.

9.3.4 Emergency Generator

The emergency generator is also to comply with 4-3-2/9.1, 4-3-2/9.3, 4-3-2/9.5 and 4-3-2/9.7, where applicable. See also 4-3-2/5.9.

9.5 Protection for Alternating-current (AC) Generators

9.5.1 Short-time Delay Trip (2008)

Short-time delay trips are to be provided with circuit breakers for AC generators. See also 4-3-2/9.3.2. The current setting of the short time delay trip is to be less than the steady state short circuit current of the generator.

For generators with a capacity of less than 200 kW having prime movers such as diesel engines or gas turbines which operate independently of the electrical system, consideration may be given to omission of short-time delay trips, if instantaneous trips and long time overcurrent protection (see 4-3-2/9.3.1) are provided. When the short time delay trips are omitted, the thermal withstand capacity of the generator is to be greater than the steady state short-circuit current of the generator, until activation of the tripping system.

9.5.2 Parallel Operation

Where AC generators are arranged for parallel operation with other AC generators, the following protective devices are to be provided.

9.5.2(a) Instantaneous Trip (2016).

Instantaneous trips are to be installed and set in excess of the maximum short-circuit contribution of the individual generator where three or more generators are arranged for parallel operation. Alternative suitable protection, such as generator differential protection, which will trip the generator circuit breaker in the event of a fault in the generator or in the supply cable between the generator and its circuit breaker, would also be acceptable. See also 4-3-2/9.3.2.

9.5.2(b) Reverse Power Protection (2006).

A time-delayed reverse active power protection or other devices which provide adequate protection is to be provided. The setting of protective devices is to be in the range of 8% to 15% of the rated power for diesel engines. A setting of less than 8% of the rated power of diesel engines may be allowed with a suitable time delay recommended by the diesel engine manufacturer. A fall of 50% in the applied voltage is not to render the reverse power protection inoperative, although it may alter the setting to open the breaker within the above range.

9.5.2(c) Undervoltage Protection.

Means are to be provided to prevent the generator circuit breaker from closing if the generator is not generating, and to open the same when the generator voltage collapses.

In the case of an undervoltage release provided for this purpose, the operation is to be instantaneous when preventing closure of the breaker, but is to be delayed for discrimination purposes when tripping a breaker.
9.7 Protection for Direct Current (DC) Generators

9.7.1 Instantaneous Trip
DC generator circuit breakers are to be provided with an instantaneous trip set below the generator maximum short-circuit current and are to coordinate with the trip settings of feeder circuit breakers supplied by the generator.

9.7.2 Parallel Operation

9.7.2(a) Reverse Current Protection.
DC generators arranged for parallel operation with other DC generators or with an accumulator battery are to be provided with instantaneous or short-time delayed reverse current protection. The setting of the protection devices is to be within the power range specified by 4-3-2/9.5.2(b). When the equalizer connection is provided, the reverse current device is to be connected on the pole opposite to the equalizer connection where the series compound winding for the generator is connected. Reverse current protection is to be adequate to deal effectively with reverse current conditions emanating from the distribution system (e.g., electric driven cargo winches).

9.7.2(b) Generator Ammeter Shunts.
Generator ammeter shunts are to be so located that the ammeters indicate total generator current.

9.7.2(c) Undervoltage Protection.
Requirements for AC generator in 4-3-2/9.5.2(c) are also applicable to DC generator.

9.9 Protection for Accumulator Batteries (2019)
Accumulator (storage) batteries, other than engine starting batteries, are to be protected against overload and short circuits by devices placed as near as practicable to the batteries but outside of the battery rooms, lockers or boxes, except that the emergency batteries supplying essential services are to have short circuit protection only. Fuses may be used for the protection of emergency lighting storage batteries instead of circuit breakers up to and including 320 amperes rating. The charging equipment, except converters, for all batteries with a voltage more than 20% of the line voltage is to be provided with reverse current protection.

Where equipment or DC distribution panel is fed from two feeders or sources of DC battery power connected in parallel from separate battery charger systems, the batteries are to be protected from reverse power by means of:

- Manual change over switch as applicable
- Automatic change over from one source to the other provided in the equipment as required
- Power diodes in the feeder circuit
- Diode relay switching units

9.11 Protection for External or Shore Power Supply

9.11.1 General
Where arrangements are made for the supply of electricity from a source on shore or other external source, permanently fixed cables from the external supply or shore connection box to the main or emergency switchboard are to be protected by fuses or circuit breakers located at the connection box.

9.11.2 Interlocking Arrangement
Where the generator is not arranged for parallel operation with the external or shore power supply, an interlocking arrangement is to be provided for the circuit breakers or disconnecting devices
between generator and the external or shore power supply in order to safeguard from connecting unlike power sources to the same bus.

9.13 Protection for Motor Branch Circuits

9.13.1 General
Trip elements of circuit breaker for starting and for short-circuit protection are to be in accordance with 9.13.2 or 9.13.3, except that circuit breakers having only instantaneous trips may be provided as part of the motor control center. Where circuit breakers having only instantaneous trips are provided, the motor running protective device is to open all conductors, and the motor controller is to be capable of opening the circuit without damage to itself resulting from a current up to the setting of the circuit breaker. Circuit-disconnecting devices are to be provided for each motor branch circuit and are to be in accordance with 4-3-3/3.13.2 and 6-1-7/9.15.2.

9.13.2 Direct-current Motor Branch Circuits
The maximum fuse rating or the setting of the time-delay trip element is to be 150% of the full-load rating of the motor served. If that rating or setting is not available, the next higher available rating or setting may be used.

9.13.3 Alternating-current Motor Branch Circuits
The maximum fuse rating or setting of the trip element is to be the value stated below. If that rating or setting is not available, the next higher available rating or setting may be used.

<table>
<thead>
<tr>
<th>Type of Motor</th>
<th>Rating or Setting in % Motor Full-load Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Squirrel-cage and Synchronous Full-voltage, Reactor or Resistor-starting</td>
<td>250</td>
</tr>
<tr>
<td>Autotransformer Starting</td>
<td>200</td>
</tr>
<tr>
<td>Wound Rotor</td>
<td>150</td>
</tr>
</tbody>
</table>

When fuses are used to protect polyphase motor circuits, it is to be arranged to protect against single-phasing.

The setting of magnetic instantaneous trips for short-circuit protection only is to exceed the transient current inrush of the motor, and is to be the standard value nearest to, but not less than, 10 times full-load motor current.

9.13.4 Motor Running Protection
Running protection is to be provided for all motors having a power rating exceeding 0.5 kW, except that such protection is not to be provided for steering motors (see 4-3-2/11.3). The running protection is to be set between 100% and 125% of the motor rated current.

9.13.5 Undervoltage Protection and Undervoltage Release (2011)
Undervoltage protection is to be provided for motors having power rating exceeding 0.5 kW (0.7 hp) to prevent undesired restarting upon restoration of the normal voltage, after a stoppage due to a low voltage or voltage failure condition.

Undervoltage release is to be provided for the following motors unless the automatic restart upon restoration of the normal voltage will cause hazardous conditions:

a) Primary essential services (see 4-1-1/7.11 TABLE 3).
b) Only those secondary essential services (see 4-1-7.1 TABLE 4) necessary for safety, such as:

i) Fire pumps and other fire extinguishing medium pumps.

ii) Bilge pumps.

iii) Ventilating fans for engine and boiler rooms where they may prevent the normal operation of the propulsion machinery (See Note 1 below)

Special attention is to be paid to the starting currents due to a group of motors with undervoltage release controllers being restarted automatically upon restoration of the normal voltage. Means such as sequential starting is to be provided to limit excessive starting current, where necessary.

Note:

1 Undervoltage protection is to be provided for ventilation fans for engine and boiler room, which are supplied by an emergency source of power for the purpose of removing smoke from the space after a fire has been extinguished.

9.13.6 Jacking Gear Motors (2011)

For group installations of jacking gear motors, see the special arrangements permitted in 6-1-9/15.

9.15 Protection for Transformer Circuits

9.15.1 Setting of Overcurrent Device

Each power and lighting transformer feeder is to be protected by an overcurrent device rated or set at a value not more than 125% of rated primary current. When a transformer is provided with an overcurrent device in the secondary circuit rated or set at not more than 125% of rated secondary current, the feeder overcurrent device may be rated or set at a value less than 250% of the rated primary current.

9.15.2 Parallel Operation (2006)

When the transformers are arranged for parallel operation, means are to be provided to disconnect the transformer from the secondary circuit. Where power can be fed into secondary windings, short-circuit protection (i.e., short-time delay trips) is to be provided in the secondary connections. In addition, when the disconnecting device in primary side of the transformer is opened due to any reason (e.g., the short-circuit protection, overload protection, or manual operation for opening), the disconnecting device in the secondary side of the transformer is to be arranged to open the circuit automatically.

9.17 Protection for Meters, Pilot Lamps and Control Circuits

Indicating and measuring devices are to be protected by means of fuses or current limiting devices. For devices such as voltage regulators where interruption of the circuit may have serious consequences, fuses are not to be used. If fuses are not used, means are to be provided to prevent fire in an unprotected part of the installation. Fuses are to be placed as near as possible to the tapping from the supply.

9.18 Harmonic Distortion for Unit Electrical Distribution System including Harmonic Filters (1 July 2017)

9.18.1 Monitoring

Where the electrical distribution system on board a unit includes harmonic filters, such units are to be fitted with facilities to continuously monitor the levels of harmonic distortion experienced on the main bus bar as well as alert the crew should the level of harmonic distortion exceed the acceptable limits. Where the engine room is provided with automation systems, this reading is to be logged electronically, otherwise it is to be recorded in the engine log book for future inspection by the Surveyor. However, harmonic filters installed for single application frequency drives such as pump motors may be excluded from the requirements of this section.
9.18.2 Measurement

As a minimum, harmonic distortion levels of main bus bar on board such existing ships are to be measured annually under seagoing conditions as close to the periodical machinery survey as possible so as to give a clear representation of the condition of the entire plant to the Surveyor. Harmonic distortion readings are to be carried out when the greatest amount of distortion is indicated by the measuring equipment. An entry showing which equipment was running and/or filters in service is to be recorded in the log so this can be replicated for the next periodical survey. Harmonic distortion levels are also to be measured following any modification to the ship’s electrical distribution system or associated consumers by suitably trained ship’s personnel or from a qualified outside source. Records of all the above measurements are to be made available to the surveyor at each periodical survey in accordance with Part 7 of the Rules.

9.18.3 Validation of Calculated Harmonic

Where the electrical distribution system on board a unit includes harmonic filters, the system integrator of the distribution system is to show, by calculation, the effect of a failure of a harmonic filter on the level of harmonic distortion experienced.

The system integrator of the distribution system is to provide the unit owner with guidance documenting permitted modes of operation of the electrical distribution system while maintaining harmonic distortion levels within acceptable limits during normal operation as well as following the failure of any combination of harmonic filters.

The calculation results and validity of the guidance provided are to be verified by the Surveyor during sea trials.

9.18.4 Filter Protection Alarm

Arrangements are to be provided to alert the crew in the event of activation of the protection of a harmonic filter circuit.

A harmonic filter is to be arranged as a three-phase unit with individual protection of each phase. The activation of the protection arrangement in a single phase is to result in automatic disconnection of the complete filter. Additionally, there is to be installed a current unbalance detection system independent of the overcurrent protection alerting the crew in case of current unbalance.

Consideration is to be given to additional protection for the individual capacitor element as (e.g., relief valve or overpressure disconnector) in order to protect against damage from rupturing. This consideration is to take into account the type of capacitors used.

9.19 Protection of Harmonic Filter Circuits (1 July 2017)

Notwithstanding the requirements of 9.18 above, harmonic filters circuits shall be protected against overload and short-circuit. An alarm is to be initiated in a continuously manned location in the event of an activation of overload or short-circuit protection.

In cases where multiple harmonic filter circuits are used in series or in parallel, current imbalance between the different filter circuits is to be continuously monitored. The total rms current into each phase of a passive harmonic filter circuit is also to be monitored. Detection of a current imbalance shall be alarmed in a continuously manned location. If the current imbalance exceeds the ratings of the individual filter circuit components, the appropriate circuits shall automatically trip and be prevented from interacting with other parts of the electrical network.

Harmonic filters that contain capacitors are to have means of monitoring and of providing advance warning of capacitor(s) deterioration. Harmonic filters containing oil filled capacitors are to be provided with suitable means of monitoring oil temperature or capacitor internal pressure. Refer to 5-2-3/13 for additional requirements. Detection of capacitor(s) deterioration shall be alarmed locally at the equipment.
and in a continuously manned location. Power to the harmonic filter circuit containing the deteriorated capacitor(s) shall be automatically disconnected and the capacitor discharged safely upon detection of deterioration.

In cases where provisions for automatic/manual switching and/or disconnection of harmonic filter circuits are provided, there are to be provisions to prevent transient voltages in the system and to automatically discharge the capacitors in the harmonic filter circuits before they can be put back on-line.

Capacitors used in harmonic filters/capacitor banks are to be prevented from producing a leading system power factor which could potentially lead to generator(s) becoming self-excited. In cases where a leading power factor condition approaches the point of the generator(s) becoming self-excited, the appropriate capacitive circuits shall be automatically disconnected and prevented from interacting with the rest of the electrical network.

11 Systems for Steering Gear Installed in Self-propelled Units

11.1 Power Supply Feeder

Each electric or electro-hydraulic steering gear is to be served by at least two exclusive circuits fed directly from the main switchboard. However, one of the circuits may be supplied through the emergency switchboard.

For self-propelled units fitted with alternative propulsion and steering arrangements, such as azimuthing propulsors, where the propulsion power exceeds 2,500kW per thruster unit, see 4-3-5/5.12.3 of the Marine Vessels Rules.

An auxiliary electric or electro-hydraulic steering gear associated with a main electric or electro-hydraulic steering gear may be connected to one of the circuits supplying this main steering gear. The circuits supplying an electric or electro-hydraulic steering gear are to have adequate rating for supplying all motors, control systems and instrumentation which are normally connected to them and operated simultaneously. The circuits are to be separated throughout their length as widely as is practicable.

11.3 Protection for Steering Gear Motor Circuit

11.3.1 Short Circuit Protection (1997)

Each steering gear feeder is to be provided with short-circuit protection which is to be located at the main or emergency switchboard. Long-term overcurrent protection is not to be provided for steering gear motors.

11.3.1(a) Direct Current (DC) Motors.

For DC motors, the feeder circuit breaker is to be set to trip instantaneously at not less than 300% and not more than 375% of the rated full-load current of the steering-gear motor, except that the feeder circuit breaker on the emergency switchboard may be set to trip at not less than 200%.

11.3.1(b) Alternating Current (AC) Motors.

For AC motors, the protection against excess current, including starting current, if provided, is to be for not less than twice the full load current of the motor or circuit so protected, and is to be arranged to permit the passage of the appropriate starting currents.

11.3.1(c) Fuses as Motor-feeder Protection.

The use of fuses instead of circuit breakers for steering gear motor feeder short circuit protection is not permitted.
11.3.2 Undervoltage Release
Power unit motor controllers and other automatic motor controllers are to be fitted with undervoltage release.

11.5 Emergency Power Supply
Where the rudder stock is required by 3-2-14/7.1 of the Marine Vessel Rules to be over 230 mm (9 in.) diameter using $K_s = 1.0$ in way of the tiller, excluding strengthening for navigation in ice, an alternative power supply, sufficient at least to supply the steering gear power unit and also its associated control system and rudder angle indicator, is to be provided automatically within 45 seconds either from the emergency source of electrical power or from an independent source of power located in the steering gear compartment. The steering gear power unit under alternative power supply is to be capable of moving the rudder from 15 degrees on one side to 15 degrees on the other side in not more than 60 seconds with the unit at the line draft while running at one half the maximum speed ahead or 7 knots, whichever is the greater. This independent source of power is to be used only for this purpose. The capacity is to be sufficient for at least 10 minutes of continuous operation.

11.7 Controls, Instrumentation, and Alarms
See 4-3-4/5.7, 4-3-4/13, 4-3-4/15 and 4-3-4/17 of the Marine Vessel Rules.

13 Lighting and Navigation Light Systems

13.1 Lighting System
13.1.1 Main Lighting System
A main electric lighting system is to provide illumination throughout those parts of the unit normally accessible to and used by crew. It is to be supplied from the main source of electrical power.

13.1.2 System Arrangement
13.1.2(a) Main Lighting System.

The arrangement of the main electric lighting system is to be such that a fire or other casualty in spaces containing the main source of electrical power, associated transforming equipment, if any, the main switchboard and the main lighting switchboard will not render the emergency electric lighting system required by 4-3-2/5.3.1 and 4-3-2/5.3.11(a) inoperative.

13.1.2(b) Emergency Lighting System.

The arrangement of the emergency electric lighting system is to be such that a fire or other casualty in spaces containing the emergency source of electrical power, associated transforming equipment, if any, the emergency switchboard and the emergency lighting switchboard will not render the main electric lighting system required by 4-3-2/13.1.1 inoperative.

13.1.3 Lighting Circuits
13.1.3(a) Machinery Space and Accommodation Space (2006). In spaces such as:

- Public spaces
- Category A machinery spaces
- Galleys
- Corridors
- Stairways leading to boat-decks, including stair towers and escape trunks
there is to be more than one final subcircuit for lighting, one of which may be supplied from the emergency switchboard, in such a way that failure of any one circuit does not leave these spaces in darkness.

13.1.4 Protection for Lighting Circuits
Lighting circuits are to be protected against overload and short circuit. Overload protective devices are to be rated or set at not more than 30 amperes. The connected load is not to exceed the lesser of the rated current carrying capacity of the conductor or 80% of the overload protective device rating or setting. The control switches are to be rated for the load controlled.

13.1.5 Lighting Distribution Boards (2016)

i) To prevent the simultaneous loss of main and emergency lighting distribution boards due to localized fire or other casualty, these distribution boards are to be installed as widely apart as practicable in the machinery spaces.

ii) For spaces other than the machinery space (e.g., accommodation space, cargo spaces, etc.), these lighting distribution boards are to be installed at locations which are separated by a boundary wall. The boundary wall separation is to be a non-combustible partition complying with as a minimum a C-class panel division.

iii) For the central control room, the main and emergency lighting distribution boards are not to be installed in the same compartment of the navigation console or panel.

iv) Cables emanating from the main or emergency lighting switchboard to the main or emergency lighting distribution board, respectively, are also to be installed as widely apart as practicable.

13.3 Navigation Light System (2017)

13.3.1 Feeder
Navigation lights (mast head, side and stern lights) are to be fed by their own exclusive distribution board located on the bridge. The distribution board is to be supplied from the main as well as from the emergency source of power (see 4-3-2/5.3.2). A means to transfer the power source is to be fitted on the bridge.

13.3.2 Branch Circuit
Each navigation light is to have its own branch circuit, and each branch circuit is to be fitted with a protective device.

13.3.3 Duplicate Lamp
Each navigation light is to be fitted with duplicate lamps.

13.3.4 Control and Indication Panel
A control and indication panel for the navigation lights is to be provided on the navigation bridge. The panel is to be fitted with the following functions:

i) A means to disconnect each navigation light.

ii) An indicator for each navigation light.

iii) Automatic visual and audible warning in the event of failure of a navigation light. If a visual signal device is connected in series with the navigation light, the failure of this device is not to cause the extinction of the navigation light. The audible device is to be connected to a separate power supply so that the audible alarm may still be activated in the event of power or circuit failure to the navigation lights.
15 Interior Communication Systems

15.1 Navigation Bridge

15.1.1 General
At least two independent means are to be provided for communicating orders from the navigation bridge to the position in the machinery space or in the control room from which the speed and direction of thrust of the propellers are normally controlled. Appropriate means of communication are to be provided to any other positions from which the main propulsion machinery may be controlled. See 4-3-2/5.3.4 for power supply.

15.1.2 Engine Order Telegraph
One of the communicating means between navigation bridge and the main propulsion control position is to be an engine room telegraph which provides visual indication of the orders and responses both in the machinery space and on the navigation bridge. Final subcircuit for power supply to this system is to be independent of other electrical systems and control, monitoring and alarm systems. See 4-3-2/5.3.4 for power supply. Communication network and power supply circuit for this may be combined with the engine order telegraph system specified in 4-3-2/15.3.

