This latest edition incorporates all rule changes. The latest revisions are shown with a vertical line. The section title is framed if the section is revised completely. Changes after the publication of the rule are written in red colour.

Unless otherwise specified, these Rules apply to ships for which the date of contract for construction as defined in TL- PR 29 is on or after 1st of January 2024. New rules or amendments entering into force after the date of contract for construction are to be applied if required by those rules. See Rule Change Notices on TL website for details.

"General Terms and Conditions" of the respective latest edition will be applicable (see Rules for Classification and Surveys).

If there is a difference between the rules in English and in Turkish, the rule in English is to be considered as valid. This publication is available in print and electronic pdf version. Once downloaded, this document will become UNCONTROLLED. Please check the website below for the valid version.

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# Offshore Units and Installations – Electric

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A. General

1. Scope

1.1 These Rules apply to electrical and electronic equipment on fixed offshore installations and mobile offshore units in accordance with Chapter 59.

In particular, they apply to the components of electrical installations for:

- essential services to be maintained subject to various emergency conditions
- essential services for special purposes connected with units specifically intended for such purposes (e.g. propulsion on mobile units, ballast system on column stabilized semi-submersible units.)
- safety of crew, contractors, visitors and unit
- services for habitability
- SOLAS and MODU requirements, as far as practicable.

Refer to the Ship Rules for propelled units for the installation related to propulsion plant and steering, when the requirements of these installations and corresponding essential services apply. This covers power plants, machinery, and any additional notations that may be required.

1.2 TL reserve the right to specify requirements additional to these Rules where they are related to new systems or installations or where they are necessary because of new knowledge or operating experience.

1.3 Deviations from these Rules may be approved where there are special reasons.

2. References to Other Rules and Regulations

2.1 Where the requirements for electrical equipment and facilities are not laid down in these Rules, agreement shall be reached, wherever necessary, regarding the use of other regulations and standards. These include, e.g. IEC publications, especially all IEC 60092 "Electrical installations of ships and of mobile and fixed offshore units" and 61892 "Mobile and fixed offshore units - electrical installations" publications.

When referred to by the TL, publications by the International Electrotechnical Commission (IEC) or other internationally recognised standards stated in this chapter, are in principle those currently in force at the date of the contract for construction.

2.2 The provisions of the "International Convention for the Safety of Life at Sea 1974, as amended (SOLAS 74)" and the "Code for the Construction and Equipment of Mobile Offshore Drilling Units (MODU Code)" are taken into account in these Rules.

Special legislative provisions implemented by National Authorities may be required of units or installations depending on their flag, type, size, operational area, and intended service, as well as other specifics and details.

2.3 If necessary, in addition to the TL Rules national regulations are to be observed as well.

3. Design

Electrical installations shall be designed so that

- all electrical services necessary for maintaining normal operational and habitable conditions of the unit will be ensured without recourse to the emergency source of electrical power
- the operation of the equipment required for safety will be ensured under various defined emergency conditions
- the safety of personnel and units/installations from electrical hazards will be ensured
- electromagnetic compatibility of electrical and electronic equipment is assured (refer to general requirements for electromagnetic compatibility for all electrical and electronic equipment, adopted by IMO by resolution A.813(19).
4. Alternative Design and Arrangements

When alternative design or arrangements deviate from the prescriptive provisions of this Chapter, an engineering analysis, evaluation and approval of the design and arrangements shall be carried out in accordance with SOLAS regulation II-1/55 based on the guidelines developed by IMO (refer to the Guidelines on alternative design and arrangements for SOLAS chapters II-1 and III (MSC.1/Circ.1212)).

B. Definitions

1. Power Supply Installations

The power supply installations comprise all installations for the generating, conversion, storage and distribution of electrical energy.

2. Essential Equipment

2.1 Classification of electrical services shall conform to the TL-1 SC134 refer to SOLAS, Chapt. II-1, Reg. 40 and 41.

Essential services definitions given in this section includes propulsion and steering is only applicable for offshore units dependent on manoeuvrability.