15.3 Main Propulsion Control Stations
A common talking means of voice communication and calling or engine order telegraph repeater is to be provided between the main propulsion control station and local control positions for main propulsion engines and controllable pitch propellers. Voice communication systems are to provide the capability of carrying on a conversation while the unit is being navigated. Final subcircuit for power supply to these are to be independent of the other electrical system and the control, monitoring and alarm systems. Communication network and power supply circuit for the voice communication system may be combined with the system required in 4-3-2/15.5.

15.5 Voice Communications

15.5.1 Propulsion and Steering Control Stations
A common talking means of voice communication and calling is to be provided between the navigation bridge, main propulsion control station and the steering gear compartment so that the simultaneous talking among these spaces is possible at all times and the calling to these spaces is always possible even if the line is busy.

15.5.2 Communication in Case of an Emergency (2007)
Means of voice communication is to be available for transfer of information between all locations where action may be necessary in case of an emergency. Such locations include the emergency control stations required by 8-2-1/11.17, machinery spaces, SCR rooms and all locations vital to the safety of the unit. Simultaneous talking among these locations is to be possible at all times and the calling to these locations is always to be possible even if the line is busy.

15.5.3 Elevator
Where an elevator is installed, a telephone is to be permanently installed in all cars and connected to a continuously manned area. The telephone may be sound powered, battery operated or electrically powered from the emergency source of power.

15.5.4 Jacking System (2011)
A voice communication system is to be provided between the central jacking control station and a location at each leg in self-elevating units.
15.5.5 Independence of Power Supply Circuit

Final subcircuit for power supply to these voice communication systems is to be independent of other electrical systems and control, monitoring and alarm systems. See 4-3-2/5.3.4 for power supply.

15.7 Emergency and Interior-communication Switchboard

Emergency and interior-communication switchboards, when fitted, are to comply with the applicable parts of 6-1-7/9, and attention is directed to the requirements of the governmental authority whose flag the unit flies.

15.9 Public Address System (2007)

The public address system is to comply with subparagraphs 4-3-2/15.9.1 through 4-3-2/15.9.4 as follows:

15.9.1 System Requirements

The system is to be a loud speaker installation enabling the broadcast of messages which are clearly audible in all parts of the unit. The system is to provide for the broadcast of messages from the navigation bridge, emergency control stations (see 8-2-1/11.7) and other strategic points with an override function so that all emergency messages may be broadcast if any loudspeaker in the locations concerned has been turned off, its volume has been turned down or the public address system is in use for other purposes.

15.9.2 Minimum Sound Levels

With the unit underway or in normal operating conditions, the minimum sound levels for broadcasting emergency announcements are to be:

i) In interior locations, 75 dB (A) and at least 20 dB (A) above the speech interference level.

ii) In exterior locations, 80 dB (A) and at least 15 dB (A) above the speech interference level.

15.9.3 Emergency Source of Power

The system is to be connected to the emergency source of power.

15.9.4 Public Address System Combined with General Alarm System (2013)

Where a single system serves for both public address and general emergency alarm functions, the system is to be arranged so that a single failure is not to cause the loss of both systems and is to minimize the effect of a single failure. The major system components, such as power supply unit, amplifier, alarm tone generator, etc., are to be duplicated. Power supply is to comply with 17.1.2(b) and 17.1.2(c). The coverage provided by the arrangement of the system loops and speakers is to be such that after a single failure, the announcements and alarms are still audible in all spaces. Duplication of system loops and speakers in each room or space is not required provided the announcements and alarms are still audible in all spaces.

17 Manually Operated Alarms

17.1 General Emergency Alarm Systems

17.1.1 General (1999)

A general alarm system complying with requirements of 4-3-2/17.1.2 is to be provided to summon crew to muster stations and initiate actions included in the muster list. The system is to be supplemented by instructions over a public address system meeting the requirements of 4-3-2/15.9. Any entertainment sound system is to be automatically turned off when the general emergency alarm is activated.
17.1.2 System Requirements (2009)

17.1.2(a) The general emergency alarm system is to be capable of sounding the general emergency alarm signal, fire alarm signal and abandon unit signal on an electrically operated bell or klaxon or other equivalent warning system, which is to be powered from the unit’s main supply and the emergency source of electrical power required by 4-3-2/5.

17.1.2(b) (2017) There are to be not less than two sources of power supply for the electrical equipment used in the operation of the General Emergency Alarm System, one of which is to be from the emergency switchboard and the other from the main switchboard. The supply is to be provided by separate feeders reserved solely for that purpose. Such feeders are to run to an automatic change-over switch situated in, without passing through any other distributing switchboard, or adjacent to, the main general emergency alarm control panel.

17.1.2(c) (2017) An alarm is to be provided in a normally manned control station to indicate when there is a loss of power in any one of the feeders required by 4-3-2/17.1.2(b).

17.1.2(d) As an alternative to two feeders as described in 4-3-2/17.1.2(b), a battery may be considered as one of the required sources, provided the battery has the capacity of at least 30 minutes of continuous operation for alarming and 18 hours in standby. A low voltage alarm for the battery and the battery charger output is to be provided. The battery charger is to be supplied from the emergency switchboard.

17.1.2(e) The system is to be capable of operation from the navigation bridge, emergency control stations (see 8-2-1/11.17) and from other strategic points. The system is to be clearly audible in all parts of the unit. The alarm is to continue to function after it has been triggered until it is manually turned off or is temporarily interrupted by a message on the public address system. Self-propelled units are to be capable of sounding the general emergency alarm on the unit’s whistle, but which need only be capable of operation from the navigation bridge.

17.1.2(f) (2012) For minimum sound levels for the emergency alarm tone required to be verified onboard, see 7-1-6/17.1.

17.3 Engineers’ Alarm (2012)

An engineers’ alarm operable from the main propulsion control station or at the maneuvering platform, as appropriate, is to be provided. See 7-1-6/17.3 for minimum sound level and 4-3-2/5.3.12(c) for power supply.

17.5 Refrigerated Space Alarm

Fan and diffuser rooms serving subfreezing compartments are to be provided with a device capable of activating an audible and visual alarm in a manned control center and operable from within the latter space for the protection of personnel. See 4-3-2/5.3.12(c) for power supply.

17.7 Elevator

A device which will activate an audible and visual alarm in a manned control center is to be provided in all cars. Such alarm system is to be independent of power and control systems of the elevator. See 4-3-2/5.3.12(c) for power supply.

19 Fire Protection and Fire Detection Systems

19.1 Emergency Stop

19.1.1 Ventilation System (2013)

19.1.1(a) General.
All electrical ventilation systems are to be provided with means for stopping the motors in case of fire or other emergency. These requirements do not apply to closed recirculating systems within a single space. See also 5-3-1/7.1.

19.1.1(b) Propulsion Machinery Space Ventilation.

The main machinery-space ventilation is to be provided with means for stopping the ventilation fans. The means for stopping the power ventilation serving machinery spaces is to be entirely separate from the means for stopping the ventilation of spaces in 19.1.1(c) and 19.1.1(d).

19.1.1(c) Machinery Spaces other than Propulsion Machinery Spaces.

Power ventilation systems serving these spaces are to be fitted with means for stopping the ventilation fan motors in the event of fire. The means for stopping the power ventilation serving these spaces is to be entirely separate from the means for stopping the ventilation of spaces in 4-3-2/19.1.1(b) and 4-3-2/11.9.1(d). See 5-3-1/7.1.1.

19.1.1(d) Accommodation Spaces, Service Spaces, Control Stations and Other Spaces.

A control station for all other power ventilation systems is to be located in the fire-control room or navigation bridge, or in an accessible position leading to, but outside of the space ventilated.

19.1.2 Other Auxiliaries (2009)

See 5-3-1/7.3 for emergency tripping and emergency stop for other auxiliaries, such as forced and induced draft fans, electric motor pressurization fans, oil fuel transfer pumps, oil fuel unit pumps.

19.3 Fire Detection and Alarm System

See 5-2-5/1.1.
PART 4
CHAPTER 3 Electrical Installations
SECTION 3 Onboard Installation

1 Plans and Data to be Submitted

1.1 Booklet of Standard Details (2014)
A booklet of the standard wiring practices and details, including such items as cable supports, earthing
details, bulkhead and deck penetrations, cable joints and sealing, cable splicing, watertight and explosion-proof
connections to equipment, earthing and bonding connections, etc., as applicable, is to be submitted. Where cable
penetration methods for A- or B-class decks or bulkheads are shown, an evidence of approval by an Administration
signatory to 1974 SOLAS as amended is also to be submitted.

For high voltage systems, see installation requirements given in 4-3-5/1.9.3.

For high voltage cables, the minimum cable bending radii and securing arrangements, taking the relevant
recommendations of the cable manufacturer into consideration, are to be included. Cable tray segregation
(HV to HV and HV to LV arrangements) are also to be included.

1.3 Arrangement of Electrical Equipment
A general arrangement plan showing the location of at least the following electrical equipment is to be
submitted for review.
- Generator, Essential Motor, and Transformer
- Battery
- Switchboard, Battery Charger, and Motor Controller
- Emergency Lighting Fixture
- General Emergency Alarm Device and Alarm Actuator
- Detector, Manual Call Point and Alarm Panel for Fire
- Detection and Alarm System
- Certified-safe Type Equipment

Where cable splices or cable junction boxes are provided, locations of the splices and cable junction boxes
together with the information of their services are also to be submitted for review.

1.5 Electrical Equipment in Hazardous Areas (2018)
A plan showing hazardous areas, as defined in Section 4-3-6, is to be submitted for review together with
the following:
- A list/booklet of intended electrical equipment in the indicated hazardous areas, including a
description of the equipment, applicable degree of protection and ratings. See 4-3-3/9.3.
- The list/booklet indicated above is to include any equipment listed in 4-3-5/7.1.4 in exterior locations
(in non-hazardous area) operable after emergency shutdown.
For intrinsically-safe systems, also wiring plans, installation instructions with any restrictions imposed by the certification agency.

- Detail of installation for echo sounder, speed log and impressed current cathodic protection system where located in these areas.

When the selection of the equipment has been finalized, a list/booklet identifying all equipment in the hazardous areas, their method of protection (flameproof, intrinsically safe, etc.), rating (flammable gas group and temperature class), manufacturer’s name, model number and evidence of certification is to be submitted for review. See 7-1-6/21.17, 7-2-5/13.3, and 4-3-3/9.1.

1.7 Emergency Shutdown Procedures (2017)

Details of the emergency shutdown procedures for electrical equipment as referred to in 8-2-1/11.17. See also 4-3-5/7.1.

In addition, the following documents are to be submitted for review:

i) The ESD Functional Design Basis Document (FDS) Operation Manual (see 4-3-5/7.1.1)

ii) Gas Detection / ESD System Cause and Effect Chart (see 4-3-5/7.1.2)

1.9 Maintenance Schedule of Batteries (2008)

Maintenance schedule of batteries for essential and emergency services. See 4-3-3/3.7.5.

3 Equipment Installation and Arrangement

3.1 General Consideration

3.1.1 Equipment Location (2006)

3.1.1(a) General.

Electrical equipment is to be so placed or protected as to minimize the probability of mechanical injury or damage from the accumulation of dust, oil vapors, steam or dripping liquids. Equipment liable to generate arc is to be ventilated or placed in a compartment ventilated to avoid accumulation of flammable gases, acid fumes and oil vapors. See 4-3-3/9.7.3 TABLE 1 for required degree of protection for various locations.

3.1.1(b) Equipment in Areas Affected by Local Fixed Pressure Water-spraying or Local Water-mist Fire Extinguishing System in Machinery Spaces (2014).

Electrical and electronic equipment within areas affected by Local Fixed Pressure Water-spraying or Local Water-mist Fire Extinguishing Systems are to be suitable for use in the affected area. See 4-3-3/3.1.1(b) FIGURE 1. Where enclosures have a degree of protection lower than IP44, evidence of suitability for use in these areas is to be submitted to ABS taking into account:

i) The actual Local Fixed Pressure Water-spraying or Local Water-mist Fire Extinguishing system being used and its installation arrangements, and

ii) The equipment design and layout (e.g., position of inlet ventilation openings, filters, baffles, etc.) to prevent or restrict the ingress of water mist/spray into the equipment. The cooling airflow for the equipment is to be assured.

Notes:

Additional precautions may be required to be taken with respect to:

a) Tracking as the result of water entering the equipment
b) Potential damage as the result of residual salts from sea water systems

c) High voltage installations

d) Personnel protection against electric shock

Equipment may require maintenance after being subjected to water mist/spray.

**FIGURE 1**

Example of Area Affected by Local Fixed Pressure Water-spraying
Water mist Fire Extinguishing System in Machinery Spaces (2014)

3.3 Generators

In general, all generators on ship-type units are to be located with their shafts in a fore-and-aft direction on the unit and are to operate satisfactorily in accordance with the inclination requirements of 4-1-1/7.1. Where it is not practicable to mount the generators with the armature shafts in the fore-and-aft direction, their lubrication will require special consideration. Provision is to be made to prevent oil or oil vapor from passing into the machine windings.

3.5 Motors for Essential Services

3.5.1 General

Motors for use in the machinery space above the floor plate or spaces where subject to mechanical injury, or dripping of oil or water are to have an enclosure of at least IP22 protection in accordance with 4-3-3/9.7.3 TABLE 1. However, where they are protected by drip covers, they may have an enclosure of a lower protection grade than IP22. The motors having a protection enclosure of IP22 or lower are to be installed at a location high enough to avoid bilge water. Motors below the level of the floor plates are to have an enclosure of at least IP44 protection. Where motors intended for service at sea are not mounted with the rotor shafts in the fore-and-aft direction, the type of bearing and lubrication will require special consideration.
3.5.2 Pump Motors
Motors for operating plunger and close-coupled pumps are to have the driving end entirely enclosed or designed to prevent leakage from entering the motor.

3.5.3 Motors on Weather Decks
Motors for use on weather decks are to have an enclosure of at least IP56 protection or are to be enclosed in watertight housings.

3.5.4 Motors Below Decks (2012)
Motors below decks are to be installed at a location as dry as practicable and away from steam, water, and oil piping. The suitability of the location is to be verified onboard to the satisfaction of the attending Surveyor.

3.7 Accumulator Batteries
3.7.1 General
The following requirements are applicable to permanently installed power, control and monitoring storage batteries of acid or alkaline types. Batteries are to be so arranged that the trays are accessible and provided with not less than 254 mm (10 in.) headroom. Where a relief valve is provided for discharging excessive gas due to overcharge, arrangements are to be made for releasing the gas to the weather deck away from any source of ignition.

3.7.2 Battery Installation and Arrangements (2008)
3.7.2(a) Large Batteries (2016).
Large storage batteries, those connected to a charging device with an output of more than 2 kW, are to be installed in a room assigned to the battery only, but may be installed in a deck locker if such a room is not available. No electrical equipment is to be installed in the battery rooms unless essential for the operational purposes and certified safe for battery room atmosphere. Electrical equipment installed in battery rooms may be any of the types indicated in 4-3-3/9.1.2(b) and is to be IEC Publication 60079-20-1 group IIC class T1.

3.7.2(b) Moderate-size Batteries.
Batteries of moderate size, those connected to a charging device with a power output of 0.2 kW up to and including 2 kW, may be installed in the battery room or may be installed in battery lockers or deck boxes in the emergency generator room, machinery space or other suitable location. Cranking batteries are to be located as closely as possible to the engine or engines served.

3.7.2(c) Small Batteries.
Small batteries are to be installed in a battery box and may be located as desired, except they are not to be located in sleeping quarters unless hermetically sealed.

3.7.2(d) Low-hydrogen-emission Battery Installations.
A low-hydrogen-emission battery installation with a battery charger having a charging rate of a large or moderate battery size installation may be treated as a moderate or small battery installation, respectively, if the following are met:

i) Calculations under the worst case charging conditions are submitted that demonstrate that the low-hydrogen-emission battery installation does not emit more hydrogen under similar charging conditions than a bank of standard lead acid batteries supplied by a 2 kW charger for a moderate battery installation or 0.2 kW charger for a small battery installation, and
ii) A warning notice is placed to notify maintenance personnel that additional batteries are not to be installed, and batteries are only to be replaced by other batteries of the same or lower hydrogen emission rate.

3.7.2(e) Battery Trays.

Trays for batteries are to be chocked with wood strips or equivalent to prevent movement and each tray is to be fitted with nonabsorbent insulating supports on the bottom and with similar spacer blocks at the sides or with equivalent provision to secure air-circulation space all around each tray.

3.7.2(f) Identification of Battery Types.

Lead-acid batteries and alkaline batteries, when placed in the same battery compartment, are to be effectively identified as to type and segregated.

3.7.3 Ventilation

3.7.3(a) Battery Rooms.

Battery rooms are to be ventilated to avoid accumulation of flammable gas. Natural ventilation may be employed if ducts are run directly from the top of the battery room to the open air above.

If natural ventilation is impractical, mechanical exhaust ventilation is to be provided with fan intake at the top of the room. Fans are to be of non-sparking construction in accordance with 4-3-3/9.7 and capable of completely changing the air in the battery room in not more than two minutes. Alternatively, a lesser ventilation rate may be considered, provided that satisfactory calculations are submitted substantiating that adequate ventilation is available to maintain the flammable gases within the battery room to a level below the lower explosive limit (L.E.L.) at the maximum battery charging current. Where the ventilation rate is based on low hydrogen emission type batteries, a warning notice to this effect is to be provided in a visible place in the battery room. Openings for air inlet are to be provided near the floor.

3.7.3(b) Battery Lockers.

Battery lockers are to be ventilated, if practicable, similarly to battery rooms by a duct led from the top of the locker to the open air or to an exhaust ventilation duct. Louvers or equivalent are to be provided near the bottom for entrance of air.

3.7.3(c) Deck Boxes.

Deck boxes are to be provided with a duct from the top of the box, terminating in a goose neck, mushroom head or equivalent to prevent entrance of water. Holes for air inlet are to be provided on at least two opposite sides of the box. The entire deck box, including openings for ventilation, is to be weathertight to prevent entrance of spray or rain.

3.7.3(d) Small Battery Boxes. Boxes for small batteries require no ventilation other than openings near the top to permit escape of gas.

3.7.4 Protection from Corrosion

The interiors of battery rooms, including the structural parts and shelves therein, as well as ventilation inlets and outlets are to be painted with corrosion-resistant paint. Shelves in battery rooms or lockers for acid batteries are to have a watertight lining of sheet lead not less than 1.6 mm (1/16 in.) on all sides. For alkaline batteries, the shelves are to be similarly lined with steel not less than 0.8 mm (1/32 in.) thick. Alternatively, a battery room may be fitted with a watertight lead pan, steel for alkaline batteries, over the entire deck, carried up not less than 152 mm (6 in.) on all sides. Deck boxes are to be lined in accordance with the above alternative method. Boxes for small batteries are to be lined to a depth of 76 mm (3 in.) consistent with the methods described above.
3.7.5 Maintenance of Batteries (1 July 2016)

3.7.5(a) Maintenance Schedule of Batteries.

Where batteries are fitted for use for essential and emergency services, a maintenance schedule of such batteries is to be provided and maintained.

The schedule is to include all batteries used for essential and emergency services, including system batteries installed in battery rooms, battery lockers and deck boxes as well as batteries installed within vendor supplied equipment. Examples of batteries included with equipment are:

- Computer equipment and programmable logic controllers (PLC) use in computer based systems and programmable electronic systems, when used for essential or emergency services.
- Radiocommunication equipment, such as the equipment required by the IMO MODU Code, Chapter 11.

The schedule is to be submitted for review, during their plan approval or the new building survey, and is to include at least the following information regarding the batteries:

- Type and manufacturer’s type designation.
- Voltage and ampere-hour rating.
- Location.
- Equipment and/or system(s) served.
- Maintenance/replacement cycle dates.
- Date(s) of last maintenance and/or replacement.
- For replacement batteries in storage, the date of manufacture and shelf life (See Note below)

Note:

Shelf life is the duration of storage under specified conditions at the end of which a battery retains the ability to give a specified performance.

3.7.5(b) Procedure of Maintenance.

Procedures are to be put in place to show that, where batteries are replaced, they are to be of an equivalent performance type. Details of the schedule, procedures, and the maintenance records are to be included in the unit’s maintenance system and integrated into the unit’s operational maintenance routine, as appropriate, which are to be verified by the Surveyor.

3.7.6 Replacement of Batteries (2008)

Where a vented type battery (See Note 1) replaces a valve-regulated, sealed type battery (See Note 2), the requirements in 4-3-3/3.7.2 and 4-3-3/3.7.3 are to be complied with on the basis of the charging capacity.

Notes:

1. A vented battery is one in which the cells have a cover provided with an opening through which products of electrolysis and evaporation are allowed to escape freely from the cells to atmosphere.

2. A valve-regulated battery is one in which cells are closed but have an arrangement (valve) which allows the escape of gas if the internal pressure exceeds a predetermined value.

3.9 Switchboard (2015)

Switchboards are to be so arranged as to give easy access, as may be needed, to apparatus and equipment without danger to personnel. Switchboards are to be located in a dry place so as to provide a clear working
space of at least 900 mm (35 in.) at the front of the switchboard and a clearance of at least 600 mm (24 in.) at the rear, which may be reduced to 457 mm (18 in.) in way of stiffeners or frames, except that for switchboards which are enclosed at the rear and are fully serviceable from the front, clearance at the rear will not be required unless necessary for cooling. Switchboards are to be secured to a solid foundation. They are to be self-supported or are to be braced to the bulkhead or the deck above. In case the last method is used, means of bracing is to be flexible to allow deflection of the deck without buckling the assembly structure.

3.11 Distribution Boards

3.11.1 Location and Protection (2004)
Distribution boards are to be located in accessible positions. Distribution boards may be located behind panels/linings within accommodation spaces, including stairway enclosures, without the need to categorize the space to a fire integrity standard, provided no provision is made for storage. Distribution boards are to have approved noncombustible non-hygrosopic enclosures. Metal enclosures and all exposed metal parts in nonmetallic enclosures are to be earthed to the unit’s structure. All cases are to be of adequate mechanical strength.

3.11.2 Switchboard-type Distribution Boards
Distribution boards of the switchboard type, unless installed in machinery spaces or in compartments assigned exclusively to electric equipment and accessible only to authorized personnel, are to be completely enclosed or protected against accidental contact and unauthorized operation.

3.11.3 Safety-type Panels (1998)
If the method of operation demands the handling of switches by persons unfamiliar with electrical equipment, the distribution board is to be of the safety type. This type of distribution board is to be used for controlling branch lighting circuits. Dead front type panels are to be used where voltage to earth is in excess of 50 volts DC or 50 volts AC rms between conductors.

3.13 Motor Controllers and Control Centers

3.13.1 Location and Installation
Motor control centers are to be located in a dry place. Clear working space is to be provided around motor control centers to enable doors to be fully opened and equipment removed for maintenance and replacement. Motor control centers are to be secured to a solid foundation, be self-supported or be braced to the bulkhead.

3.13.2 Disconnecting Arrangements
3.13.2(a) Device.
Means are to be provided for disconnecting the motor and controller from all supply conductors, except that a manually operated switch or circuit breaker may serve as both controller and disconnecting means (see 6-1-7/9.15.2).

3.13.2(b) Location (1998).
The disconnecting device may be in the same enclosure with the controller or may be in a separate enclosure, and is to be externally operated. Except for remotely controlled fire extinguishing purpose motors, the branch-circuit switch or circuit breaker on the power-distribution board or switchboard may serve as the disconnect device if in the same compartment with the controller.

If the disconnecting device is not within sight of both motor and controller, or if it is more than 15.25 m (50 ft) from either, it is to be arranged for locking in the open position. For remotely
controlled fire extinguishing purpose motors, the locking means are to be provided at the feeder circuit breaker for such motors.

3.13.2(d) Identification Plate.

The disconnect switch, if not adjacent to the controller, is to be provided with an identification plate.

3.13.2(e) Open and Close Indications.

The disconnect device is to indicate by a position of the handle, or otherwise, whether it is open or closed.

3.13.3 Indicating-light Circuits

Where indicating-light circuits are employed, their potential is to be limited to 150 volts if the opening of the foregoing disconnecting devices does not de-energize the indicating circuit.

3.15 Resistors for Control Apparatus

The resistor is to be protected against corrosion, either by rust-proofing or embedding in a protective material. Resistors are to be located in well-ventilated compartments and are to be mounted with ample clearances, about 305 mm (12 in.) to prevent excessive heating of an adjacent unit’s structure or dangerous overheating of unprotected combustible material. The arrangement of the electrical equipment and wiring located within these spaces is to be such as to prevent their exposure to ambient temperatures in excess of that for which they have been designed.

3.17 Lighting Fixtures

Lighting fixtures are to be so arranged as to prevent temperature rises which could damage the cables and wiring, and to prevent surrounding material from becoming excessively hot.

3.19 Heating Equipment

Electric radiators, if used, are to be fixed in position and be so constructed as to reduce fire risks to a minimum. Electric radiators of the exposed-element type are not to be used.

3.21 Magnetic Compasses

Precautions are to be taken in connection with apparatus and wiring in the vicinity of the magnetic compass to prevent disturbance of the needle from external magnetic fields.

3.23 Portable Equipment and Outlets

Portable equipment are not to be used in hazardous areas nor are portable lights to be used for berth lights in accommodations.


Receptacles and plugs of different electrical ratings are not to be interchangeable. In cases where it is necessary to use 230 volts portable equipment, the receptacles for their attachment are to be of a type which will not permit attaching 115 volts equipment.

Where plugs and receptacles are located in hazardous areas, they are to be suitable for use in the particular Zone and have mechanical and/or electrical interlocking to prevent an ignition source occurring during insertion or removal of the plug.

3.27 Installation Requirements for Recovery from Dead Ship Condition (2019)

Means are to be provided to ensure that machinery for self-propelled units can be brought into operation from the dead ship condition without external aid. See 4-1-1/7.3.
Where the emergency source of power is an emergency generator which complies with 4-3-2/5.15 and 4-3-2/3.1.4, this emergency generator may be used for restoring operation of the main propulsion plant, boilers and auxiliary machinery.

Where there is no emergency generator installed, the arrangements for bringing main and auxiliary machinery into operation are to be such that the initial charge of starting air or initial electrical power and any power supplies for engine operation can be developed onboard the unit without external aid. If for this purpose an emergency air compressor or an electric generator is required, these units are to be powered by a hand-starting oil engine or a hand-operated compressor.

The arrangements for bringing the main and auxiliary machinery into operation are to have a capacity such that the starting energy and any power supplies for propulsion engine operation are available within 30 minutes from a dead ship condition.

3.29 Services Required to be Operable Under a Fire Condition (2008)

For the purpose of 4-3-3/5.17.2, services required to be operable under a fire condition include, but not limited thereto, are the following:

i) Fire and general alarm system

ii) Fire extinguishing system including fire extinguishing medium release alarms

iii) Emergency Fire Pump

iv) Fire detection system

v) Control and power systems for all power operated fire doors and their status indicating systems

vi) Control and power systems for all power operated watertight doors and their status indicating systems

vii) Emergency lighting

viii) Public address system

ix) Remote emergency stop/shutdown arrangement for systems which may support the propagation of fire and/or explosion

3.31 High Fire Risk Areas (1 July 2016)

For the purpose of 4-3-3/5.17, the examples of the high fire risk areas are the following:

i) Machinery spaces as defined by 4-1-1/3.3, except spaces having little or no fire risk such as machinery spaces which do not contain machinery having a pressure lubrication system and where storage of combustibles is prohibited (e.g., ventilation and air-conditioning rooms, windlass room, steering gear room, stabilizer equipment room, electrical propulsion motor room, rooms containing section switchboards and purely electrical equipment other than oil-filled electrical transformers (above 10 kVA), shaft alleys and pipe tunnels, and spaces for pumps and refrigeration machinery not handling or using flammable liquids).

ii) Spaces containing fuel treatment equipment and other highly flammable substances

iii) Galley and pantries containing cooking appliances

iv) Laundry containing drying equipment

v) Enclosed drilling and industrial spaces requiring a fixed fire extinguishing system by 8-2-1/11.3.
5 Cable Installation

5.1 General Considerations

5.1.1 Continuity of Cabling
Electric cables are to be installed in continuous lengths between terminations at equipment or in cable junction boxes. See 4-3-3/5.25. However, approved splices will be permitted at interfaces of new construction modules, when necessary to extend existing circuits for a unit undergoing repair or alteration, and in certain cases to provide for cables of exceptional length (See 4-3-3/5.21).

5.1.2 Choice of Cables
The rated operating temperature of the insulating material is to be at least 10°C (18°F) higher than the maximum ambient temperature likely to exist, or to be produced, in the space where the cable is installed.

5.1.3 Cable Voltage Drop for New Installation
The cross-sectional area of conductors are to be so determined that the drop in voltage from the main or emergency switchboard bus-bars to any and every point of the installation when the conductors are carrying the maximum current under normal steady conditions of service, will not exceed 6% of the nominal voltage. For supplies from batteries with a voltage not exceeding 55 V, this figure may be increased to 10%.

The above values are applicable under normal steady conditions. Under special conditions of short duration, such as motor starting, higher voltage drops may be accepted, provided the installation is capable of withstanding the effects of these higher voltage drops.

5.1.4 Restricted Location of Cabling (2015)
Cables and wiring are to be installed and supported in such a manner as to avoid chafing or other damage. Cables are to be located with a view to avoiding, as far as practicable, spaces where excessive heat and gases may be encountered; also, spaces where they may be exposed to damage, such as exposed sides of deckhouses. Cables are not to be installed in the bilge area unless protected from bilge water. Cables are not to be installed in water tanks, oil tanks, cargo tanks, ballast tanks or any liquid tanks except to supply equipment and instrumentations specifically designed for such locations and whose functions require it to be installed in the tank.

5.1.5 Means of Drainage from Cable Enclosures
Where cables are installed in a cable draw box and horizontal pipes or the equivalent is used for cable protection, means of drainage are to be provided.

5.1.6 High Voltage Cables
Cables serving systems above 1 kV are not to be bunched with cables serving systems of 1 kV and below.

5.1.7 Cable Installation above High Voltage Switchgear and Control-Gear (2006)
Where a pressure relief flap is provided for high voltage switchgear and high voltage control-gear, the cables are not to be installed near and above this equipment in order to prevent the damage of cables from the flare/flame released from the relief flap upon occurrence of short circuit in this equipment.

5.1.8 Ultraviolet (UV) Light Protection for Wiring Insulation within Fluorescent Light Fixtures (2014)
Where the supply cable’s outer sheathing or covering is removed once the cable enters a fluorescent light fixture to facilitate routing and/or connection, the insulation on the individual conductors is to be protected against the possible detrimental effects of UV light exposure by one of the following:
The insulation is to be manufactured with additives that protect the insulation from UV light damage and a test report is to be submitted to ABS.

Adequate shielding arrangements are to be provided inside the fixture for the entire length of the exposed insulation within the fixture.

UV protective sleeves are to be installed on the full length of the exposed conductors inside the fixture during the installation.

5.1.9 Protection of Cables in Tanks (2015)
Where cables are installed in liquid tanks, the following arrangements are to be complied with:

i) Cables are to be installed in steel pipes with at least extra-heavy wall thickness with all joints welded and with corrosion-resistant coating.

ii) Cable gland with gastight packing is to be provided for the cable at both ends of the cable conduit pipe.

iii) Cable inside of the vertical cable conduit pipe is to be suitably supported (e.g., by sand-filling or by strapping to a support-wire). Alternatively, the cable inside of the vertical conduit pipe may be accepted without provided support if the mechanical strength of the cable is sufficient to prevent cable damage due to the cable weight within the conduit pipe under continuous mechanical load. Supporting documentation is to be submitted to verify the mechanical strength of the cable with respect to the cable weight inside of the conduit.

5.3 Insulation Resistance for New Installation (2012)
For insulation resistance test of each power and each light circuit, refer to 7-1-5/5.3.

5.5 Protection for Electric-magnetic Induction

5.5.1 Multiple Conductor Cables
All phase conductors of alternating-current cables are to be contained within the same sheath in order to avoid overheating due to induction by use of multiple conductor cables.

5.5.2 Single Conductor Cables (1999)
AC installations are to be carried out, as far as possible, in twin or multi-conductor cables. However, when it is necessary to use single conductor cables in circuits rated in excess of 20 A, the following arrangements are to be complied with:

5.5.2(a) Cables are supported on non-fragile insulators;

5.5.2(b) There are to be no magnetic materials between cables of a group; and

5.5.2(c) (1999) Where single conductor cables are run in bunches, each group of cables is to comprise 360 electrical degrees. To this end, in three-phase circuits, single conductor cable runs of 30 m (100 ft) or longer and having a cross-sectional area of 185 mm² (365,005 circ. Mils) or more are to be transposed throughout the length at intervals not exceeding 15 m (50 ft) in order to equalize to some degree the impedance of the three phase circuits. Alternatively, such cables may be installed in trefoil formation. See 4-3-4/7.1.5 for armor.

5.5.3 Non-shielded Signal Cables
Except for fiber optic cables, non-shielded signal cables for automation and control systems essential for the safe operation of the unit which may be affected by electromagnetic interference are not to be run in the same bunch with power or lighting cables.

5.7 Joints and Sealing
Cables not having a moisture-resistant insulation are to be sealed against the admission of moisture by methods such as taping in combination with insulating compound or sealing devices. Cables are to be
installed in such a manner that stresses on the cable are not transmitted to the conductors. Terminations and joints in all conductors are to be so made as to retain the original electrical, flame retarding and, where necessary, fire resisting properties of the cable. Terminal boxes are to be secured in place and the moisture-resistant jacket is to extend through the cable clamp. Enclosures for outlets, switches and similar fittings are to be flame- and moisture-resistant and of adequate mechanical strength and rigidity to protect the contents and to prevent distortion under all likely conditions of service. See also 4-3-3/5.17.1 and 4-3-3/5.21.

### 5.9 Support and Bending

#### 5.9.1 Support and Fixing (2012)

For support and fixing of cables, refer to 7-1-5/5.9.1.

#### 5.9.2 Bending Radius

For bending radius requirements, see 7-1-5/5.9.2 TABLE 1.

#### 5.9.3 Plastic Cable Trays and Protective Casings (2004)

**5.9.3(a) Installations (2012).**

Cable trays and protective casings made of plastic materials are to be flame retardant (see Appendix 4-8-4-A1 of the *Marine Vessel Rules*). Where plastic cable trays and protective casings are used on open deck, they are additionally to be protected against UV light by such as anti-UV coating or equivalent. Refer to 7-1-5/5.9.3 for additional installation details.

*Note:*

"Plastic" means both thermoplastic and thermosetting plastic materials with or without reinforcement, such as PVC and fiber reinforced plastics (FRP). "Protective casing" means a closed cover in the form of a pipe or other closed ducts of non-circular shape.

**5.9.3(b) Safe Working Load (2008).**

The load on the cable trays and protective casings is to be within the Safe Working Load (SWL). The support spacing is to be not greater than the manufacturer’s recommendation nor in excess of the spacing at the SWL test (see Appendix 4-8-4-A1 of the *Marine Vessel Rules*). In general, the spacing is not to exceed 2 meters.

*Numerator:

The selection and spacing of cable tray and protective casing supports are to take into account:

- Dimensions of the cable trays and the protective casings;
- Mechanical and physical properties of their material;
- Mass of the cable trays/protective casings;
- Loads due to weight of cables, external forces, thrust forces and vibrations;
- Maximum accelerations to which the system may be subjected;
- Combination of loads.

**5.9.3(c) Hazardous areas (2008).**

Cable trays and protective casings passing through hazardous areas are to be electrically conductive (see Appendix 4-8-4-A1 of the *Marine Vessel Rules*).

**5.9.3(d) Type Testing (2008).**
Cable trays and protective casings made of plastic materials are to be type tested in accordance with Appendix 4-8-4-A1 of the Marine Vessel Rules. Alternate test procedures for impact resistance test, safe working load test, flame retardant test, smoke and toxicity tests and/or resistivity test from an international or national standard may be considered instead of the test specified in Appendix 4-8-4-A1 of the Marine Vessel Rules. The type test reports are to be submitted for review.

5.11 Cable Run in Bunches

5.11.1 Reduction of Current Rating
Where cables which may be expected to operate simultaneously are laid close together in a cable bunch in such a way that there is an absence of free air circulation around them, the following reduction factor is to be applied to the current rating obtained from 4-3-4/7.5 TABLE 2.

<table>
<thead>
<tr>
<th>Number of Cables in One Bunch</th>
<th>Reduction Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>One to six</td>
<td>1.00</td>
</tr>
<tr>
<td>Seven to twelve</td>
<td>0.85</td>
</tr>
</tbody>
</table>

Bunches of more than twelve cables will be subject to special consideration based on the type and service of the various cables in the bunch.

5.11.2 Clearance and Segregation
A clearance is to be maintained between any two cable bunches of at least the diameter of the largest cable in either bunch. Otherwise, for the purpose of determining the number of cables in the bunch, the total number of cables on both sides of the clearance will be used.

5.11.3 Cable of Lower Conductor Temperature
The current rating of each cable in a bunch is to be determined based on the lowest conductor temperature rating of any cable in the bunch.

5.13 Deck and Bulkhead Penetrations (1 July 2013)

5.13.1 General
Where cables pass through watertight, firetight, or smoke-tight bulkheads or decks, the penetrations are to be made through the use of approved stuffing tubes, transit devices or pourable materials installed in accordance with manufacturer’s installation procedures to maintain the watertight integrity or fire-rating of the bulkheads or decks. These devices or pourable materials are not to damage the cable physically or through chemical action or through heat build-up, and are to be examined and tested as specified in 7-1-2/19.5 and 7-1-2/23 TABLE 2.

Where cable conduit pipe or equivalent is carried through decks or bulkheads, arrangements are to be made to maintain the integrity of the water or gas tightness of the structure.

5.13.2 Non-watertight Penetrations
When cables pass through non-watertight bulkheads where the bearing surface is less than 6.4 mm (0.25 in.), the holes are to be fitted with bushings having rounded edges and a bearing surface for the cable of at least 6.4 mm (0.25 in.) in length. Where cables pass through deck beams or similar structural parts, all burrs are to be removed in way of the holes and care is to be taken to eliminate sharp edges.

5.13.3 Collision Bulkhead
Cables are not to pass through a collision bulkhead.
5.15 Mechanical Protection

5.15.1 Metallic Armor
Electric cables installed in locations liable to damage during normal operation of the unit are to be provided with braided metallic armor and otherwise suitably protected from mechanical injury as appropriate for the location.

5.15.2 Conduit Pipe or Structural Shapes (2012)
Where cables are installed in locations in way of hatches, tank tops, open decks subject to seas, and where passing through decks, they are to be protected by substantial metal shields, structural shapes, pipe or other equivalent means. All such coverings are to be of sufficient strength to provide effective protection to the cables. Where cables are installed in metal piping or in a metal conduit system, such piping and systems are to be earthed and are to be mechanically and electrically continuous across all joints.

5.17 Emergency and Essential Feeders

5.17.1 Location (2013)
As far as practicable, cables and wiring for emergency and essential services, including those listed in 4-3-3/3.29, are not to pass through high fire risk areas (see 4-3-3/3.31). For Emergency Fire Pumps, see requirements in 4-3-3/5.17.3.

5.17.2 Services Necessary Under a Fire Condition (2013)
Where cables for services required to be operable under a fire condition (see 4-3-3/3.29) including their power supplies pass through high fire risk areas (see 4-3-3/3.31) other than those which they serve, they are to be so arranged that a fire in any of these areas does not affect the operation of the service in any other area. For Emergency Fire Pumps, see requirements in 4-3-3/5.17.3. This may be achieved by any of the following measures:

5.17.2(a) Fire resistant cables in accordance with 4-3-4/7.1.3 are installed and run continuous to keep the fire integrity within the high fire risk area. See 4-3-3/5.17.2 FIGURE 2.

**FIGURE 2**
Cables within High Fire Risk Areas (2008)

5.17.2(b) At least two loops/radial distributions run as widely apart as is practicable and so arranged that in the event of damage by fire at least one of the loops/radial distributions remains operational.
Systems that are self monitoring, fail safe or duplicated with cable runs separated as widely as practicable, may be exempted from the requirements in 4-3-3/5.17.2(a) and 4-3-3/5.17.2(b).

5.17.3 **Electrical Cables For The Emergency Fire Pump (2013)**

The electrical cables to the emergency fire pump are not to pass through the machinery spaces containing the main fire pumps and their sources of power and prime movers. They are to be of a fire resistant type, in accordance with 4-3-4/7.1.3, where they pass through other high fire risk areas.