2.1.1 Essential for ship operation are all main propulsion plants,

2.1.2 Essential are the following auxiliary machinery and plants, which:

- Are necessary for the propulsion and manoeuvrability of the ship
- Are necessary for the navigation of the ship
- Are required for maintaining ship’s safety
- Are required to maintain the safety of human life at sea as well as
- Equipment according to special Characters of Classification and Class Notations

These requirements apply for the electrical part of the equipment and complete equipment units supplied by subcontractors.

2.1.3 Essential equipment is subdivided into:

- primary essential equipment according to 2.2
- secondary essential equipment according to 2.3

2.2 Primary essential equipment

Primary essential equipment is that required to be operative at all times to maintain the manoeuvrability as regards propulsion and steering of a mobile unit or the safe stability of a fixed installation and that required directly for the primary duty of units or installations.

It comprises e.g.:

- generator units and associated power sources supplying primary essential equipment
- steering gear of mobile units
- Fuel oil supply units including viscosity control equipment
- Lubricating oil pumps
- Cooling water/cooling media pumps
- Charging air blowers
- Electrical equipment for oil firing equipment
- Electrical equipment for thermal oil systems
- Hot and warm water generation plants
- Azimuth drives of the main propulsion plants
- Adjusting, control and safety devices/systems for primary essential equipment
- Monitoring equipment for primary essential equipment
- Electrical equipment for electric propulsion plant with lubricating oil pumps and cooling water pumps
- Blow-out preventer control Systems
- Well control systems

- main propulsion plant with internal combustion engines and gas turbines, gears, main shafting, propellers of units
- controllable pitch propeller installation of units
- scavenging air blowers, fuel oil supply pumps, fuel booster pumps, fuel valve cooling pumps, lubricating oil pumps, cooling water pumps for main and auxiliary engines necessary for propulsion of units
- dynamic positioning system of floating and semi-submersible units, including various propulsion elements and related auxiliary systems, like lubricating oil pumps, cooling water pumps, etc.
- jacking system
- anchoring and mooring systems for exact position keeping as used for tension leg platforms, pipelaying units, FPSO, FSO, etc.
- forced draught fans, feed water pumps, water circulating pumps, vacuum pumps and condensate pumps for auxiliary boilers where steam is used for equipment supplying primary essential equipment
- burner equipment for auxiliary steam boilers where steam is used for equipment supplying primary essential equipment
- safety systems, shut down system
- hydraulic pumps for primary essential equipment
- equipment directly involved in keeping the primary duty of the unit/installation in operation
- drilling safety equipment, if applicable
- electrical supply for process system

2.3 Secondary essential equipment

Secondary essential equipment is that required for the safety of unit/installation and crew, and is such equipment which can briefly be taken out of service without the propulsion, steering, position keeping and equipment needed for the primary duty of the unit or installation, being unacceptably impaired.

It comprises e.g.:

- windlasses and capstans not directly used for exact position keeping, Anchor windlass
- dynamic positioning equipment, if it is auxiliary equipment
- fuel oil transfer pumps and fuel oil treatment equipment
- lubrication oil transfer pumps and lubrication oil treatment equipment
- starting air and control air compressors
- starting installations for auxiliary and main engines
- turning device for main engines
- bilge, ballast and heel-compensating installations
- fire pumps and other fire fighting installations
- ventilating fans for engine and boiler rooms
- equipment considered necessary to maintain endangered spaces in a safe condition, Ventilation fans for hazardous areas
- equipment for watertight and fire-tight closing appliances
1. - generator units supplying secondary essential equipment, if this equipment is not supplied by generators as described in 2.2
- hydraulic pumps for secondary essential equipment
- parts of the installations for helicopter operation
- auxiliary equipment assisting the primary duty of the unit/installation
- Ballast water treatment system
- Electrical equipment for auxiliary steam plants
- Transverse thrusters, if they are auxiliary equipment
- Lighting system
- Position and navigating lights, aids and signal equipment
- Navigational appliances and navigational systems
- Fire detection and alarm systems
- Internal safety communication equipment
- Bulkhead door closing equipment
- Bow and stem ramps as well as shell openings
- Adjusting, control and safety devices/systems for secondary essential equipment
- Monitoring equipment for secondary essential equipment
- Heavy fuel oil heaters
- Inerting Systems
- Ambient temperature control equipment

2. - generator units supplying secondary essential equipment, if this equipment is not supplied by generators as described in 2.2
- hydraulic pumps for secondary essential equipment
- parts of the installations for helicopter operation
- auxiliary equipment assisting the primary duty of the unit/installation
- Ballast water treatment system
- Electrical equipment for auxiliary steam plants
- Transverse thrusters, if they are auxiliary equipment
- Lighting system
- Position and navigating lights, aids and signal equipment
- Navigational appliances and navigational systems
- Fire detection and alarm systems
- Internal safety communication equipment
- Bulkhead door closing equipment
- Bow and stem ramps as well as shell openings
- Adjusting, control and safety devices/systems for secondary essential equipment
- Monitoring equipment for secondary essential equipment
- Heavy fuel oil heaters
- Inerting Systems
- Ambient temperature control equipment

3. Non-essential Equipment

Non-essential equipment is that, where temporary disconnection does not impair the principal requirements defined in 2.

4. Emergency Consumers

Emergency consumers are mandatory consumers which, after breakdown of the main energy supply, must be fed by the emergency energy supply.

5. Electric Network

5.1 An electric network comprises all the equipment items connected together at the same rated voltage.

5.2 Isolated electric network

This term refers to a system in which neither a conductor nor the neutral is connected to the structure in normal operation. If it is earthed via measuring or protective devices with very high impedance, the system is likewise deemed to be isolated.

5.3 Electric network with earthed neutral

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. This is a system in which the neutral is connected to the structure in normal operation.

6. Rated Voltage of an Electric Network

The rated voltage UN (Root Mean Square value – RMS) of a system is a characteristic system parameter to which specific characteristics of the connected facilities and the limit and test values of the system and of the facilities are referred.

7. Low Voltage Systems

Systems operating with rated voltages of more than 50 V up to 1000 V inclusive and with rated frequencies of 50 Hz or 60 Hz or direct current systems where the maximum instantaneous value of the voltage under rated operating conditions does not exceed 1500 V.
7.1 Main generating station
The space where the main source of electrical power is placed.

7.2 Main switchboard
A switchboard which is directly supplied by the main source of electrical power and is intended to distribute electrical energy to the unit's services.

7.3 Emergency switchboard
A switchboard that, in the event of failure of the main system of electrical power supply is directly supplied by the emergency source of electrical power and/or the transitional source of emergency power and is intended to distribute electrical energy to the emergency services.

7.4 Emergency source of electrical power
A source of electrical power, intended to supply the necessary services in the event of failure of the supply from the main source of electrical power.

7.5 Section boards
A switchgear and controlgear assembly that is supplied by another assembly and arranged for the distribution of electrical energy to other section boards or distribution boards.

7.6 Distribution board
A switchgear and controlgear assembly arranged for the distribution of electrical energy to final sub-circuits.

7.7 Final sub-circuit
That portion of a wiring system extending beyond the final required overcurrent protective device of a board.

8. Safety Voltage
Safety voltage is a protection provision and consists of a circuit with rated voltage not exceeding 50 V AC, operated un-earthed and isolated safely from supply circuits exceeding 50 V.

9. High Voltage Systems
Systems operating with rated voltages of more than 1 kV and with rated frequencies of 50 Hz or 60 Hz, or direct current systems, with the maximum instantaneous value of the voltage under rated operating conditions over 1500 V.

10. Machinery Spaces
Machinery spaces are spaces in which machines and equipment are installed and which are accessible only to authorized persons, e.g. engine rooms.

10.1 Wet operating spaces
Wet operating spaces are spaces in which facilities may be exposed to moisture.

10.2 Dry operating spaces
Dry operating spaces are spaces in which no moisture normally occurs.

10.3 Locked electrical spaces
Locked electrical spaces are spaces which are provided with lockable doors and are intended solely for the installation of electrical equipment such as switchgear, transformers, etc. They have to be constructed as dry spaces.