5.17.4 **Requirements by the Governmental Authority**

Attention is directed to the requirements of the governmental authority of the country whose flag the unit flies, for the installation of emergency circuits required in various types of units.

5.19 **Battery Room**

Where cables enter battery rooms, the holes are to be bushed as required for watertight bulkheads in 4-3-3/5.13. All connections within battery rooms are to be resistant to the electrolyte. Cables are to be sealed to resist the entrance of electrolyte by spray or creepage. The size of the connecting cable is to be based on current-carrying capacities given in 4-3-4/7.5 TABLE 2 and the starting rate of charge or maximum discharge rate, whichever is the greater, is to be taken into consideration in determining the cable size.

5.21 **Splicing of Electrical Cables**

5.21.1 **Basis of Approval**

Replacement insulation is to be fire resistant and is to be equivalent in electrical and thermal properties to the original insulation. The replacement jacket is to be at least equivalent to the original impervious sheath and is to assure a watertight splice. Splices are to be made using an approved splice kit which contains the following:

- Connector of correct size and number
- Replacement insulation
- Replacement jacket
- Instructions for use

In addition, prior to approval of a splicing kit, it will be required that completed splices be tested for fire resistance, watertightness, dielectric strength, etc. to the satisfaction of the Surveyor. This requirement may be modified for splice kits which have had such tests conducted and reported on by an independent agency acceptable to ABS.

5.23 **Splicing of Fiber Optic Cables**

Splicing of fiber optic cables is to be made by means of approved mechanical or fusion methods.

5.25 **Cable Junction Box**

Except for propulsion cables, junction boxes may be used in the installation of electric cables aboard the unit, provided the plans required by 4-3-3/1.3 for junction boxes are submitted and the following requirements are complied with:

5.25.1 The design and construction of the junction boxes are to comply with 6-1-7/13.7, as well as 4-3-3/5.25.2 below.
5.25.2 The junction boxes are to be suitable for the environment in which they are installed (i.e., explosion-proof in hazardous areas, watertight or weathertight on deck, etc.).

5.25.3 *(1998)* Separate* junction boxes are to be used for feeders and circuits of each of the following rated voltage levels:

Note:

*A physical barrier may be used in lieu of two separate junction boxes for circuits having rated voltage levels corresponding to those in either 4-3-3/5.25.3(a) or 4-3-3/5.25.3(b).

5.25.3(a) Rated voltage levels not exceeding those specified in 4-3-3/7.1.i

5.25.3(b) Rated voltage levels exceeding those in 4-3-3/5.25.3(a), up to and including 1 kV. A physical barrier is to be used within the junction box to separate distribution systems of different rated voltages, such as 480 V, 600 V and 750 V.

5.25.3(c) Rated voltage levels exceeding 1 kV. Separate junction boxes are to be used for each of the rated voltage levels exceeding 1 kV.

Each junction box and the compartment in the junction box separated by a physical barrier are to be appropriately identified as regards the rated voltage of the feeders and circuits it contains.

5.25.4 The junction boxes for emergency feeders and circuits are to be separate from those used for normal unit main service feeders and circuits.

In addition to the above, the applicable requirements in 4-3-3/5 and 4-3-4/7 regarding cable installation and application details are to be complied with.

7 **Earthing**

7.1 **General**

Exposed metal parts of electrical machines or equipment which are not intended to be live but which are liable under fault conditions to become live are to be earthed unless the machines or equipment are:

i) *(1998)* Supplied at a voltage not exceeding 50 volts DC or 50 volts AC rms between conductors; auto-transformers are not to be used for the purpose of achieving this voltage; or

ii) Supplied at a voltage not exceeding 250 V AC rms By safety isolating transformers supplying only one consuming device; or

iii) Constructed in accordance with the principle of double insulation.

7.3 **Permanent Equipment**

The metal frames or cases of all permanently installed generators, motors, controllers, instruments and similar equipment are to be permanently earthed through a metallic contact with the unit’s structure.

Alternatively, they are to be connected to the hull by a separate conductor in accordance with 4-3-3/7.5. Where outlets, switches and similar fittings are of nonmetallic construction, all exposed metal parts are to be earthed.
7.5 Connections

7.5.1 General
All earthing conductors are to be of copper or other corrosion-resistant material and are to be protected against damage. The nominal cross-sectional area of every copper earthing conductor is to be not less than that required by 4-3-3/9.7.3 TABLE 2.

7.5.2 Earthed Distribution System
Earthing conductors in an earthed distribution system are to comply with 4-3-3/7.5.1, except that the earthing conductor in line C4 of 4-3-3/9.7.3 TABLE 2 is to be A/2.

7.5.3 Connection to Hull Structure
All connections of an earth-continuity conductor or earthing lead to the unit’s structure are to be made in accessible positions and are to be secured by a screw of brass or other corrosion-resistant material having a cross-sectional area equivalent to the earth-continuity conductor or earthing lead, but not less than 4 mm (0.16 in.) in diameter. The earth connection screw is to be used for this purpose only. See 4-2-1/11.31 for control of static electricity.

7.7 Portable Cords (1998)
Receptacle outlets operating at 50 volts DC or 50 volts AC rms or more are to have an earthing pole.

7.9 Cable Metallic Covering
All metal sheaths, armor of cable and mineral-insulated, metal-sheathed cable are to be electrically continuous and are to be earthed to the metal hull at each end of the run, except that final subcircuits may be earthed at the supply end only. All metallic coverings of power and lighting cables passing through hazardous area or connected to equipment in such an area are to be earthed at least at each end.

9 Equipment and Installation in Hazardous Area

9.1 General Consideration

9.1.1 General (2016)
Electrical equipment and wiring are not to be installed in a hazardous area unless essential for operational purposes. Where the installation of electrical equipment in such location is necessary, the selection and installation of equipment and cables in hazardous areas is to be in accordance with IEC Publication 61892-7, or other recognized standards. Generally electrical equipment certified for use in hazardous areas in accordance with the IEC 60079 series is considered suitable for use in temperatures from -20°C to 40°C (-4°F to 104°F). Account is to be taken of the temperature at the point of installation when selecting electrical equipment for installation in hazardous areas.

Consideration is to be given to:

i) The zone in which the apparatus will be used;

ii) The sensitivity to ignition of the gases or vapors likely to be present, expressed as a gas group; and

iii) The sensitivity of the gases and vapors likely to be present to ignition by hot surfaces, expressed as a temperature classification.

Hazardous areas are defined in Section 4-3-6. For certified safe-type equipment, see 4-3-3/9.3.

Fans used for the ventilation of the hazardous areas are to be of non-sparking construction in accordance with 4-3-3/9.7.
9.1.2 Electrical Equipment (2016)

Electrical equipment used in hazardous areas is to be manufactured, tested, marked and installed in accordance with IEC Publication 60079 series, or other recognized standards, and certified by an independent testing laboratory acceptable to ABS.

The following equipment and cables are acceptable for installation in hazardous locations:

9.1.2(a) Zone 0 Areas.

Only certified intrinsically-safe circuits or equipment (type "ia") and associated wiring are permitted in Zone 0 areas.

9.1.2(b) Zone 1 Areas.

Equipment and cables permitted in Zone 1 areas are to be:

1. Certified intrinsically-safe circuits or equipment (type "ia" or "ib") and associated wiring
2. Certified flameproof (explosion proof) equipment (type "d")
3. Certified increased safety equipment (type "e"); for increased safety motors, consideration is to be given to the protection against overcurrent
4. Certified pressurized enclosure type equipment (type "p") (see 4-3-3/9.3.3).
5. Permanently installed cables with:
   - metallic armor, or
   - of mineral-insulated, metallic-sheathed type, or
   - installed in metallic conduit with explosion-proof gas-tight fittings, or
6. Flexible cables, where necessary, provided they are of heavy duty type.

Other suitable types of electrical equipment may be specially considered for installation in Zone 1 areas.

9.1.2(c) Zone 2 Areas.

Equipment and cables permitted in Zone 2 areas are to be:

1. All equipment approved for Zone 1 areas
2. The following equipment, provided the operating temperature does not exceed 315°C (600°F) and provided any brushes, switching mechanisms or similar arc-producing devices are approved for Zone 1 areas:
   - Enclosed squirrel-cage induction motors
   - Fixed lighting fixtures protected from mechanical damage
   - Transformers, solenoids or impedance coils in general purpose enclosures
   - Cables with moisture-resistant jacket (impervious-sheathed) and protected from mechanical damage.

Other suitable types of electrical equipment may be specially considered for installation in Zone 2 areas.
9.1.3 Grouping and Temperature Class (2016)
IEC Publication 60079-20-1 Groups IIA, IIB or IIC are to be selected for intrinsically-safe or flameproof (explosion proof) equipment dependent on the gas/vapor group of the gases and vapors likely to be present. Other types of certified equipment are to be Group II.

Electrical equipment is to be so selected that its maximum surface temperature will not reach the ignition temperature of any gas/vapor likely to be present in the hazardous areas in which the electrical equipment is located. Temperature classes are to be selected in accordance with IEC Publication 60079-20-1 or 61892-7.

Electrical equipment located in hazardous drilling well areas and active mud processing areas is to meet at least Group IIA and temperature class T3.

9.1.4 Cables Installation (2006)
Cables in hazardous areas are to be armored or mineral-insulated metal-sheathed where required by 4-3-3/9.1.2, except for cables of intrinsically safe circuits subject to the requirements of 4-3-3/5.15. Where cables pass through hazardous area boundaries, they are to be run through gastight fittings. No splices are allowed in hazardous areas, except in intrinsically-safe circuits. Where it is necessary to join cables in hazardous areas (e.g., flexible cable connections to non-flexible cables), the joints are to be made in approved junction boxes.

9.1.5 Lighting Circuits (2012)
All switches and protective devices for lighting fixtures in hazardous areas are to interrupt all poles or phases and are to be located in a non-hazardous area. However, a switch may be located in a hazardous area if the switch is of a certified-safe type for the hazardous location in which it is to be installed. On solidly grounded distribution systems, the switches need not open the grounded conductor.

9.3 Certified-safe Type and Pressurized Equipment and Systems

9.3.1 Installation Approval
Electrical equipment in hazardous areas is to be of a type suitable for such locations. Where permitted by the Rules, electrical equipment of certified-safe type will be approved for installation, provided such equipment has been type-tested and certified by a competent independent testing laboratory as suitable for hazardous areas and provided that there is no departure in the production equipment from the design so tested and approved.

9.3.2 Intrinsically-safe System
9.3.2(a) Separation.
Intrinsically-safe systems are to be completely separated and independent of all other electric systems. Intrinsically-safe cables are to have shielded conductors or to be installed a minimum of 50 mm (2 in.) from other electric cables and are not to occupy an enclosure (such as a junction box or terminal cabinet) with non-intrinsically-safe circuits.

9.3.2(b) Physical Barrier.
When intrinsically-safe components are located by necessity within enclosures that contain non-intrinsically-safe systems, such as control consoles and motor starters, such components are to be effectively isolated in a sub-compartment by physical barriers having a cover or panel secured by bolts, locks, allen screws or other approved methods. The physical barrier is not intended to apply to the source of power for the intrinsically-safe circuit interface.

9.3.2(c) Replacement.
Unless specifically approved, replacement equipment for intrinsically-safe circuits is to be identical to the original equipment.

9.3.3 Pressurized Equipment (1997)
Pressurized equipment is to consist of separately ventilated enclosures supplied with positive-pressure ventilation from a closed-loop system or from a source outside of the hazardous areas, and provision is to be made such that the equipment cannot be energized until the enclosure has been purged with a minimum of ten air changes and required pressure is obtained. Ventilating pipes are to have a minimum wall thickness of 3 mm (0.12 in. or 11 gauge). In the case of loss of pressurization, power is to be automatically removed from the equipment, unless this would result in a condition more hazardous than that created by failure to de-energize the equipment. In this case, in lieu of removal of power, an audible and visual alarm is to be provided at a normally manned control station.

Pressurized equipment in compliance with IEC Publication 60079-2, NFPA 496 or other recognized standard will also be acceptable.

9.5 Paint Stores
9.5.1 General (2016)
Electrical equipment in paint stores and in ventilation ducts serving such spaces as permitted in 4-3-3/9.1 is to comply with the requirements for group IIB class T3 in IEC Publication 60079 series.

The following type of equipment will be acceptable for such spaces:

i) Intrinsically-safe defined by 4-3-1/3.15

ii) Explosion-proof defined by 4-3-1/3.7

iii) (1997) Pressurized defined by 4-3-1/3.35

iv) Increased safety defined by 4-3-1/3.17

v) Other equipment with special protection, recognized as safe for use in explosive gas atmospheres by a national or other appropriate authority

9.5.2 Open Area Near Ventilation Openings
In the areas on open deck within 1 m (3.3 ft) of ventilation inlet or within 1 m (3.3 ft) (if natural) or 3 m (10 ft) (if mechanical) of exhaust outlet, the installation of electrical equipment and cables is to be in accordance with 4-3-3/9.1.

9.5.3 Enclosed Access Spaces
The enclosed spaces giving access to the paint store may be considered as non-hazardous, provided that:

i) The door to the paint store is gastight with self-closing devices without holding back arrangements.

ii) The paint store is provided with an acceptable, independent, natural ventilation system ventilated from a safe area, and

iii) Warning notices are fitted adjacent to the paint store entrance stating that the store contains flammable liquids.

9.7 Non-sparkling Fans
9.7.1 Design Criteria

9.7.1(a) Air Gap.
The air gap between the impeller and the casing is to be not less than 10% of the shaft diameter in way of the impeller bearing, but not less than 2 mm (0.08 in.). It need not be more than 13 mm (0.5 in.).

9.7.1(b) Protection Screen.

Protection screens of not more than 13 mm (0.5 in.) square mesh are to be fitted in the inlet and outlet of ventilation openings on the open deck to prevent the entrance of objects into the fan casing.

9.7.2 Materials

9.7.2(a) Impeller and its Housing.

Except as indicated in 4-3-3/9.7.2(c) below, the impeller and the housing in way of the impeller are to be made of alloys which are recognized as being spark proof by appropriate test.

9.7.2(b) Electrostatic Charges.

Electrostatic charges both in the rotating body and the casing are to be prevented by the use of antistatic materials. Furthermore, the installation onboard of the ventilation units is to be such as to ensure the safe bonding to the hull of the units themselves.

9.7.2(c) Acceptable Combination of Materials.

Tests referred to in 4-3-3/9.7.2(a) above are not required for fans having the following combinations:

i) Impellers and/or housings of nonmetallic material, due regard being paid to the elimination of static electricity;

ii) Impellers and housings of nonferrous materials;

iii) Impellers of aluminum alloys or magnesium alloys and a ferrous (including austenitic stainless steel) housing on which a ring of suitable thickness of nonferrous materials is fitted in way of the impeller;

iv) Any combination of ferrous (including austenitic stainless steel) impellers and housings with not less than 13 mm (0.5 in.) tip design clearance.

9.7.2(d) Unacceptable Combination of Materials.

The following impellers and housings are considered as sparking-producing and are not permitted:

i) Impellers of an aluminum alloy or magnesium alloy and a ferrous housing, regardless of tip clearance;

ii) Housing made of an aluminum alloy or a magnesium alloy and a ferrous impeller, regardless of tip clearance;

iii) Any combination of ferrous impeller and housing with less than 13 mm (0.5 in.) design tip clearance.

9.7.3 Type Test (2007)

Type tests on the finished product are to be carried out using an acceptable national or international standard. Such type test reports are to be made available when requested by the Surveyor.
### TABLE 1

Minimum Degree of Protection [See 4-3-3/3.1.1] (2018)

(For high voltage equipment see 4-3-5/7.1 TABLE 1)

<table>
<thead>
<tr>
<th>Example of Location</th>
<th>Condition of Location</th>
<th>Switchboards, Distribution Boards, Motor Control Centers &amp; Controllers (See 4-3-3/3.9 to 4-3-3/3.13)</th>
<th>Generators (See 4-3-3/3.3)</th>
<th>Motors (See 4-3-3/3.5)</th>
<th>Transformers, Converters</th>
<th>Lighting Fixtures (See 4-3-3/3.17)</th>
<th>Heating Appliances (See 4-3-3/3.19)</th>
<th>Accessories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry accommodation space</td>
<td>Danger of touching live parts only</td>
<td>IP20 - IP20 IP20</td>
<td>IP20</td>
<td>IP20</td>
<td>IP20</td>
<td>IP20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control rooms (1999)</td>
<td>Danger of dripping liquid and/or moderate mechanical damage</td>
<td>IP22 - IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery spaces above floor plates (3)</td>
<td></td>
<td>IP22 IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steering gear rooms</td>
<td></td>
<td>IP22 -</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refrigerating machinery rooms</td>
<td></td>
<td>IP22 -</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency machinery rooms</td>
<td></td>
<td>IP22 -</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General store rooms</td>
<td></td>
<td>IP22 IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pantries</td>
<td></td>
<td>IP22 -</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provision rooms</td>
<td></td>
<td>IP22 -</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bathrooms &amp; Showers</td>
<td>Increased danger of liquid and/or mechanical damage</td>
<td>- - - -</td>
<td>IP34</td>
<td>IP44</td>
<td>IP55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery spaces below floor plates</td>
<td></td>
<td>- -</td>
<td>IP44</td>
<td>-</td>
<td>IP34</td>
<td>IP44</td>
<td>IP55 (3)</td>
<td></td>
</tr>
<tr>
<td>Closed fuel oil or lubricating oil separator rooms</td>
<td></td>
<td>IP44 -</td>
<td>IP44</td>
<td>-</td>
<td>IP34</td>
<td>IP44</td>
<td>IP55 (3)</td>
<td></td>
</tr>
<tr>
<td>Ballast pump rooms</td>
<td>Increased danger of liquid and/or mechanical damage</td>
<td>IP44 -</td>
<td>IP44</td>
<td>IP44</td>
<td>IP34</td>
<td>IP44</td>
<td>IP55</td>
<td></td>
</tr>
<tr>
<td>Refrigerated rooms</td>
<td></td>
<td>- -</td>
<td>IP44</td>
<td>-</td>
<td>IP34</td>
<td>IP44</td>
<td>IP55</td>
<td></td>
</tr>
<tr>
<td>Galleys and Laundries</td>
<td></td>
<td>IP44 -</td>
<td>IP44</td>
<td>IP44</td>
<td>IP34</td>
<td>IP44</td>
<td>IP44 (7)</td>
<td></td>
</tr>
<tr>
<td>Open decks</td>
<td>Exposure to heavy seas</td>
<td>IP56 -</td>
<td>IP56</td>
<td>-</td>
<td>IP55</td>
<td>IP56</td>
<td>IP56</td>
<td></td>
</tr>
<tr>
<td>Bilge wells</td>
<td>Exposure to submersion</td>
<td>- - - -</td>
<td>IPX8</td>
<td>-</td>
<td>IPX8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

1. Empty spaces shown with “-” indicate installation of electrical equipment is not recommended.
"Accessory" includes switches, detectors, junction boxes, etc. Accessories which are acceptable for use in hazardous areas are limited by the condition of the areas. Specific requirements are given in the Rules. See 4-3-3/3.23.

Socket outlets are not to be installed in machinery spaces below the floor plates, enclosed fuel and lubricating oil separator rooms. Plugs and sockets that are present in a hazardous area are to be certified for use in the particular zone.

For the purpose of this Table, the wheelhouse may be categorized as a “dry control room”, and consequently, the installation of IP20 equipment would suffice therein, provided that: (a) the equipment is located as to preclude being exposed to steam, or dripping/spraying liquids emanating from pipe flanges, valves, ventilation ducts and outlets, etc., installed in its vicinity, and (b) the equipment is placed to preclude the possibility of being exposed to sea or rain.

Electrical equipment used for the power operation, remote control and status indication of watertight doors and located below the worst damage waterline is to provide suitable protection against the ingress of water, as follows:

- Electrical motors, associated circuits and control components: protected to IPX7 standard
- Door position indicators and associated circuit components: protected to IPX8 standard (The water pressure testing of the enclosure is to be based on the pressure that may occur at the location of the component during flooding for a period of 36 hours)
- Door movement warning signals: protected to IPX6 standard.

Socket outlets in galleys and laundries are to maintain their protection against splashed water when not in use.