10.4 Category A machinery spaces
Category A machinery spaces are spaces which contain internal combustion engines having a total power output of at least 375 kW, or which contain an oil-fired boiler or an oil-treatment plant. The trunks to such spaces are included.

11. Type Test
A type test is a special test which is conducted in the presence of a TL representative either in the manufacturer's works or, by agreement, in other suitable institutes, and whose scope is laid down by the TL.
12. Types of Lighting

12.1 Main lighting

The main lighting system shall be supplied by the main source of electrical power and shall illuminate all areas normally accessible to and used by personnel.

12.2 Emergency lighting

The emergency lighting system shall be supplied by the emergency source of electrical power and shall illuminate all spaces necessary for emergency operation of the installation/unit, the escape routes, muster stations, etc. as defined in Section 3, D.2.1.2.

12.3 Additional emergency lighting

Additional emergency lighting may be provided on request of the operator for start-up operations and the illumination should be approximately 30% of the main lighting.

12.4 Transitional emergency lighting

The transitional emergency lighting is based on an accumulator battery and shall illuminate special areas for at least ½ hour in the event of failure of the main or the emergency lighting, see also Section 3, D.

13. Types of Cables

13.1 Fire-resistant cables

Fire-resistant cables are those which under the influence of flames demonstrate function-sustaining characteristics for a certain time, e.g. 3 h and meet the IEC publication 60331 test requirements.

13.2 Flame-Retardation of Individual Cables and cable bunches

Single cables and -wires are considered to be flame-retardant if they meet the test requirements of IEC publication 60332-1-2:2004+AMD1:2015 regarding flame propagation.

13.3 Flame-Retardation of Cable Bunches

Cable bunches and wire bunches are considered flame-retardant if they are flame retardant as single cables, and laid bundled, meet the requirements of IEC publication 60332-3-21 with regard to flame propagation.

13.4 Cable Bundles

Arrangement of two or more cables laid parallel and directly contiguous.

14. Dead Ship Condition

Dead ship condition means that the complete machinery plant including the main source of electrical power is out of operation and auxiliary energy as compressed air, starting current from batteries, etc. are not available for the restoration of the main power supply, for the restart of the auxiliaries and for the start-up of the propulsion plant. It is however assumed that the equipment for start-up of the emergency diesel-generator is ready for use.

15. Systems

Systems contain all equipment necessary for monitoring, control and safety including the in- and output devices. Systems cover defined functions including behaviour under varying operating conditions, cycles and running.

16. Protection Devices

Protective devices detect actual values, activate alarms in the event of limit-value infringement and prevent machinery and equipment being endangered. They automatically initiate curative measures or calls for appropriate ones.

17. Safety Devices

Safety devices detect critical limit-value infringements and prevent any immediate danger to persons, ship or machinery.
18. **Safety Systems**

Combination of several safety devices and/or protection devices into one functional unit.

19. **Alarms**

An alarm gives optical and acoustical warning of abnormal operating conditions.

20. **Power Electronics**

All equipment and arrangements for generation, transformation, switching and control of electrical power by the use of semi-conductor components.

21. **Equipment of Power Electronics**

All equipment which directly affect the flow of electrical energy; consist of the functional wired semi-conductor elements together with their protection and cooling devices, the semi-conductor transformers or inductors and the switchgear in the main circuits.

22. **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.

22.1 **Category “ia”**

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.

23. **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.

C. **Documents for Approval**

1. **Newbuildings**

1.1 The drawings and documents listed in Table 1.1 are to be submitted in triplicate or in electronic format for examination at a sufficiently early date to ensure that they are approved. They shall be available to the Surveyor in the approved state at the beginning of manufacture or installation of the electrical equipment.

1.2 The drawings of switchgear and control systems are to be accompanied by parts lists indicating the manufacturers and characteristics of the electrical components, circuit diagrams together with descriptions, where these constitute a necessary aid to understanding.

The drawings and documents must make it clear that the requirements set out in this Chapter have been complied with.

1.3 Any non-standard symbols used are to be explained in a key.

1.4 All documents are to be indicated with the yard number and the name of the yard.

1.5 Where electric systems are operated at variable frequency, relevant documents have to be submitted.

1.6 All documentation shall be submitted in Turkish or English language.

**TL reserves the right to request the submission of additional documents in the case of non-conventional design or if it is deemed necessary for the evaluation of the system, equipment or components.**
1.7 TL reserve the right to demand further documents and drawings if those submitted are insufficient for an evaluation of the installation or unit.

1.8 Required documents

The required documents for the different types of offshore units and installations are defined in Table 1.1.

2. Modifications and Extensions

Major modifications to the electrical installations of an installation or unit under construction or in service are subject to approval. Appropriate documentation is to be submitted in ample time prior to the execution of the work.

3. Further Rules and Standards to be considered

3.1 TL Rules and Guidelines

Further Rules and Guidelines of TL mentioned in this Chapter are to be observed.

3.2 National Regulations

If necessary, beside of the TL's rules, national regulations are to be observed as well.

3.3 International Regulation and Codes

3.3.1 Where the requirements for electrical equipment and facilities are not laid down in these Rules, decision shall be made, wherever necessary, regarding the use of other regulations and standards. These include e.g. IEC publications, especially all IEC 60092 publications.

3.3.2 The provisions of the "International Convention for the Safety of Life at Sea (SOLAS)" are taken into account in these Rules, insofar as these affect electrical installations.

D. Documents to be kept on board

When the unit or installation is commissioned, or following major modifications and extensions of the electrical equipment, at least the documents subject to approval, specified in C. and showing the final arrangement of the final equipment, are to be supplied on board. The documents are to be marked with the name or the yard number of the unit or installation, the name of the yard and the date of preparation of the documents.

E. Ambient Conditions

1. Environmental Effects

1.1 The selection, layout and arrangement of all shipboard machinery, equipment and appliances shall be such as to ensure faultless continuous operation. Therefore the manufacturer/supplier shall be informed by the user about the expected environmental conditions. The requirements are specified in Tables 1.2 to 1.5.

Note: The following additional survival requirements are to be taken into account:

1. IMO IGC Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, clause 2.7.2.2.

2. IMO IBC Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, clause 2.9.3.2.

1.2 Products are classified according to their applications into the environmental categories as stated in Table 1.6. In type approval Certificates will be referred to the respective category.

1.3 Care has to be taken of the effects on the electrical installations caused by distortions of a unit’s hull.

1.4 For units/installations intended for operation only in specified zones, TL may approve deviating ambient conditions.
1.5 Ambient temperatures for electrical equipment in areas other than machinery spaces

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

- the equipment is not for use for emergency power supply (see Section 3, D.) and is located outside of the machinery space(s)

- temperature control is achieved by at least two cooling units so arranged that in the event of loss of one cooling unit, for any reason, the remaining unit is capable of satisfactorily maintaining the design temperature

- the equipment is able to be initially set to work safely within 45 °C ambient temperature until such a time that the lesser ambient temperature may be achieved; the cooling equipment is to be rated for a 45 °C ambient temperature

- audible and visual alarms are provided, at a continually manned control station, to indicate any malfunctions of the cooling units

1.5.2 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.

1.5.3 The equipment used for cooling and maintaining the lesser ambient temperature is to be classified as a secondary essential service, in accordance with TL-1 SC 134 and to be subject to survey in accordance with the requirements of the TL.

2. Vibrations

2.1 General

Electrical equipment and components shall be built to resist a vibration frequency range of 5 to 50 Hz with a vibration velocity amplitude of 20 mm/s without malfunctioning or electrical connections loosening. Since bigger vibrations may occur with flexible mounted equipment, additional care should be given to the equipment's structure.

2.1.1 Electrical machinery and appliances are normally subjected to vibration stresses. On principle their design, construction and installation must consider these stresses.

The natural frequencies of the equipment, suspensions, and supports shall be outside the specified frequency ranges. Where this is not achievable through the use of an appropriate construction method, the equipment vibrations must be eliminated to avoid undesirable amplifications.

The faultless long-term operation of individual components shall not be impaired by vibration stresses.