### TABLE 2
**Size of Earth-continuity Conductors and Earthing Connections**

**[See 4-3-3/7.5] (2003)**

<table>
<thead>
<tr>
<th>Type of Earthing Connection</th>
<th>Cross-sectional Area, $A$, of Associated Current Carrying Conductor</th>
<th>Minimum Cross-sectional Area of Copper Earthing Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth-continuity conductor in flexible cable or flexible cord</td>
<td>A1 $A \leq 16 \text{ mm}^2$</td>
<td>$A$</td>
</tr>
<tr>
<td></td>
<td>A2 $16 \text{ mm}^2 &lt; A \leq 32 \text{ mm}^2$</td>
<td>$16 \text{ mm}^2$</td>
</tr>
<tr>
<td></td>
<td>A3 $A &gt; 32 \text{ mm}^2$</td>
<td>$A/2$</td>
</tr>
<tr>
<td>For cables having an insulated earth-continuity conductor</td>
<td>B1a $A \leq 1.5 \text{ mm}^2$</td>
<td>$1.5 \text{ mm}^2$</td>
</tr>
<tr>
<td></td>
<td>B1b $1.5 \text{ mm}^2 &lt; A \leq 16 \text{ mm}^2$</td>
<td>$A$</td>
</tr>
<tr>
<td></td>
<td>B1c $16 \text{ mm}^2 &lt; A \leq 32 \text{ mm}^2$</td>
<td>$16 \text{ mm}^2$</td>
</tr>
<tr>
<td></td>
<td>B1d $A &gt; 32 \text{ mm}^2$</td>
<td>$A/2$</td>
</tr>
<tr>
<td>Earth-continuity conductor incorporated in fixed cable</td>
<td>For cables with bare earth wire in direct contact with the lead sheath</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B2a $A \leq 2.5 \text{ mm}^2$</td>
<td>$1 \text{ mm}^2$</td>
</tr>
<tr>
<td></td>
<td>B2b $2.5 \text{ mm}^2 &lt; A \leq 6 \text{ mm}^2$</td>
<td>$1.5 \text{ mm}^2$</td>
</tr>
<tr>
<td>Type of Earthing Connection</td>
<td>Cross-sectional Area, $A$, of Associated Current Carrying Conductor</td>
<td>Minimum Cross-sectional Area of Copper Earthing Connection</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>C1a</td>
<td>$A \leq 3$ mm$^2$</td>
<td>Stranded earthing connection: $1.5$ mm$^2$ for $A \leq 1.5$ mm$^2$ $A$ for $A &gt; 1.5$ mm$^2$</td>
</tr>
<tr>
<td>C1b</td>
<td>$3$ mm$^2 &lt; A \leq 6$ mm$^2$</td>
<td>Unstranded earthing connection: $3$ mm$^2$</td>
</tr>
<tr>
<td>C2</td>
<td>$6$ mm$^2 &lt; A \leq 125$ mm$^2$</td>
<td>$A/2$</td>
</tr>
<tr>
<td>C3</td>
<td>$A &gt; 125$ mm$^2$</td>
<td>$64$ mm$^2$ (see Note (1))</td>
</tr>
</tbody>
</table>

Notes:

1. For earthed distribution systems, the size of earthing conductor is not to be less than $A/2$.
2. Conversion Table for mm$^2$ to circular mils:

<table>
<thead>
<tr>
<th>mm$^2$</th>
<th>circ. mils</th>
<th>mm$^2$</th>
<th>circ. mils</th>
<th>mm$^2$</th>
<th>circ. mils</th>
<th>mm$^2$</th>
<th>circ. mils</th>
<th>mm$^2$</th>
<th>circ. mils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,973</td>
<td>2.5</td>
<td>4,933</td>
<td>6</td>
<td>11,841</td>
<td>70</td>
<td>138,147</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>2,960</td>
<td>4</td>
<td>7,894</td>
<td>16</td>
<td>31,576</td>
<td>120</td>
<td>236,823</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PART 4
CHAPTER 3 Electrical Installations
SECTION 4 Machinery and Equipment

1 Certification of Electrical Machinery and Equipment (2012)
Electrical machinery and equipment required to be certified by ABS are covered under Section 6-1-7.

3 Battery Systems and Uninterruptible Power Systems (UPS)

3.1 References
3.1.1 Emergency Services
For requirements covering emergency services and transitional source of power, see 4-3-2/5.5.3 and 4-3-2/5.7, respectively.

3.1.2 Protection of Batteries
For requirements covering protection of batteries, see 4-3-2/9.9.

3.1.3 Battery Installation
For requirements covering battery installation, ventilation of the battery location and protection from corrosion, see 4-3-3/3.7.

3.1.4 Cable Installation
For requirements covering cable installation in the battery room, see 4-3-3/5.19.

3.3 Engine-starting Battery
Battery systems for engine-starting purposes may be of the one-wire type and the earth lead is to be carried to the engine frame. See also 4-8-2/11.11 of the Marine Vessel Rules and 4-3-2/5.15 of this Chapter for main engine starting and the starting arrangement of the emergency generator, respectively.

3.5 Location (2008)
3.5.1 Location
The UPS unit is to be suitably located for use in an emergency. The UPS unit is to be located as near as practical to the equipment being supplied, provided the arrangements comply with all other Rules, such as 4-3-3/3.7, 4-3-3/3.9, 4-3-3/3.11, and 4-3-3/3.13 for location of electrical equipment.

3.5.2 Ventilation
UPS units utilizing valve regulated sealed batteries may be located in compartments with normal electrical equipment, provided the ventilation arrangements are in accordance with the requirements of 4-3-3/3.7. Since valve regulated sealed batteries are considered low-hydrogen-emission batteries, calculations are to be submitted in accordance with 4-3-3/3.7.2(d) to establish the gas emission performance of the valve regulated batteries compared to the standard lead acid batteries. Arrangements are to be provided to allow any possible gas emission to be led to the weather, unless the gas emission performance of the valve regulated batteries does not exceed that of standard lead acid batteries connected to a charging device of 0.2 kW.
3.5.3 Battery Installation

For battery installation arrangements, see 4-3-3/3.7.

3.7 Performance (2008)

3.7.1 Duration

The output power is to be maintained for the duration required for the connected equipment as stated in 4-3-2/5.3 for emergency services and 4-3-2/5.7 of transitional source of power, as applicable.

3.7.2 Battery Capacity

No additional circuits are to be connected to the battery charger unit or UPS unit without verification that the batteries have adequate capacity. The battery capacity is, at all times, to be capable of supplying the designated loads for the time specified in 4-3-4/3.7.1.

3.7.3 Recharging

On restoration of the input power, the rating of the charging facilities are to be sufficient to recharge the batteries while maintaining the output supply to the load equipment. See also 6-1-7/9.17.2.

5 Programmable Electronic System (PES) (2017)

A Programmable Electronic System is a system based on one or more programmable electronic devices, connected to (and including) input devices (e.g. sensors) and/or output devices/final elements (e.g. actuators), for the purposes of control, protection or monitoring. The term PES includes all elements in the system, including power supplies, extending from sensors or other input devices, via data highways or other communicating paths, to the actuators, or other output devices, associated software, peripherals and interfaces.

Programmable Electronic Systems are to meet the requirements of Section 4-9-3 of the Marine Vessel Rules, even when the unit will not be assigned with ACC or ACCU notations.

For Programmable Electronic Systems associated with remote propulsion control, see also 4-3-5/3.11.2.

7 Cables and Wires

7.1 Cable Construction

7.1.1 General (1 July 2017)

Electric cables are to have conductors, insulation and moisture-resistant jackets in accordance with IEC Publication 60092-350, 60092-352, 60092-353, 60092-354, 60092-360, 60092-370, 60092-376, IEEE Std-45. Other recognized marine standards of an equivalent or higher safety level, will also be considered. The tests may be carried out by the manufacturer whose certificate of tests will be acceptable and is to be submitted upon request from ABS. Network cables are to comply with a recognized industry standard. Cables such as flexible cable, fiber-optic cable, etc., used for special purposes may be accepted provided they are manufactured and tested in accordance with recognized standards accepted by ABS. Conductors are to be of copper and stranded in all sizes. Conductors are not to be less than the following in cross sectional size:

- 1.0 mm$^2$ (1,973.5 circ. mils) for power and lighting,
- 0.5 mm$^2$ (986.8 circ. mils) for control cables,
- 0.5 mm$^2$ (986.8 circ. mils) for essential or emergency signaling and communications cables, except for those assembled by the equipment manufacturer, and
- 0.35 mm$^2$ (690.8 circ. mils) for telephone cables for nonessential communication services, except for those assembled by the equipment manufacturer.
See 4-3-4/7.5 TABLE 2 for current carrying capacity for insulated copper wires and cables.

For electric cables in hazardous areas, the electric cable construction and the cable glands are to achieve the appropriate seal, such that gas cannot migrate through the cable.

Note:

See clause 3.16 and clause 4.6 of IEC 60092-350 concerning the provision of an extruded impervious inner sheath that will prevent the migration of gas through the cable.

7.1.2 Flame Retardant Property

7.1.2(a) Standards.

All electric cables are to be at least of a flame-retardant type complying with the following:

i) (2016) Depending on the intended installation, cables constructed to IEC Publication 60092 standards are to comply with the flammability criteria of IEC Publication 60332-3-22 or 60332-3-21, Category A or A F/R, or

ii) Cables constructed to IEEE Std. 45 are to comply with the flammability criteria of that standard, or

iii) (2016) Cables constructed to another recognized marine standard, where specially approved, are to comply with the flammability criteria of IEC Publication 60332-3-22 or 60332-3-21, Category A or A F/R (depending on the intended installation) or other acceptable standards.

Consideration will be given to the special types of cables, such as radio frequency cable, which do not comply with the above requirements.

7.1.2(b) Alternative Arrangement (2005).

Flame retardant marine cables, including network cables, which have not passed the above-mentioned bunched cable flammability criteria may be considered, provided that the cable is treated with approved flame-retardant material or the installation is provided with approved fire stop arrangements. Special consideration may be given to the flame retardancy of special types of cables, such as radio frequency cables. When specifically approved, bus duct may be used in lieu of cable.

7.1.3 Fire Resistant Property (2016)

When electric cables are required to be fire-resistant, they are to comply with the requirements of IEC Standard 60331-1 for cables greater than 20 mm overall in diameter, otherwise they are to comply with the IEC Standard 60331-2 for cable diameters 20 mm or less. For special cables, requirements in the following standards may be used:

- IEC Standard 60331-23: Procedures and requirements – Electric data cables
- IEC Standard 60331-25: Procedures and requirements – Optical fiber cables

Cables complying with alternative national standards suitable for use in a marine environment may be considered. Fire resistant type cables are to be easily distinguishable. See also 4-3-3/3.29 and 4-3-3/5.17.

7.1.4 Insulation Material

All electrical cables for power, lighting, communication, control and electronic circuits are to have insulation suitable for a conductor temperature of not less than 60°C (140°F). See 4-3-4/7.5 TABLE 1 for types of cable insulation.
7.1.5 Armor for Single-conductor Cables
The armor is to be nonmagnetic for single-conductor alternating-current cables.

7.1.6 Fiber Optic Cables
Fiber optic cables are to be constructed and tested to a recognized fiber optic cable construction standard acceptable to ABS. The requirements of flame retardancy for the electrical cables is applicable to the fiber optic cables. The construction of the fiber optic cable which may pass through or enter a hazardous area is to be such that escape of gases to a safe area is not possible through the cable.

7.3 Portable and Flexing Electric Cables
Unless otherwise required in the Rules, cables for portable equipment and cables subject to flexing service need not be armored.

7.5 Mineral-insulated, Metal-sheathed Cable
Mineral-insulated cable provided with approved fittings for terminating and connecting to boxes, outlets and other equipment may be used for any service up to 600 volts and may be used for feeders and branch circuits in both exposed and concealed work, in dry or wet locations. The moisture-resisting jacket (sheath) of mineral-insulated, metal-sheathed cable exposed to corrosive conditions is to be made of or protected by materials suitable for those conditions.

### TABLE 1
Types of Cable Insulation [See 4-3-4/7.1.4] (2013)

<table>
<thead>
<tr>
<th>Insulation Type Designation</th>
<th>Insulation Materials</th>
<th>Maximum Conductor Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>R85, XLPE</td>
<td>Cross-linked Polyethylene</td>
<td>85°C (185°F) *</td>
</tr>
<tr>
<td>E85, EPR</td>
<td>Ethylene Propylene Rubber</td>
<td>85°C (185°F) *</td>
</tr>
<tr>
<td>R90, XLPE</td>
<td>Cross-linked Polyethylene</td>
<td>90°C (194°F) *</td>
</tr>
<tr>
<td>E90, EPR</td>
<td>Ethylene Propylene Rubber</td>
<td>90°C (194°F) *</td>
</tr>
<tr>
<td>M95</td>
<td>Mineral (MI)</td>
<td>95°C (203°F) *</td>
</tr>
<tr>
<td>S95</td>
<td>Silicone Rubber</td>
<td>95°C (203°F) *</td>
</tr>
</tbody>
</table>

* A maximum conductor temperature of 250°C (482°F) is permissible for special applications and standard end fittings may be used, provided the temperature does not exceed 85°C (185°F) at the end of fittings. However, when the temperature at the end of the fittings is higher than 85°C (185°F), special consideration will be given to an appropriate end fitting.
<table>
<thead>
<tr>
<th>Conductor Size</th>
<th>Maximum Current in Amperes (see 4-3-4/7.1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm²</td>
<td>1-core</td>
</tr>
<tr>
<td></td>
<td>10¹ circ mils</td>
</tr>
<tr>
<td>1.0</td>
<td>13 16 20</td>
</tr>
<tr>
<td>1.25</td>
<td>15 18 23</td>
</tr>
<tr>
<td>1.5</td>
<td>17 21 23</td>
</tr>
<tr>
<td>4.11</td>
<td>21 25 32</td>
</tr>
<tr>
<td>2.5</td>
<td>24 28 32</td>
</tr>
<tr>
<td>6.53</td>
<td>28 34 38</td>
</tr>
<tr>
<td>4</td>
<td>32 38 40</td>
</tr>
<tr>
<td>10.4</td>
<td>38 45 51</td>
</tr>
<tr>
<td>6</td>
<td>41 49 52</td>
</tr>
<tr>
<td>16.5</td>
<td>51 60 68</td>
</tr>
<tr>
<td>10</td>
<td>57 67 72</td>
</tr>
<tr>
<td>20.8</td>
<td>59 70 78</td>
</tr>
<tr>
<td>26.3</td>
<td>68 81 91</td>
</tr>
<tr>
<td>16</td>
<td>76 91 96</td>
</tr>
<tr>
<td>33.1</td>
<td>79 93 105</td>
</tr>
<tr>
<td>41.7</td>
<td>91 108 121</td>
</tr>
<tr>
<td>25</td>
<td>101 120 127</td>
</tr>
<tr>
<td>52.6</td>
<td>105 124 140</td>
</tr>
<tr>
<td>66.4</td>
<td>121 144 162</td>
</tr>
<tr>
<td>35</td>
<td>125 148 157</td>
</tr>
<tr>
<td>83.7</td>
<td>140 166 187</td>
</tr>
<tr>
<td>50</td>
<td>156 184 196</td>
</tr>
<tr>
<td>106</td>
<td>163 193 217</td>
</tr>
<tr>
<td>133</td>
<td>188 222 250</td>
</tr>
<tr>
<td>70</td>
<td>192 228 242</td>
</tr>
<tr>
<td>168</td>
<td>217 257 289</td>
</tr>
<tr>
<td>95</td>
<td>232 276 293</td>
</tr>
<tr>
<td>212</td>
<td>251 297 335</td>
</tr>
</tbody>
</table>
### Conductor Size

| **mm²** | **10³ circ mils** | **1-core** | | **2-core** | | **3- or 4-core** |
|---|---|---|---|---|---|
| | | **R85 XLPE E85 EPR** | **R90 XLPE E90 EPR** | **M95 S95** | **R85 XLPE E85 EPR** | **R90 XLPE E90 EPR** | **M95 S95** |**R85 XLPE E85 EPR** | **R90 XLPE E90 EPR** | **M95 S95** |
| 120 | | 269 | 319 | 339 | 359 | 229 | 271 | 288 | 305 | 188 | 223 | 237 | 251 |
| 250 | | 278 | 330 | 371 | 236 | 281 | 315 | 359 | 195 | 231 | 260 |
| 150 | | 309 | 367 | 389 | 412 | 263 | 312 | 331 | 350 | 216 | 257 | 272 | 288 |
| 300 | | 312 | 370 | 416 | 265 | 315 | 354 | 318 | 259 | 291 |
| 350 | | 343 | 407 | 458 | 292 | 346 | 389 | 240 | 285 | 321 |
| 185 | | 353 | 418 | 444 | 470 | 300 | 355 | 377 | 400 | 247 | 293 | 311 | 329 |
| 400 | | 373 | 442 | 498 | 317 | 376 | 423 | 261 | 309 | 349 |
| 450 | | 402 | 476 | 536 | 342 | 405 | 456 | 261 | 309 | 375 |
| 240 | | 415 | 492 | 522 | 553 | 353 | 418 | 444 | 470 | 291 | 344 | 365 | 387 |
| 500 | | 429 | 509 | 572 | 365 | 433 | 486 | 300 | 356 | 400 |
| 550 | | 455 | 540 | 607 | 387 | 459 | 516 | 319 | 378 | 425 |
| 300 | | 477 | 565 | 601 | 636 | 405 | 480 | 511 | 541 | 334 | 396 | 421 | 445 |
| 600 | | 481 | 570 | 641 | 409 | 485 | 545 | 337 | 399 | 449 |
| 650 | | 506 | 599 | 674 | 430 | 509 | 573 | 354 | 419 | 472 |
| 700 | | 529 | 628 | 706 | 450 | 534 | 600 | 370 | 440 | 494 |
| 750 | | 553 | 655 | 737 | 470 | 557 | 626 | 387 | 459 | 516 |
| 400 | | 571 | 677 | 690 | 761 | 485 | 575 | 587 | 647 | 400 | 474 | 483 | 533 |
| 800 | | 576 | 682 | 767 | 490 | 580 | 652 | 403 | 477 | 540 |
| 850 | | 598 | 709 | 797 | 508 | 603 | 677 | 419 | 496 | 558 |
| 900 | | 620 | 734 | 826 | 527 | 624 | 702 | 434 | 514 | 578 |
| 950 | | 641 | 760 | 854 | 545 | 646 | 726 | 449 | 532 | 598 |
| 500 | | 656 | 778 | 780 | 875 | 558 | 661 | 663 | 744 | 459 | 545 | 546 | 613 |
| 1000 | | 662 | 784 | 882 | 563 | 666 | 750 | 463 | 549 | 617 |
| 600 | | 736 | 872 | 981 | 626 | 741 | 834 | 515 | 610 | 687 |
| 625 | | 755 | 894 | 1006 | 642 | 760 | 855 | 529 | 626 | 704 |

**Notes:**

1. The values given above have been calculated for an ambient of 45°C (113°F) and assume that a conductor temperature equal to the maximum rated temperature of the insulation is reached and maintained continuously in the case of a group of four cables bunched together and laid in free air.

2. The current rating values given in 4-3-4/7.5 TABLE 2 (and those derived therefrom) may be considered applicable, without correction factors, for cables double-banked on cable trays, in cable conduits or cable pipes, except as noted in Note 3.
3 For bunched cables, see 4-3-3/5.11.1.

4 These current ratings are applicable for both armored and unarmored cables.

5 If ambient temperature differs from 45°C (113°F), the values in 4-3-4/7.5 TABLE 2 are to be multiplied by the following factors. (See below table.)

<table>
<thead>
<tr>
<th>Maximum Conductor Temperature</th>
<th>Ambient Correction Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40°C (104°F)</td>
</tr>
<tr>
<td>75°C (167°F)</td>
<td>1.08</td>
</tr>
<tr>
<td>85°C (185°F)</td>
<td>1.06</td>
</tr>
<tr>
<td>95°C (203°F)</td>
<td>1.05</td>
</tr>
<tr>
<td>95°C (203°F)</td>
<td>1.05</td>
</tr>
</tbody>
</table>

6 Where the number of conductors in a cable exceeds four, as in control cables, the maximum current carrying capacity of each conductor is to be reduced as in the following table:

<table>
<thead>
<tr>
<th>No. of Conductors</th>
<th>% of 3–4/C Type Values in 4-3-4/7.5 TABLE 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 – 6</td>
<td>80</td>
</tr>
<tr>
<td>7 – 24</td>
<td>70</td>
</tr>
<tr>
<td>25 – 42</td>
<td>60</td>
</tr>
<tr>
<td>43 and above</td>
<td>50</td>
</tr>
</tbody>
</table>

7 When a mineral-insulated cable is installed in such a location that its copper sheath is liable to be touched when in service, the current rating is to be multiplied by the correction factor 0.80 in order that the sheath temperature does not exceed 70°C (158°F).