2.1.2 Where an electrical machine or device generates vibrations when in operation, the intensity of the vibration shall not exceed defined limits. The purpose is to protect the vibration exciter themselves, and the connected assemblies, peripheral equipment and structural components, from excessive vibration stresses liable to cause premature failures or malfunctions.

2.1.3 On principle, investigation of vibration shall be carried out over the whole load and speed range of the vibration exciter.

2.2 Assessment

2.2.1 Electrical machines and equipment for use on board of mobile units must be designed at least for a vibration load corresponding to Table 1.6. With the agreement of TL, a lower endurance limit may be permitted in exceptional cases. In such cases, suitable countermeasures (vibration damping, etc.) must be taken to compensate for the increased sensitivity. Reference is made to IEC 60068-2, test FC.
<table>
<thead>
<tr>
<th>No</th>
<th>Documents</th>
<th>Offshore units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Barges</td>
</tr>
<tr>
<td>1.</td>
<td><strong>Power supply equipment</strong></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Electrical power balance</td>
<td>X</td>
</tr>
<tr>
<td>1.2</td>
<td>Generators, UPS units, transformers</td>
<td>X</td>
</tr>
<tr>
<td>1.3</td>
<td>Power electronics</td>
<td>X</td>
</tr>
<tr>
<td>1.4</td>
<td>Short circuit calculation</td>
<td>X</td>
</tr>
<tr>
<td>1.5</td>
<td>Calculation of load distribution</td>
<td>X</td>
</tr>
<tr>
<td>1.6</td>
<td>Proof of selectivity</td>
<td>X</td>
</tr>
<tr>
<td>1.7</td>
<td>General diagrams of distribution systems</td>
<td>X</td>
</tr>
<tr>
<td>1.8</td>
<td>General plan of earthing/equipotential system</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Layout plan and circuit diagrams for</td>
<td></td>
</tr>
<tr>
<td>1.9</td>
<td>Main switchboard</td>
<td>X</td>
</tr>
<tr>
<td>1.10</td>
<td>Energy switchboard</td>
<td>X</td>
</tr>
<tr>
<td>1.11</td>
<td>Sub-distribution boards</td>
<td>X</td>
</tr>
<tr>
<td>1.12</td>
<td>Plan of main cable ways</td>
<td>X</td>
</tr>
<tr>
<td>1.13</td>
<td>Cable list</td>
<td>X</td>
</tr>
<tr>
<td>1.14</td>
<td>Hazardous areas layout</td>
<td>X</td>
</tr>
<tr>
<td>2.</td>
<td><strong>Safety systems</strong> (circuit diagrams and functional descriptions)</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>General alarm systems</td>
<td>X</td>
</tr>
<tr>
<td>2.2</td>
<td>Technical officer’s alarm system</td>
<td>X</td>
</tr>
<tr>
<td>2.3</td>
<td>Fire detection system</td>
<td>X</td>
</tr>
<tr>
<td>2.4</td>
<td>Gas detection system</td>
<td>X</td>
</tr>
<tr>
<td>2.5</td>
<td>Watertight doors operating and position monitoring system</td>
<td>X</td>
</tr>
<tr>
<td>2.6</td>
<td>Emergency shut-down systems</td>
<td>X</td>
</tr>
<tr>
<td>2.7</td>
<td>Power electronic systems</td>
<td>X</td>
</tr>
<tr>
<td>2.8</td>
<td>Platform identification systems</td>
<td>X</td>
</tr>
<tr>
<td>2.9</td>
<td>Navigational aids</td>
<td>X</td>
</tr>
<tr>
<td>2.10</td>
<td>Communication systems/alarm devices</td>
<td>X</td>
</tr>
<tr>
<td>2.11</td>
<td>Automatic/manual controls for fire extinguishing/fire protection equipment</td>
<td>X</td>
</tr>
<tr>
<td>2.12</td>
<td>Machinery alarm systems</td>
<td>X</td>
</tr>
<tr>
<td>2.13</td>
<td>Miscellaneous safety systems (computer based or hard wired)</td>
<td>X</td>
</tr>
<tr>
<td>2.14</td>
<td>Cause and effect charts</td>
<td>–</td>
</tr>
<tr>
<td>2.15</td>
<td>Location diagram of safety systems sensors</td>
<td>X</td>
</tr>
<tr>
<td>2.16</td>
<td>Location diagram of visual and audible signalling devices</td>
<td>X</td>
</tr>
<tr>
<td>2.17</td>
<td>Automatic or manual control for systems to maintain stability</td>
<td>X</td>
</tr>
<tr>
<td>3.</td>
<td><strong>Propulsion equipment</strong></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Propulsion motors</td>
<td>–</td>
</tr>
<tr>
<td>3.2</td>
<td>Static converters</td>
<td>–</td>
</tr>
</tbody>
</table>
### Table 1.2  Inclinations of barge type units

<table>
<thead>
<tr>
<th>Equipment, components</th>
<th>Angle of inclination [°] (2)</th>
<th>Athwartships</th>
<th>Longitudinally</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Static</td>
<td>Dynamic</td>
<td>Static</td>
</tr>
<tr>
<td>Main engines and auxiliary</td>
<td>15</td>
<td>22,5</td>
<td>5</td>
</tr>
<tr>
<td>Unit's safety equipment including, for example, emergency source of power, emergency fire pumps and other drives</td>
<td>22,5 (3)</td>
<td>22,5 (3)</td>
<td>10</td>
</tr>
</tbody>
</table>

1. No unintended switching operations or functional changes shall occur up to an angle of inclination of 45°.
2. Inclinations may occur simultaneously athwartships and longitudinally.
3. On units carrying liquified gases, the emergency power supply must also remain operational with the unit flooded up to a maximum final athwartship inclination of 30°.
4. Rolling period.

---

### Table 1.3  Inclinations of column-stabilized units

<table>
<thead>
<tr>
<th>Elements of machinery</th>
<th>Angle of inclination in any direction [°] (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Static</td>
</tr>
<tr>
<td>Main and auxiliary machinery essential to the propulsion and safety of the unit</td>
<td>15</td>
</tr>
<tr>
<td>Emergency machinery and equipment, fitted in accordance with statutory requirements</td>
<td>25</td>
</tr>
</tbody>
</table>

1. Athwartships and fore and aft inclinations may occur simultaneously.
### Table 1.4 Inclinations of self-elevating units

<table>
<thead>
<tr>
<th>Elements of machinery</th>
<th>Angle of inclination in any direction [°] (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machin...in elevated condition</td>
<td>Static 10 (1) Dynamic -</td>
</tr>
<tr>
<td>Machin...in floating condition</td>
<td>See Table 1.2</td>
</tr>
<tr>
<td>Emergency source of power</td>
<td>15</td>
</tr>
</tbody>
</table>

(1) Athwartships and fore and aft inclinations may occur simultaneously.

2.2.2 If an electrical machine or equipment generates mechanical vibrations when in service, e.g. because it is out of balance, reference is made to Chapter 63 – Machinery Installations, Section 7.

2.2.3 Electrical appliances and equipment operating in positions where they are exposed to severe vibration loads, e.g. in the immediate vicinity of reciprocating machines and in steering gear compartments, must be designed for these severe vibration loads.

2.3 Proofs

2.3.1 A vibration test in accordance with TL Rules, Additional Rules and Guidelines, Test Requirements for Electrical / Electronic Equipment and Systems is deemed to constitute proof. The test must conform to the operational requirements.

### Table 1.5 Water temperature

<table>
<thead>
<tr>
<th>Coolant</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seawater</td>
<td>-1 °C to + 32 °C (1)</td>
</tr>
</tbody>
</table>

(1) TL may approve lower water temperatures for units/installations with special operational areas

2.3.2 Other forms of proof, e.g. calculations, may be accepted upon agreement with TL.

2.4 Measurements

Where such measures are justified, TL reserve the right to demand that measurements be performed under operating or similar conditions. This applies both to proof of the vibration level and to the assessment of the self-generated exciter spectrum.