8 Cables being accepted based on approved alternate standard may have current carrying capacity of that standard, provided the cables are in full compliance with that standard.
1.1 General

1.1.1 Application (2003)

The following requirements in this Subsection are applicable to AC systems with nominal voltage (phase to phase) exceeding 1 kV. Unless stated otherwise, high voltage equipment and systems are to comply with the other parts in Part 4, Chapter 3 for low voltage equipment and systems, as well.

1.1.2 Standard Voltages (2003)

The nominal standard voltage is not to exceed 15 kV. A higher voltage may be considered for special applications.

1.1.3 Air Clearance and Creepage Distance (2014)

1.1.3(a) Air Clearance.

Phase-to-phase air clearances and phase-to-earth air clearances between non-insulated parts are to be not less than the minimum as specified below.

<table>
<thead>
<tr>
<th>Nominal Voltage in kV</th>
<th>Minimum air clearance in mm (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 – 3.3</td>
<td>55 (2.2)</td>
</tr>
<tr>
<td>6 – 6.6</td>
<td>90 (3.6)</td>
</tr>
<tr>
<td>10 – 11</td>
<td>120 (4.8)</td>
</tr>
<tr>
<td>15</td>
<td>160 (6.3)</td>
</tr>
</tbody>
</table>

Where intermediate values of nominal voltages are accepted, the next higher air clearance is to be observed. In the case of smaller distances, an appropriate voltage impulse test is to be applied.

1.1.3(b) Reduction.

Alternatively, reduced clearance distances may be used provided:

i) The equipment is not installed in ‘Machinery Spaces of Category A’ or in areas affected by a Local Fixed Pressure Water-spraying or Local Water-mist Fire Extinguishing System.

ii) The equipment is subject to an impulse voltage test with test voltage values shown in Table below. Where intermediate values of rated operational voltage are used, the next higher rated impulse withstand test voltage is to be used. The impulse voltage test reports are to be submitted to ABS for review.
1.1.3(c) Insulating Material.

Any insulating material that is used to cover live parts of equipment used to comply with clearance distance requirements is to be suitable for the application. The equipment manufacturer is to submit documentation which demonstrates the suitability of such insulation material.

1.1.3(d) Creepage Distance (1 July 2016)

i) The minimum creepage distances for main switchboards and generators are given in the Table below:

<table>
<thead>
<tr>
<th>Nominal Voltage V</th>
<th>Minimum Creepage Distance for Proof Tracking Index mm (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>300V</td>
</tr>
<tr>
<td>1000-1100</td>
<td>26 (1.02)</td>
</tr>
<tr>
<td>&lt; 3300</td>
<td>63 (2.48)</td>
</tr>
<tr>
<td>&lt; 6600</td>
<td>113 (4.45)</td>
</tr>
<tr>
<td>≤ 11000(2)</td>
<td>183 (7.20)</td>
</tr>
</tbody>
</table>

Notes:
1. A distance of 35 mm is required for busbars and other bare conductors in main switchboards.
2. Creepage distances for equipment with nominal voltage above 11 kV shall be subject to consideration.

ii) The minimum creepage distances for equipment other than main switchboards and generators are given in the Table below:

<table>
<thead>
<tr>
<th>Nominal Voltage V</th>
<th>Minimum Creepage Distance for Proof Tracking Index mm (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>300V</td>
</tr>
<tr>
<td>1000-1100</td>
<td>18 (0.71)</td>
</tr>
<tr>
<td>&lt;3300</td>
<td>42 (1.65)</td>
</tr>
<tr>
<td>&lt;6600</td>
<td>83 (3.27)</td>
</tr>
<tr>
<td>≤11000*</td>
<td>146 (5.75)</td>
</tr>
</tbody>
</table>

Note:
* Creepage distances for equipment with nominal voltage above 11 kV shall be subject to consideration.

iii) Creepage distances between live parts and between live parts and earthed metal parts are to be in accordance with IEC 60092-503 for the nominal voltage of the system, the nature of the insulation material, and the transient overvoltage developed by switch and fault conditions.
1.3 System Design

1.3.1 Selective Coordination
Selective coordination is to be in accordance with 4-3-2/9.1.5, regardless of the system neutral earthing arrangement.

1.3.2 Earthed Neutral Systems

1.3.2(a) Neutral Earthing (2003).

The current in the earth fault condition is to be not in excess of full load current of the largest generator on the switchboard or relevant switchboard section and in no case less than three times the minimum current required for operation of any device in the earth fault condition.

At least one source neutral to ground connection is to be available whenever the system is in the energized mode.

1.3.2(b) Equipment (2003).

Electrical equipment in directly earthed neutral or other neutral earthed systems is to be able to withstand the current due to a single phase fault against earth for a period necessary to trip the protection device.

1.3.3 Neutral Disconnection
Each generator neutral is to be provided with means for disconnection.

1.3.4 Hull Connection of Earthing Impedance (2003)
All earthing impedances are to be connected to the hull. The connection to the hull is to be so arranged that any circulating currents in the earth connections will not interfere with radio, radar, communication and control equipment circuits. In systems with neutral earthed, connection of the neutral to the hull is to be provided for each generator switchboard section.

1.3.5 Earth Fault Detection and Indication (2018)

An earth fault is to be indicated by visual and audible means. In low impedance or direct earthed systems, provision is to be made to automatically disconnect the faulty circuits. In high impedance earthed systems where outgoing feeders will not be isolated in case of an earth fault, the insulation of the equipment is to be designed for the phase to phase voltage.

i) In unearthed or high impedance earthed systems, an earth fault is to be indicated by visual and audible means at the centralized control system.

ii) In low impedance or direct earthed systems, provision is to be made to automatically disconnect the faulty circuits. Audible and visual indication is to be provided at the centralized control station to indicate that a ground fault had occurred and has been cleared by ground fault protection. An audible alarm is to be provided if the ground fault was not successfully cleared.

iii) In high impedance earthed systems where outgoing feeders will not be isolated in case of an earth fault, the insulation of the equipment is to be designed for the phase to phase voltage.

1.3.6 Number and Capacity of Transformers (2014)
Requirements for the number and capacity of transformers are given in 4-3-2/7.1.6(a).

For transformers with a high voltage winding over 1000 V, the following would not be accepted as complying with the above requirement:

i) The provision of a spare single phase transformer to substitute a failed transformer.

ii) The operation of two single phase transformers in an open delta (V-V) connection.

1.5.1 Source and Capacity of Power Supply
Where electrical energy or mechanical energy is required for the operation of circuit breakers and switches, a means of storing such energy is to be provided with a capacity at least sufficient for two on/off operation cycles of all of the components. However, the tripping due to overload or short-circuit, and under-voltage is to be independent of any stored electrical energy sources. This does not preclude the use of stored energy for shunt tripping, provided alarms are activated upon loss of continuity in the release circuits and power supply failures. The stored energy may be supplied from within the circuit in which the circuit breakers or switches are located.

1.5.2 Number of External Sources of Stored Energy
Where the stored energy is supplied from a source external to the circuit, such supply is to be from at least two sources so arranged that a failure or loss of one source will not cause the loss of more than one set of generators and/or essential services. Where it will be necessary to have the source of supply available for dead ship startup, the source of supply is to be provided from the emergency source of electrical power.

1.7 Circuit Protection

1.7.1 Protection of Generator (2003)
Protection against phase-to-phase fault in the cables connecting the generators to the switchboard and against interwinding faults within the generator is to be provided. This is to trip the generator circuit breaker and automatically de-excite the generator. In distribution systems with a low-impedance earthed neutral, phase to earth faults are to be likewise treated.

1.7.2 Protection of Power Transformers (2014)
Power transformers are to be provided with overload and short circuit protection. Each high-voltage transformer intended to supply power to the low-voltage unit main service switchboard is to be protected in accordance with 4-3-2/9.15. In addition, the following means for protecting the transformers or the electric distribution system are to be provided:

1.7.2(a) Coordinated Trips of Protective Devices (2002).
Discriminative tripping is to be provided for the following. See 4-3-2/9.1.5.

i) Between the primary side protective device of the transformer and the feeder protective devices on the low-voltage unit main service switchboard, or

ii) Between the secondary side protective device of the transformer, if fitted, and the feeder protective devices on the low-voltage unit main service switchboard.

1.7.2(b) Load Shedding Arrangement (2002).
Where the power is supplied through a single set of three-phase transformers to a low-voltage unit main service switchboard, automatic load shedding arrangements are to be provided when the total load connected to the low voltage unit main service switchboard exceeds the rated capacity of the transformer. See 4-3-2/1.7 and 4-3-2/9.3.3.

1.7.2(c) Protection from Electrical Disturbance (2002).
Means or arrangements are to be provided for protecting the transformers from voltage transients generated within the system due to circuit conditions, such as high-frequency current interruption and current suppression (chopping) as the result of switching, vacuum cartridge circuit breaker operation, or thyristor-switching.
An analysis or data for the estimated voltage transients is to be submitted to show that the insulation of the transformer is capable of withstanding the estimated voltage transients. See 6-1-7/15.3.3(b).

1.7.2(d) Protection from Earth-Faults (2002).

Where a Y-neutral of three-phase transformer windings is earthed, means for detecting an earth-fault are to be provided. The detection of the earth fault is to activate an alarm at the manned control station or to automatically disconnect the transformer from the high-voltage power distribution network.

1.7.2(e) Transformers Arranged in Parallel (2014).

Refer to 4-3-2/9.5.2 for requirements.

1.7.3 Voltage Transformers for Control and Instrumentation (2003)

Voltage transformers are to be provided with overload and short circuit protection on the secondary side.

1.7.4 Fuses (2003)

Fuses are not to be used for overload protection.

1.7.5 Over Voltage Protection (2003)

Lower voltage systems supplied through transformers from high voltage systems are to be protected against overvoltages. This may be achieved by:

i) Direct earthing of the lower voltage system,

ii) Appropriate neutral voltage limiters, or

iii) Earthed screen between primary and secondary winding of transformers

1.9 Equipment Installation and Arrangement

1.9.1 Degree of Protection

The degree of equipment protection is to be in accordance with 4-3-5/7.1 TABLE 1.

1.9.2 Protective Arrangements

1.9.2(a) Interlocking Arrangements.

Where high-voltage equipment is not contained in an enclosure, but a room forms the enclosure of the equipment, the access doors are to be so interlocked that they cannot be opened until the supply is isolated and the equipment earthed down.

1.9.2(b) Warning Plate (1 July 2016).

At the entrance of such spaces, a suitable marking is to be placed which indicates danger of high-voltage and the maximum voltage inside of the space. For high-voltage electrical equipment installed outside of these spaces, a similar marking is to be provided. An adequate, unobstructed working space is to be left in the vicinity of high voltage equipment for preventing potential severe injuries to personnel performing maintenance activities. In addition, the clearance between the switchboard and the overhead/deckhead above is to meet the requirements of the Internal Arc Classification according to IEC 62271-200.

1.9.2(c) Spaces Containing High Voltage Equipment (2014).
All entrances to spaces containing high voltage equipment are to have suitable marking indicating
the danger of high voltage and the maximum voltage inside the space. Where the spaces contain
high voltage switchgear the marking at the entrances is also to include marking indicating that the
space is only accessible to authorized personnel only.

1.9.2(d) Exposure of HV Equipment to Damaging Environments (2014).

Consideration should be given to designing the arrangement of the installation to avoid exposure
of high voltage equipment to contaminants, such as oil or dust, as might be found in machinery
spaces or close to ventilation air inlets to the space, or to water spray from water-mist systems and
local fire hose connections.

1.9.3 Cables
1.9.3(a) Runs of Cables (2003).

In accommodation spaces, high voltage cables are to be run in enclosed cable transit systems.

1.9.3(b) Segregation (2003).

High voltage cables of different voltage ratings are not to be installed in the same cable bunch,
duct, pipe or box. Where high voltage cables of different voltage ratings are installed on the same
cable tray, the air clearance between cables is not to be less than the minimum air clearance for the
higher voltage side in 4-3-5/1.1.3(a). However, high voltage cables are not to be installed on the
same cable tray for the cables operating at the nominal system voltage of 1 kV or less.

Higher voltage equipment is not to be combined with lower voltage equipment in the same
enclosure unless segregation or other suitable measures are taken to ensure safe access to lower
voltage equipment

1.9.3(c) Installation Arrangements (2003).

High voltage cables are to be installed on cable trays or equivalent when they are provided with a
continuous metallic sheath or armor which is effectively bonded to earth. Otherwise, they are to be
installed for their entire length in metallic casings effectively bonded to earth.

1.9.3(d) Termination and Splices (2014).

Terminations in all conductors of high voltage cables are to be, as far as practicable, effectively
covered with suitable insulating material. In terminal boxes, if conductors are not insulated, phases
are to be separated from earth and from each other by substantial barriers of suitable insulating
materials. High voltage cables of the radial field type, i.e., having a conductive layer to control the
electric field within the insulation, are to have terminations which provide electric stress control.

Terminations are to be of a type compatible with the insulation and jacket material of the cable
and are to be provided with means to ground all metallic shielding components (i.e., tapes, wires
etc.).

Splices and joints are not permitted in propulsion cables. For purposes of this Rule, propulsion
cables are those cables whose service is related only to propulsion.

1.9.3(e) Cable Rating (2019)

The rated phase to earth voltage ($U_o$) of high voltage cables shall not be less than shown in the
Table below:
### Nominal System Voltage

$$U_n (kV)$$

- **Highest System Voltage**
  - $$U_m (kV)$$

<table>
<thead>
<tr>
<th>Nominal System Voltage ($U_n$) (kV)</th>
<th>Highest System Voltage ($U_m$) (kV)</th>
<th>Minimum Rated Voltage of Cable ($U_o/U$) (kV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0/3.3</td>
<td>3.6</td>
<td>1.8/3.0</td>
</tr>
<tr>
<td>6.0/6.6</td>
<td>7.2</td>
<td>3.6/6.0</td>
</tr>
<tr>
<td>10.0/11.0</td>
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<td>6.0/10.0</td>
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<tr>
<td>15.0/16.5</td>
<td>17.5</td>
<td>8.7/15.0</td>
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<tr>
<td>20.0/22.0</td>
<td>24.0</td>
<td>12.0/20.0</td>
</tr>
<tr>
<td>30.0/33.0</td>
<td>36.0</td>
<td>18.0/30.0</td>
</tr>
</tbody>
</table>

#### Notes:

1. Nominal System Voltage ($U_n$) in 50 Hz and 60 Hz.
2. Cables being accepted based on approved alternate standard may have voltage ratings of that standard provided the cables are in full compliance with that standard.

### 1.9.3(f) Cable Current Carrying Capacities (2019)

The maximum current carrying capacity of high voltage cables is to be in accordance with 4-3-4/7.5 TABLE 2.

### 1.9.3(g) Marking

High voltage cables are to be readily identifiable by suitable marking.

### 1.9.3(h) Test after Installation (1 July 2016)

A voltage withstand test is to be carried out on each completed cable and its accessories before a new high voltage installation, including additions to an existing installation, is put into service.

An insulation resistance test is to be carried out prior to the voltage withstand test being conducted.

For cables with rated voltage ($U_o/U$) above 1.8/3 kV ($U_m = 3.6$ kV) an AC voltage withstand test may be carried out upon advice from high voltage cable manufacturer. One of the following test methods to be used:

- **i)** An AC test voltage for 5 min with the phase-to-phase voltage of the system applied between the conductor and the metallic screen/sheath.
- **ii)** An AC voltage test for 24 h with the normal operating voltage of the system.
- **iii)** A DC test voltage equal to $4U_o$ may be applied for 15 minutes.

For cables with rated voltage ($U_o/U$) up to 1.8/3 kV ($U_m = 3.6$ kV), a DC voltage equal to $4U_o$ shall be applied for 15 minutes.

After completion of the test, the conductors are to be connected to earth for a sufficient period in order to remove any trapped electric charge.

The insulation resistance test is then repeated.
Alternatively, an AC voltage withstand test may be carried out upon advice from the high voltage cable manufacturer at a voltage not less than the normal operating voltage of the cable, and it is to be maintained for a minimum of 24 hours.

*Note:* Tests in accordance with IEC Publication 60502 will also be considered adequate.

The above tests are for newly installed cables. If due to repairs or modifications, cables which have been in use are to be tested, lower voltages and shorter durations should be considered.

1.9.4 **High Voltage Shore Connection (2014)**

Where arrangements are made for the supply of electricity at high voltage from onshore, and designed to allow the shipboard generators to be shut down while in port, the requirements given in the ABS *Guide for High Voltage Shore Connection* are to be complied with.

1.11 **Cable Construction (2012)**

Cables are to be constructed to IEC Publication 60092-353, 60092-354, or other equivalent recognized standard. See also 4-3-4/7.1.

1.13 **Design Operating Philosophy (2014)**

1.13.1 **Objective**

While this section covers the specific ABS requirements for High Voltage (HV) systems, it is recognized that system design and equipment construction are only parts of an overall approach that are required to allow HV systems to be operated safely. Other aspects that contribute towards HV safety include maintenance procedures, vessel and equipment operating procedures, permit to work procedures, company safety policy, personal protective equipment (PPE) and training, most of which are beyond the role of Classification. However, in order to assist ABS in its review of the design and construction of the vessel and its equipment it is necessary for ABS to be assured that the design is part of a larger overall approach or plan.

The High Voltage Design Principles document is to outline the concepts that are the basis of the design. It should identify risks and document the strategies that are used to mitigate each of the risks (e.g., remote switching, arc flash energy reduction equipment).

1.13.2 **HV System Failures**

The design should take into account each reasonably foreseeable failure type and address what actions will be expected of the crew for each failure. Due to the limited availability of specialist tools, equipment and spare parts on board and recognizing the additional dangers associated with space limitations, the remoteness of specialized medical help and facilities in the event of emergencies, it is desirable that, as far as practicable, the crew is not exposed to dangers that could be avoided. For these reasons it is preferable that the vessel’s HV electrical system be designed such that the crew can safely isolate any damaged distribution equipment and switch to alternative supplies without the need to open the HV equipment.

1.13.3 **Activities**

For all HV switchboards and distribution boards, each type of operation or activity is to be identified and the means of undertaking the operation or activity safely is to be established. The operations and activities to be considered are to include the following:

- **i)** Taking readings
- **ii)** Normal operational switching
- **iii)** Isolation and making safe
- **iv)** Maintenance
- **v)** Fault finding
vi) Inspection

vii) Class Surveys

Where switchgear design calls for circuit breakers to be inspected prior to being put back into service following operation on overcurrent, this should also be covered.

1.13.4 Accessibility (1 July 2016)

An adequate, unobstructed working space of at least 2 m (6 ft) is to be left in the vicinity of high voltage equipment for preventing potential severe injuries to personal performing maintenance activities. Where the clear space around a location where activity is taking place is less than 2 m (6 ft), then the activities are to be covered in sufficient detail to take into account the work involved and the possible need to have clear and safe access for emergency medical evacuation. Where recommended by the switchgear manufacturer, the working space may be reduced to a minimum of 1.5 m (5 feet) due to special considerations such as the use of arc resistant switchgear.

Activities that do not require operation at the switchboard (e.g., telephones or manual call points) should not require the operator to be within 2 m (6 ft) of the switchboard.

1.13.5 Modifications

No modifications are to be made to HV switchgear without the plans being approved and the drawings being made available to the ABS Surveyor in advance of the work taking place. Testing of approved modifications is to be conducted in the presence of the ABS Surveyor. Temporary repairs are to be in full compliance with the requirements of these Rules.

1.13.6 HV Systems with Enhanced Operating Redundancy

Where the HV electrical system is designed with sufficient redundancy to allow switching and isolation along the principles in 4-3-5/1.13.2 and still meet the requirements of 4-3-2/3.1.2 with one generator in reserve, then the activity associated with that failure is not required to be included.

1.15 Preliminary Operations Manual (2014)

1.15.1 Objective

The preliminary operations manual contains the shipyard’s description of operations affecting the vessel’s HV equipment. The description ‘preliminary’ is used to capture the fact that it may not be the final document used by the vessel’s Owner.

The manual is to be complete and sufficiently detailed to capture each piece of HV equipment and how the activities associated with that equipment can be achieved consistently with the Design Operating Philosophy. This manual is to be made available to the Owner by the shipyard.

The Owner will need the information contained in the preliminary operations manual to understand how the shipyard designed the HV equipment to be operated safely. It is likely that the Owner will modify some aspects of the manual to bring it in line with their own company policies, organizational responsibilities and legal duties.

The preliminary operations manual is to include for each piece of HV equipment:

i) Details of the tasks (operations and activities) associated with that piece of equipment

ii) Details of the ‘Authorization’ needed to perform each of the tasks

iii) Details of the tools required to perform each of the tasks

iv) Details of PPE and safety equipment (locks, barriers, tags, rescue hooks, etc.)

v) Identify the tasks for which a ‘permit to work’ system is to be used.
1.15.2 Details of Authorization

For each operation or task involving HV switchgear and for access to the HV switchgear rooms, the appropriate authorizations are to be determined before delivery.

1.15.3 Training Requirements for Authorization

Part of the basis of establishing any level of authorization is training. It is not expected that the shipyard will stipulate what training qualifications are required. However, a description of the subjects that would need to be covered in the training for each level of authorization should be included.

The Owner can be guided by the above information in making decisions regarding the crew training requirements.

1.15.4 Test, Maintenance Tools and PPE

Where tasks require the use of PPE, the required protection clothing rating should be identifiable in the preliminary operations manual and on a label on the HV equipment where that task will take place. The level of protection offered by the PPE is to be readily identified on the PPE itself in the same terms or units as used on the labels.

Some PPE for general use is not suitable for High Voltage or arc flash hazards, mostly through inappropriate fire performance; such PPE is to be excluded from high voltage switchgear rooms. Information alerting the crew of the need to be able to recognize and use the right PPE is to be included in the manual.

1.15.5 Inspection and Maintenance of Test Equipment Tools and PPE

Where PPE or test equipment is provided by the shipyard the means for its proper use, inspection, calibration and maintenance is to be made available. The instructions or directions regarding where they are kept are to be contained in the Preliminary Operations Manual.

Where the PPE is not provided by the shipyard a description or specification regarding the required tools and PPE should be provided in the Preliminary Operations Manual.

3 Electric Propulsion System

3.1 General (2007)

3.1.1 Application (2014)

The following requirements in this Subsection are applicable to the electric propulsion system. Electric propulsion systems complying with other recognized standards will also be considered, provided it can be shown, through either satisfactory service experience or a systematic analysis based on sound engineering principles, to meet the overall safety standards of these Rules. Unless stated otherwise, electric propulsion equipment and systems are to comply with the applicable requirements in other parts of Part 4, Chapter 3, as well.

3.1.2 Plans and Data to be Submitted

In addition to the plans and data to be submitted in accordance with 4-3-2/1, 4-3-3/1, and 6-1-7/3, the following plans and data are to be submitted for review.

- One line diagrams of propulsion control system for power supply, circuit protection, alarm, monitoring, safety and emergency shutdown systems, including list of alarm and monitoring points.
- Plans showing the location of propulsion controls and its monitoring stations.
- Arrangements and details of the propulsion control console or panel including schematic diagram of the system therein.
• Arrangements and details of electric coupling.
• Arrangements and details of the semiconductor converters enclosure for propulsion system including data for semiconductor converter, cooling system with its interlocking arrangement.

3.3 **System Design (2007)**

3.3.1 **General (2016)**

For the purposes of the electric propulsion system requirements, an electric propulsion system is one in which the main propulsion of the vessel is provided by at least one electric motor. A vessel may have more than one electrical propulsion system.

An integrated electric propulsion system is a system where a common set of generators supply power to the vessel service loads as well as the propulsion loads.

In the case of an integrated electrical propulsion system the electrical drive train is considered to consist of the equipment connected to the electrical network such as a drive (frequency converter) and the propulsion motor(s).

All electrical equipment that is part of the electric propulsion drive train is to be built with redundancy such that a single failure will not completely disable the propulsion of the vessel. Where electric motors are to provide the sole means of propulsion for a vessel, a single propulsion motor with dual windings does not meet this requirement.

3.3.2 **Generating Capacity**

For vessels with an integrated electric propulsion system, under normal sea-going conditions, when one generator is out of service, the remaining generator capacity is to be sufficient to carry all of the loads for vessel services (essential services, normal services and for minimum comfortable conditions of habitability) and the propulsion loads to provide for a speed of not less than 7 knots or one half of the design speed, whichever is the lesser.

3.3.3 **Power Management System (2014)**

For vessels with an integrated electric propulsion system, a power management system is to be provided. The power management system is to be designed to control load sharing between generators, prevent blackouts, maintain power to the essential service loads and maintain power to the propulsion loads.

The system is to account for the following operating scenarios.

• All generators in operation, then the loss of one generator
• When at least one generator is not in operation and there is an increase in the propulsion loads, or a loss of one of the generators, that would result in the need to start a generator that was not in operation.
• Upon failure of the power management system, there is to be no change in the available electrical power. Failure of the power management system is to be alarmed at a manned control station.

Further, the system is to prevent overloading the generators, by reducing the propulsion load or load shedding of non-essential loads. In general, the system is to limit power to the propulsion loads to maintain power to the vessel’s essential service loads. However, the system is to shed non-essential loads to maintain power to the propulsion loads.

An audible and visible alarm is to be installed at each propulsion control location and is to be activated when the system is limiting the propulsion power in order to maintain power to the other essential service loads.
3.3.4 Regenerative Power (2014)

For systems where regenerative power may be developed, the regenerative power is not to cause overspeeding of the prime mover or in the system voltage and frequency which exceeds the limits of 4-3-1/9. See also 6-1-3/3.7.1 and 6-1-3/3.7.5.

3.3.5 Harmonics (2014)

A harmonic distortion calculation is to be submitted for review for all vessels with electric propulsion. The calculation is to indicate that the harmonic distortion levels at all locations throughout the power distribution system (main generation switchboard, downstream power distribution switchboards, etc.) are within the limits of 4-3-2/7.9. The harmonic distortion levels at dedicated propulsion buses are also to be within the limits of 4-3-2/7.9, otherwise documentation from the manufacturer is to be submitted indicating that the equipment is designed for operation at a higher level of distortion.

Where higher values of harmonic distortion are expected, any other possible effects, such as additional heat losses in machines, network resonances, errors in control and monitoring systems are to be considered.

Means of monitoring voltage harmonic distortion shall be provided, including alarms at the main generation switchboard and at continuously manned stations when to notify of an increase in total or individual harmonic distortion levels above the maximum allowable levels.

Harmonic filters, if used, are to comply with requirements mentioned in 4-3-2/9.19.

3.5 Propulsion Power Supply Systems (2014)

3.5.1 Propulsion Generators

3.5.1(a) Power Supply.

The power for the propulsion equipment may be derived from a single generator. If a unit main service generator is also used for propulsion purposes other than for boosting the propulsion power, such generator and power supply circuits to propulsion systems are also to comply with the applicable requirements in this subsection. See also 4-3-2/3.1.4.

3.5.1(b) Single System.

If a propulsion system contains only one generator and one motor and cannot be connected to another propulsion system, more than one exciter set is to be provided for each machine. However, this is not necessary for self-excited generators or for multi-propeller propulsion units where any additional exciter set may be common for the unit.

3.5.1(c) Multiple Systems.

Systems having two or more propulsion generators, two or more semiconductor converters, or two or more motors on one propeller shaft are to be so arranged that any unit may be taken out of service and disconnected electrically without preventing the operation of the remaining units.

3.5.1(d) Excitation Systems.

Arrangements for electric propulsion generators are to be such that propulsion can be maintained in case of failure of an excitation system or failure of a power supply for an excitation system. Propulsion may be at reduced power under such conditions where two or more propulsion generators are installed, provided such reduced power is sufficient to provide for a speed of not less than 7 knots or \( \frac{1}{2} \) of the design speed, whichever is the lesser.

3.5.1(e) Features for Other Services.
If the propulsion generator is used for purposes other than for propulsion, such as dredging, cargo oil pumps and other special services, overload protection in the auxiliary circuit and means for making voltage adjustments are to be provided at the control board. When propulsion alternating-current generators are used for other services for operation in port, the port excitation control is to be provided with a device that is to operate just below normal idling speed of the generator to remove excitation automatically.

3.5.2 Propulsion Excitation

3.5.2(a) Excitation Circuits.

Every exciter set is to be supplied by a separate feeder. Excitation circuits are not to be fitted with overload circuit-interrupting devices, except those intended to function in connection with the protection for the propulsion generator. In such cases, the field circuit breaker is to be provided with a discharge resistor, unless a permanent discharge resistor is provided.

3.5.2(b) Field Circuits.

Field circuits are to be provided with means for suppressing voltage rise when a field switch is opened. Where fuses are used for excitation circuit protection, it is essential that they do not interrupt the field discharge resistor circuit upon rupturing.

3.5.2(c) Unit’s Service Generator Connection.

Where the excitation supply is obtained from the unit’s service generators, the connection is to be made to the generator side of the generator circuit breaker with the excitation supply passing through the overload current device of the breaker.

3.7 Circuit Protection (2016)

3.7.1 Setting

Overcurrent protective devices, if any, in the main circuits are to be set sufficiently high so as not to operate on overcurrents caused by maneuvering or normal operation in heavy seas or in floating broken ice.

3.7.2 Direct-current (DC) Propulsion Circuits

3.7.2(a) Circuit Protection.

Direct-current propulsion circuits are not to have fuses. Each circuit is to be protected by overload relays to open the field circuits or by remote-controlled main-circuit interrupting devices. Provision is to be made for closing circuit breakers promptly after opening.

3.7.2(b) Protection for Reversal of the Rotation.

Where separately driven DC generators are connected electrically in series, means shall be provided to prevent reversal of the rotation of a generator upon failure of the driving power of its prime mover.

3.7.3 Excitation Circuits

An overload protection is not to be provided for opening of the excitation circuit.

3.7.4 Reduction of Magnetic Fluxes

Means are to be provided for selective tripping or rapid reduction of the magnetic fluxes of the generators and motors so that overcurrents do not reach values which may endanger the plant.
3.7.5 Direct-current (DC) Propulsion Motors Supplied by Semiconductor Converters (2008)

The protection features of the semiconductor converters are to be arranged to avoid a damaging flashover in the DC propulsion motor. A possible cause of a damaging flashover would be removal of the field current. The protection features of the semiconductor converters are to take into account the increase in armature current created by the removal of the field current, due to accidental loss of the field, or activation of a protection feature intended to protect the field.

To verify compliance with the above, the maximum time-current characteristics that can be commutated by the motor as well as the time-current characteristics of the protective features of the semiconductor converters are to be submitted for review. To avoid a damaging flashover, the maximum time-current characteristics of the motor is to be provided by the motor manufacturer and is to be used by the semiconductor converter manufacturer to determine the appropriate set points for the protection features of the semiconductor converters.

3.9 Protection for Earth Leakage

3.9.1 Main Propulsion Circuits

Means for earth leakage detection are to be provided for the main propulsion circuit and be arranged to operate an alarm upon the occurrence of an earth fault. When the fault current flowing is liable to cause damage, arrangements for opening the main propulsion circuit are also to be provided.

3.9.2 Excitation Circuits

Means are to be provided for earth leakage detection in excitation circuits of propulsion machines but may be omitted in circuits of brushless excitation systems and of machines rated up to 500 kW.

3.9.3 Alternating-current (AC) Systems

Alternating-current propulsion circuits are to be provided with an earthing detector alarm or indicator. If the neutral is earthed for this purpose, it is to be through an arrangement which will limit the current at full-rated voltage so that it will not exceed approximately 20 amperes upon a fault to earth in the propulsion system. An unbalance relay is to be provided which is to open the generator and motor-field circuits upon the occurrence of an appreciable unbalanced fault.

3.9.4 Direct-current (DC) Systems

The earthing detector may consist of a voltmeter or lights. Provision is to be made for protection against severe overloads, excessive currents and electrical faults likely to result in damage to the plant. Protective equipment is to be capable of being so set as not to operate on the overloads or overcurrents experienced in a heavy seaway or when maneuvering.

3.11 Electric Propulsion Control

3.11.1 General

Failure of a control signal is not to cause an excessive increase in propeller speed. The reference value transmitters in the control stations and the control equipment are to be so designed that any defect in the desired value transmitters or in the cables between the control station and the propulsion system will not cause a substantial increase in the propeller speed.

3.11.2 Automatic and Remote Control Systems

Where two or more control stations are provided outside of the engine room, or where automatic control of the propulsion machinery is provided, Part 4, Chapter 9 of the Marine Vessel Rules, as applicable, are to be complied with. See 4-9-1/3 of the Marine Vessel Rules for propulsion class symbols.
3.11.3 Initiation of Control
The control of the propulsion system can be activated only when the delegated control lever is in zero position and the system is ready for operation.

3.11.4 Emergency Stop
Each control station shall have an emergency stop device which is independent of the control lever.

3.11.5 Prime Mover Control
Where required by the system of control, means are to be provided at the control assembly for controlling the prime mover speed and for mechanically tripping the throttle valve.

3.11.6 Control Power Failure
If failure of the power supply occurs in systems with power-aided control (e.g., with electric, pneumatic or hydraulic aid), it is to be possible to restore control in a short time.

3.11.7 Protection
Arrangements are to be made so that opening of the control system assemblies or compartments will not cause inadvertent or automatic loss of propulsion. Where steam and oil gauges are mounted on the main-control assembly, provision is to be made so that the oil will not come in contact with the energized parts in case of leakage.

3.11.8 Interlocks
All levers for operating contactors, line switches, field switches and similar devices are to be interlocked to prevent their improper operation. Interlocks are to be provided with the field lever to prevent the opening of any main circuits without first reducing the field excitation to zero, except that when the generators simultaneously supply power to an auxiliary load apart from the propulsion, the field excitation need only be reduced to a low value.

3.13 Instrumentation at the Control Station
3.13.1 Indication, Display and Alarms
The necessary instruments to indicate existing conditions at all times are to be provided and mounted on the control panel convenient to the operating levers and switches. Instruments and other devices mounted on the switchboard are to be labeled and the instruments provided with a distinguishing mark to indicate full-load conditions. Metallic cases of all permanently installed instruments are to be permanently earthed. The following instruments, where applicable, are to be provided.

Ammeter, voltmeter, indicating wattmeter, and field ammeter* for each propulsion generator and for each synchronous motor.

3.13.1(b) For DC Systems.
An ammeter for each main circuit and one or more voltmeters with selector switches for reading voltage on each propulsion generator and motor.

3.13.1(c) For Electric Slip Couplings.
An ammeter for the coupling excitation circuit.

* Field ammeter is not required for brushless generators.
3.13.2 Indication of Propulsion System Status
The control stations of the propulsion systems are to have at least the following indications for each propeller.

3.13.2(a) "Ready for Operation".
Power circuits and necessary auxiliaries are in operation.

3.13.2(b) "Faulty".
Propeller is not controllable.

3.13.2(c) "Power Limitation".
In case of disturbance, for example, in the ventilators for propulsion motors, in the converters, cooling water supply or load limitation of the generators.

3.15 Equipment Installation and Arrangement (2014)
3.15.1 General
The arrangement of bus bars and wiring on the back of propulsion-control assemblies is to be such that all parts, including the connections, are accessible. All nuts and connections are to be fitted with locking devices to prevent loosening due to vibration. Clearance and creepage distance are to be provided between parts of opposite polarity and between live parts and earth to prevent arcing. See 4-3-1/19, 6-1-7/9.9.6 and 6-1-7/15.3.2(b).

3.15.2 Accessibility and Facilities for Repairs
3.15.2(a) Facility for Supporting.
Facilities shall be provided for supporting the shaft to permit inspection and withdrawal of bearings.

3.15.2(b) Slip-couplings.
Slip-couplings are to be designed to permit removal as a unit without axial displacement of the driving and driven shaft, and without removing the poles.

3.15.3 Propulsion Cables
Propulsion cables are not to have splices or joints, except terminal joints, and all cable terminals are to be sealed against the admission of moisture or air. Similar precautions are to be taken during installation by sealing all cable ends until the terminals are permanently attached. Cable supports are to be designed to withstand short-circuited conditions. They are to be spaced less than 915 mm (36 in.) apart and are to be arranged to prevent chafing of the cable. See 7-1-5/5.9.1.

3.17 Machinery and Equipment (2012)
3.17.1 Certification
For certification requirements of machinery and equipment related to electric propulsion system, see 6-1-7/17.

3.17.2 Switches
3.17.2(a) General Design.
All switches are to be arranged for manual operation and so designed that they will not open under ordinary shock or vibration. Contactors, however, may be operated pneumatically, by solenoids or other means in addition to the manual method which is to be provided, unless otherwise approved.
3.17.2(b) Generator and Motor Switches.

Switches for generators and motors are preferably to be of the air-break type, but for alternating-current systems where they are to be designed to open full-load current at full voltage, oil-break switches using nonflammable liquid may be used if provided with leak-proof, non-spilling tanks.

3.17.2(c) Field Switches. Where necessary,

field switches are to be arranged for discharge resistors unless discharge resistors are permanently connected across the field. For alternating-current systems, means are to be provided for de-energizing the excitation circuits by the unbalance relay and earth relay.

3.17.3 Cooling Systems for Machinery and Equipment

3.17.3(a) Air Coolers.

For requirements covering air cooling systems of propulsion generators and motors, see 6-1-7/17.3.1(c).

3.17.3(b) Forced Cooling.

For requirements covering forced ventilation or forced water cooling of semiconductor converters, see 6-1-7/12.5.8.

5 Three-wire Dual-voltage DC System

5.1 Three-wire DC Unit’s Generators

Separate circuit-breaker poles are to be provided for the positive, negative, neutral and also for the equalizer leads unless protection is provided by the main poles. When equalizer poles are provided for the three-wire generators, the overload trips are to be of the algebraic type. No overload trip is to be provided for the neutral pole, but it is to operate simultaneously with the main poles. A neutral overcurrent relay and alarm system is to be provided and set to function at a current value equal to the neutral rating.

5.3 Neutral Earthing

5.3.1 Main Switchboard

The neutral of three-wire dual-voltage direct-current systems is to be solidly earthed at the generator switchboard with a zero-center ammeter in the earthing connection. The zero-center ammeter is to have a full-scale reading of 150% of the neutral-current rating of the largest generator and be marked to indicate the polarity of earth. The earth connection is to be made in such a manner that it will not prevent checking the insulation resistance of the generator to earth before the generator is connected to the bus. The neutrals of three-wire DC emergency power systems are to be earthed at all times when they are supplied from the emergency generator or storage battery. The earthed neutral conductor of a three-wire feeder is to be provided with a means for disconnecting and is to be arranged so that the earthed conductor cannot be opened without simultaneously opening the unearthed conductors.

5.3.2 Emergency Switchboard

No direct earth connection is to be provided at the emergency switchboard. The neutral bus or buses are to be solidly and permanently connected to the neutral bus of the main switchboard. No interrupting device is to be provided in the neutral conductor of the bus-tie feeder connecting the two switchboards.
5.5 **Size of Neutral Conductor**

The capacity of the neutral conductor of a dual-voltage feeder is to be 100% of the capacity of the unearthed conductors.

7 **Emergency Shutdown Arrangements**

The following requirements are applicable to drilling units, or units operating next to drilling units or units producing hydrocarbons.

7.1 **Emergency Shutdown Facilities (2017)**

Arrangements are to be provided for the disconnection or shutdown, either selectively or simultaneously, of all electrical equipment and devices, including the emergency generator, except for the services listed under 4-3-5/7.1.4 from the emergency control station (see 8-2-1/11.17). Initiating of the above shutdowns may vary according to the nature of the emergency. A recommended sequence of shut-downs is to be provided in the unit’s operating manual.

Risks associated with technical faults and inadvertent operations of the emergency shutdown. Each vessel is to develop a detailed plan for recovery and restoration of operation after operation of each level of ESD.

ESD Stations that can enable a total unit shutdown should not be located in locations which are unmanned under normal operations except in the backup DP Control Station, if applicable and provided. Where ESD stations are provided at the lifeboat stations or other unmanned locations, the total unit ESD (complete shutdown) is to be protected from unauthorized personnel or not available at these unmanned locations.

7.1.1 **Functional Design Basis Document (FDS)**

The ESD FDS Operation Manual is to define the ESD levels and provide a list of equipment or areas that are affected by the different ESD levels. Also, this is to indicate which ESD levels are available at each ESD station. Further, the manual is to provide instructions on to reset the affected systems after each ESD.

The ESD FDS is to provide guidance describing the typical scenarios that the ESD levels should be used and who has access to use them.

The ESD FDS is to be included or referenced in the unit’s operating manual.

7.1.2 **Gas Detection / ESD System Cause and Effect Chart**

Where shutdown groups are initiated automatically upon gas detection, a Gas Detection / ESD System Cause and Effect Chart is to relate gas detection sensors to ESD shutdown groups of equipment and areas on the unit.

7.1.3 **Machinery Associated with Dynamic Positioning System (2012)**

In the case of units using dynamic positioning systems as a sole means of position keeping, special consideration may be given to the selective disconnection or shutdown of machinery and equipment associated with maintaining the operability of the dynamic positioning system in order to preserve the integrity of the well.

7.1.4 **Operation After Shutdown**

The following services are to be operable after an emergency shutdown:

- \(i\) **(2014)** Emergency lighting for locations listed in 4-3-2/5.3.1 for half an hour
- \(ii\) General alarm
- \(iii\) Blow-out preventer control system
- \(iv\) Public address system
- \(v\) Distress and safety radiocommunications
All equipment in exterior locations which is capable of operation after shutdown is to be suitable for installation in Zone 2 locations.

**TABLE 1**
High Voltage Equipment Locations and Minimum Degree of Protection (2014)

<table>
<thead>
<tr>
<th>Example of Location</th>
<th>Condition of Location</th>
<th>Switchboards, Distribution Boards, Motor Control Centers and Controllers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry control rooms</td>
<td>Authorized Personnel Only</td>
<td>IP32                       N/A                       N/A                       IP23                       IP44</td>
</tr>
<tr>
<td>Dry control rooms</td>
<td>Unauthorized Personnel Only</td>
<td>IP42                       N/A                       N/A                       IP44                       IP44</td>
</tr>
<tr>
<td>Control rooms</td>
<td>Authorized Personnel Only</td>
<td>IP32                       N/A                       N/A                       IP23                       IP44</td>
</tr>
<tr>
<td>Control Rooms</td>
<td>Unauthorized Personnel Only</td>
<td>IP42                       N/A                       N/A                       IP44                       IP44</td>
</tr>
<tr>
<td>Above floor plates</td>
<td>Authorized Personnel Only (1)</td>
<td>IP32                       IP23                      IP23                      IP23                      IP44</td>
</tr>
<tr>
<td>Above floor plates</td>
<td>Unauthorized Personnel Only</td>
<td>IP42                       IP23                      IP43                      IP44                      IP44</td>
</tr>
<tr>
<td>Emergency machinery</td>
<td>Authorized Personnel Only</td>
<td>IP32                       IP23                      IP23                      IP23                      IP44</td>
</tr>
<tr>
<td>Emergency machinery</td>
<td>Unauthorized Personnel Only</td>
<td>IP42                       IP23                      IP43                      IP44                      IP44</td>
</tr>
<tr>
<td>Below floor plates</td>
<td>Authorized Personnel Only</td>
<td>Increased danger of liquid and/or mechanical damage                      N/A                       N/A                       *                         *                         IP44</td>
</tr>
<tr>
<td>Below floor plates</td>
<td>Unauthorized Personnel Only</td>
<td>Increased danger of liquid and/or mechanical damage                      N/A                       N/A                       *                         N/A                       IP44</td>
</tr>
<tr>
<td>Ballast pump rooms</td>
<td>Authorized Personnel Only</td>
<td>Increased danger of liquid and mechanical damage                         IP44                      N/A                       IP44                      IP44                      IP44</td>
</tr>
<tr>
<td>Ballast pump rooms</td>
<td>Unauthorized Personnel Only</td>
<td>Increased danger of liquid and mechanical damage                         IP44                      N/A                       IP44                      IP44                      IP44</td>
</tr>
<tr>
<td>Holds for general cargo</td>
<td></td>
<td>Danger of liquid spray presence of cargo dust, serious mechanical damage, and/or aggressive fumes</td>
</tr>
<tr>
<td>Open decks (2)</td>
<td>Not exposed to seas</td>
<td>N/A                       IP56                      IP56                      IP56                      IP56</td>
</tr>
<tr>
<td>Open decks (2)</td>
<td>Exposed to seas</td>
<td>N/A                       N/A                       *                         *                         *                         *</td>
</tr>
</tbody>
</table>

**“*”** indicates that equipment in excess of 1000V is not normally permitted in these locations.
Notes:

1. See 4-3-3/3.1.1 where the equipment is located within areas affected by local fixed pressure water-spraying or water-mist fire extinguishing systems.

2. For High Voltage Shore Connections (HVSC) see the requirements in the ABS Guide for High Voltage Shore Connection.

3. Where the IP rating of the high voltage electrical equipment has been selected on the basis that it is only accessible to authorized personnel, the entrance doors to the spaces in which such equipment is located, are to be marked accordingly.


9.1. **Lithium Batteries**
For units provided with lithium batteries, see the requirements in the ABS Guide for Use of Lithium Batteries in the Marine and Offshore Industries.

9.3. **Supercapacitors**
For units provided with supercapacitors, see the requirements in the ABS Guide for Supercapacitors in the Marine and Offshore Industries.
PART 4
CHAPTER 3 Electrical Installations
SECTION 6 Hazardous Areas

1 Definitions

1.1 Hazardous Areas (2016)

Hazardous areas are all those areas where a flammable atmosphere may be expected to exist continuously or intermittently. See IEC Publication 60079-10-1. Such flammable atmospheres may arise from drilling or well test operations, other operations such as use and storage of flammable liquids, paint and acetylene, or any such operation pertinent to the particular service of the unit. Hazardous areas are subdivided into Zones 0, 1, 2, defined as follows:

- **Zone 0** A zone in which ignitable concentrations of flammable gases or vapors are continuously present or present for long periods.
- **Zone 1** A zone in which ignitable concentrations of flammable gases or vapors are likely to occur in normal operating conditions.
- **Zone 2** A zone in which ignitable concentrations of flammable gases or vapors are not likely to occur, and if it occurs, it will exist only for a short time.

1.3 Enclosed Space

An enclosed space is considered to be a space bounded by decks and bulkheads which may or may not have doors, windows or other similar openings.

1.5 Semi-Enclosed Location

A semi-enclosed location is considered to be a location where natural conditions of ventilation are notably different from those on open decks due to the presence of structure such as roofs, windbreaks and bulkheads and which are arranged so that the dispersion of gas may not occur.

1.7 Outdoor Location

An outdoor location is considered to be a location substantially free of structures (or other obstructions) where natural ventilation is not impeded and causes the rapid dispersion (dilution) of gases and vapors, and stagnant areas are not present.

3 Plans and Data to be Submitted (2012)

The following data should generally be submitted electronically to ABS. However, hard copies will also be accepted.

- Arrangement plans clearly indicating the hazardous areas
- A description of the ventilating system for all hazardous areas
- Complete particulars of the ventilating system including capacities of fans, number of complete changes of air per minute, air flows, areas subject to positive and negative pressure, and location and direction of opening of self-closing doors
5 Classification of Areas (None Hydrocarbon Related)

The following hazardous areas are defined for mobile offshore units in general. In addition, hazardous area classifications for specific unit types and operations are defined in Part 8, e.g. 8-2-1/9 for classification of area associated with drilling activities.

5.1 Hazardous Areas Zone 0 Include:

i) Internal spaces of closed tanks and piping or oil [closed-cup flash point below 60°C (140°F)] or flammable gas and vapor.

ii) Outdoor location within 0.5 m (1.65 ft) from an opening to the hazardous areas defined in 4-3-6/5.1.i, such as a tank vent.

5.3 Hazardous Areas Zone 1 Include:

i) Enclosed spaces containing tanks and pipes described in 4-3-6/5.1.i;

ii) Enclosed spaces containing liquid or solid substances that are likely to emit flammable gases or vapors;

iii) An enclosed space or semi-enclosed location:

- Having a direct access or opening into the hazardous areas defined in 4-3-6/5.3.i or 4-3-6/5.3.ii or other Zone 1 areas, through a door, a ventilation opening, etc.;
- Immediately adjacent to the closed tanks defined in 4-3-6/5.1.i; or
- Containing pumps or piping used for conveying liquid described in 4-3-6/5.1.i, except for all-welded or continuous closed piping systems without valves, flanges or similar devices;

iv) Outdoor location within 1 m (3.3 ft) beyond the Zone 0 area defined in 4-3-6/5.1.ii;

v) Outdoor location within 1.5 m (5 ft) from pumps or piping used for conveying liquid described in 4-3-6/5.1.i, except for all-welded or continuous closed piping systems without valves, flanges or similar devices;

vi) Outdoor location within 1.5 m (5 ft) beyond the Zone 1 areas defined in 4-3-6/5.3.iv and 4-3-6/5.3.vi, such as a door, a ventilation opening, a tank vent, etc.;

viii) Outdoor or semi-enclosed location within 1.5 m (5 ft) from any equipment, container, etc., stowed in a designated open deck area, that are likely to emit flammable gases or vapors. An area of open deck may be a designated Zone 1 hazardous area for the future stowage of this type of products with a height of 1.5 m (5 ft) above the estimated maximum height of the equipment, container, etc. to be stowed. Equipment, containers, etc., that can generate a Zone 1 hazardous area, may be located within the designated Zone 1 hazardous area;

vii) Pits, ducts or similar structures in locations which otherwise would be Zone 2 but which are arranged so the dispersion of gas may not occur.

5.5 Hazardous Areas Zone 2 Include:

i) Outdoor location within 3 m (10 ft) from the boundaries of the closed tanks defined in 4-3-6/5.1.i;

ii) Outdoor location within 1.5 m (5 ft) from pumps or piping used for conveying liquid described in 4-3-6/5.1.i, except for all-welded or continuous closed piping systems without valves, flanges or similar devices;

iii) Outdoor location within 1.5 m (5 ft) beyond the Zone 1 areas defined in 4-3-6/5.3.iv and 4-3-6/5.3.v;

iv) Outdoor or semi-enclosed location within 1.5 m (5 ft) beyond the Zone 1 areas defined in 4-3-6/5.3.vi. An area of the open deck may be a designated Zone 2 hazardous area. Equipment, containers, etc. that can generate a Zone 2 hazardous area, may be located within the designated Zone 2 hazardous area;

v) Air lock spaces between Zone 1 and non-hazardous space, in accordance with 4-3-6/7.5.1.i
6 Classification of Miscellaneous Areas (2015)

6.1 Paint Stores

   i) Hazardous Areas Zone 1:

       ● The interior of the paint store;
       ● Outdoor or semi-enclosed locations within 0.5 m (1.65 ft) from the boundaries of the ventilation inlet and natural ventilation outlet;
       ● Outdoor or semi-enclosed locations within 1.5 m (5 ft) from the boundaries of the power ventilation outlet.

   ii) Hazardous Areas Zone 2:

       ● Outdoor or semi-enclosed locations within 0.5 m (1.65 ft) beyond the Zone 1 area from the ventilation inlet and natural ventilation outlet;
       ● Outdoor or semi-enclosed locations within 1.5 m (5 ft) beyond the Zone 1 area from the power ventilation outlet.

See also 4-3-3/9.5.

6.3 Battery Rooms

   i) Hazardous Areas Zone 1:

       ● The interior of the battery room;
       ● Outdoor or semi-enclosed locations within 0.5 m (1.65 ft) from the boundaries of the natural ventilation outlet;
       ● Outdoor or semi-enclosed locations within 1.5 m (5 ft) from the boundaries of the power ventilation outlet.

   ii) Hazardous Areas Zone 2:

       ● Outdoor or semi-enclosed locations within 0.5 m (1.65 ft) beyond the Zone 1 area from the natural ventilation outlet;
       ● Outdoor or semi-enclosed locations within 1.5 m (5 ft) beyond the Zone 1 area from the power ventilation outlet.

See also 4-3-3/3.7.

6.5 Helicopter Refueling Facilities

   i) Hazardous Areas Zone 1:

       ● Enclosed space containing components of the refueling pump/equipment;
       ● Outdoor or semi-enclosed locations within 1.5 m (5 ft) from the boundaries of the ventilation outlet of enclosed space containing refueling pump/equipment;
       ● Outdoor or semi-enclosed locations within 1.5 m (5 ft) from the boundaries of the tank vent outlet;
       ● Outdoor or semi-enclosed locations within 1.5 m (5 ft) from the boundaries of the refueling pump/equipment.

   ii) Hazardous Areas Zone 2:

       ● Outdoor or semi-enclosed locations within 1.5 m (5 ft) beyond the Zone 1 area from the ventilation outlet of enclosed space containing refueling pump/equipment;
● Outdoor or semi-enclosed locations within 1.5 m (5 ft) beyond the Zone 1 area from the tank vent outlet;

● Outdoor or semi-enclosed locations within 1.5 m (5 ft) beyond the Zone 1 area from the refueling pump/equipment.

See also 4-2-6/7.1.2.

6.7 Oxygen-acetylene Storage Rooms

i) Hazardous Areas Zone 1:

● The interior of the storage room;

● Outdoor or semi-enclosed locations within 0.5 m (1.65 ft) from the boundaries of natural ventilation outlet;

● Outdoor and semi-enclosed locations within 1.5 m (5 ft) from the boundaries of power ventilation outlet.

ii) Hazardous Areas Zone 2:

● Outdoor or semi-enclosed locations within 0.5 m (1.65 ft) beyond the Zone 1 area from the natural ventilation outlet;

● Outdoor or semi-enclosed locations within 1.5 m (5 ft) beyond the Zone 1 area from the power ventilation outlet.

See also 4-2-6/5.3.

7 Openings, Access, and Ventilation Conditions Affecting the Extent of Hazardous Zones

Except for operational reasons, access doors or other openings are not to be provided between a non-hazardous space and a hazardous zone, nor between a Zone 2 space and a Zone 1 space.

Where such access doors or other openings are provided, any enclosed space not referred to under 4-3-6/5.3 or 4-3-6/5.5 and having a direct access to any Zone 1 location or Zone 2 location becomes the same zone as the location, except that:

7.1 Enclosed Space with Direct Access to any Zone 1 Location

An enclosed space with direct access to any Zone 1 location is considered as Zone 2, provided: (see also 4-3-6/7.1 FIGURE 1):

i) (2012) The access is fitted with a self-closing gas-tight door opening into the Zone 2 space,

ii) Ventilation is such that the air flow with the door open is from the Zone 2 space into the Zone 1 location, and

iii) Loss of ventilation is alarmed at a normally manned station;
7.3 Enclosed Space with Direct Access to any Zone 2 Location

An enclosed space with direct access to any Zone 2 location is not considered hazardous, provided (see also 4-3-6/7.3 FIGURE 2):

i) The access is fitted with self-closing gas-tight door that opens into the non-hazardous space,

ii) Ventilation is such that the air flow with the door open is from the non-hazardous space into the Zone 2 locations, and

iii) Loss of ventilation is alarmed at a normally manned station.
7.5 Enclosed Space with Access to any Zone 1 Location (2013)

An enclosed space with access to any Zone 1 location is not considered hazardous, provided the access is through either arrangement described below (see also 4-3-6/7.5 FIGURE 3):

7.5.1 Air Lock

i) The access is fitted with two self-closing doors forming an air lock, which open toward the non-hazardous space and has no hold-back devices,

ii) The doors are to be spaced apart at least a distance that prevents an individual from opening both doors simultaneously. A notice is to be affixed to each side of each door to the effect that only one door is to be open at a time.

iii) An audible and visual alarm system to give a warning on both sides of the air lock is provided to indicate if more than one door is moved from the closed position,

iv) Ventilation is such that the non-hazardous space has ventilation overpressure greater than 25 Pa (0.25 mbar) in relation to the Zone 1 location,

v) The air lock space has independent mechanical ventilation from a gas-safe area such that, with any of the air lock doors open, the air flow is from the less hazardous space to the more hazardous space or area,

vi) The air lock space is fitted with gas detection, and
vii) Loss of ventilation overpressure is alarmed at a normally manned station.

7.5.2 Single Door

i) The access is fitted with a single self-closing, gas-tight door which opens toward the nonhazardous space and has no hold-back device,

ii) Ventilation is such that the air flow with the door open is from the non-hazardous space into the Zone 1 location with over-pressure greater than 25 Pa (i.e., non-hazardous space has ventilation overpressure greater than 25 Pa (0.25 mbar) in relation to the Zone 1 location), and

iii) Loss of ventilation overpressure is alarmed at a normally manned station.

7.7 Ventilation Alarms (2012)

The alarms to indicate failure of the mechanical ventilation as required by 4-3-6/7.1.iii and 4-3-6/7.3.iii are to provide audible and visual signals at the designated normally manned station. The initiation of these alarms by a fan motor running or fan rotation monitoring device is not acceptable.

The alarms to indicate loss of ventilation overpressure as required by 4-3-6/7.5.1.vii and 4-3-6/7.5.2.iii are to be set to a minimum overpressure of 25 Pa (0.25 mbar) with respect to the adjacent Zone 1 location. A differential pressure monitoring device or a flow monitoring device may be used for the initiation of the alarm. When a flow monitoring device is used and a single self-closing gas-tight door is fitted, the minimum overpressure is to be maintained with the door fully open without setting off the alarm, or alternatively, an alarm is to be given if the door is not closed. The initiation by a fan motor running or fan rotation monitoring device is not acceptable.

7.9 Hold-back Devices (2012)

Hold-back devices are not to be used on self-closing gas-tight doors forming hazardous area boundaries.
9  **Ventilation (2013)**

9.1  **General**

Attention is to be given to ventilation inlet and outlet locations and airflow in order to minimize the possibility of cross contamination. Ventilation inlets are to be located in non-hazardous areas and as far as practicable from the boundaries of any hazardous area, but to a distance not less than 1.5 m (5 ft). Ventilation for hazardous areas is to be completely separate from that for non-hazardous areas.

9.3  **Ventilation of Hazardous Areas**

Enclosed hazardous spaces are to be provided with adequate ventilation so as to dilute a possible release of flammable gas or vapor in them and to maintain them at a lower pressure than adjacent less hazardous spaces or areas. Refer to 4-3-6/7 for adjacent spaces not separated by gastight boundaries. The arrangement of ventilation inlet and outlet openings in the space is to be such that the entire space is efficiently ventilated, giving special consideration to location of equipment which may release gas and to spaces where gas may accumulate.

The outlet air from Zone 0, Zone 1 and Zone 2 spaces is to be led in separate ducts to outdoor locations which in the absence of the considered outlet are of the same or lesser hazard than the ventilated space. The internal spaces of such ducts are the same Zone as the inlet space. Ventilation ducts for hazardous areas are to be at under pressure in relation to less hazardous areas and at overpressure in relation to more hazardous areas, when passing through such areas, and are to be rigidly constructed to avoid air leaks.

Fans are to be of non-sparking construction, in accordance with 4-3-3/9.7.

9.5  **Ventilation of Non-hazardous Areas**

Enclosed non-hazardous spaces adjacent to hazardous spaces or areas are to be provided with adequate ventilation so as to maintain them at a higher pressure than adjacent hazardous spaces or areas. Refer to 4-3-6/7 for adjacent spaces not separated by gastight boundaries. Ventilation inlets and outlets for non-hazardous spaces are to be located in non-hazardous areas. See 4-3-6/9.1. Where passing through hazardous areas, ducts are to have overpressure in relation to the hazardous area.

11  **Machinery Installations in Hazardous Areas (1 July 2015)**

Electrical equipment and wiring in hazardous areas is to be in accordance with 4-3-3/9.

Internal combustion engines are not to be installed in Zone 0 hazardous areas. When essential for operational purposes, internal combustion engines may be installed in Zone 1 and 2 hazardous areas. Such installations will be subject to special consideration. Fired boilers are not to be installed in hazardous areas.

Exhaust outlets of internal combustion engines and boilers are to discharge outside of all hazardous areas. Air intakes are to be not less than 3 m (10 ft) from hazardous areas. Exhaust outlets of internal combustion engines are to be fitted with suitable spark-arresting devices, and exhaust piping insulation is to be protected against possible oil absorption in areas or spaces where the exhausting piping is exposed to oil or oil vapors.