F. Operating Conditions

1. Voltage Variations and Frequency Variations

1.1 All electrical equipment shall be so designed that it remains operational during the voltage and frequency variations occurring in the normal course of operation. The variations indicated in Table 1.8 are to be taken as a basis.

1.2 Unless otherwise stated in national or international standards, all equipment shall operate satisfactorily with the variations from its rated value shown in Table 1.8 to 1.10 on the following conditions:

- For alternative current components, voltage and frequency variations shown in the Table 1.8 are to be assumed.

- For direct current components supplied by d.c. generators or converted by rectifiers, voltage variations shown in the Table 1.9 are to be assumed.

- For direct current components supplied by electrical batteries, voltage variations shown in the Table 1.10 are to be assumed.

1.3 Any special system, e.g. electronic circuits, whose function cannot operate satisfactorily within the limits shown in the Table shall not be supplied directly from the system but by alternative means, e.g. through stabilized supply.
2. **Mains Quality**

2.1 In systems without substantial static converter load and supplied by synchronous generators, the total voltage harmonic distortion shall not exceed 5%.

2.2 In systems fed by static converters, and systems in which the static converter load predominates, for single harmonics in permanence the limit values indicated in Fig. 1.1 apply.

The total harmonic distortion shall not exceed 8 %.

2.3 If in particular cases, e.g. electrical propulsion plant systems, the above mentioned limits are exceeded, the faultless function of all electrical devices shall be ensured.

G. **Power Supply Systems**

1. **Low-Voltage Systems**

The following systems are permitted in principle, for restrictions, see paragraph 3:

For direct current and single-phase alternating current:

- 2 conductors, with one conductor earthed (1/N/PE);

- Single conductor with hull return (1/PEN);

- 2 conductors insulated from the ship's hull (2/PE).

2. **3-phase Alternating Current**

For three-phase current (alternating current):

- 4 conductors with neutral earthed, without hull return (3/N/PE);

- 3 conductors with neutral earthed, with hull return (3/PEN);

- 3 conductors insulated from the ship's hull (3/PE).

For High-Voltage Systems See Section 6.

3. **Main Structure Return**

3.1. The use of return via the main structure is not permitted.

3.2. Hull return is not permitted on ships of 1600 GRT and over.

3.3 The hull return system is not to be used for power, heating or lighting, except that the following systems may be used

3.3.1 Impressed current cathodic protective systems;

3.3.2 Limited and locally earthed systems (e.g., engine starting systems);

3.3.3 Limited and locally earthed welding systems;

3.3.4 Insulation level monitoring devices provided the circulation current does not exceed 30 mA under the most unfavourable conditions.

3.3.5 Intrinsically safe circuits where this is technically required.

3.3.6 Circuits where it is necessary for safety reasons and in which the current will not exceed 5 A during normal operation and in case of failure.

3.3.7 Star point earthing of three-phase high voltage installations, see Section 6, C.

3.4 Current-carrying parts with potential to earth are to be protected against accidental contact.
## Table 1.6  Environmental conditions/environmental categories

<table>
<thead>
<tr>
<th>Environmental category</th>
<th>Environmental conditions</th>
<th>Open deck area</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Closed area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature $T_e$</td>
<td>Relative humidity</td>
<td>Vibrations</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>0 °C to +45°C</td>
<td>0,7 g (Curve 1)</td>
<td>For general applications except category B, C, D, F, G, H</td>
</tr>
<tr>
<td></td>
<td>to %100</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>0 °C to +45°C</td>
<td>4 g (Curve 2)</td>
<td>For application at a higher level of vibration strain</td>
</tr>
<tr>
<td></td>
<td>to %100</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0 °C to +55°C</td>
<td>0,7 g (Curve 1)</td>
<td>For application at a higher degree of heat</td>
</tr>
<tr>
<td></td>
<td>to %100</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>0 °C to +55°C</td>
<td>4 g (Curve 2)</td>
<td>For application at a higher degree of heat and higher level of vibration strain</td>
</tr>
<tr>
<td></td>
<td>to %100</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>0 °C to +40°C</td>
<td>0,7 g (Curve 1)</td>
<td>For use in air-conditioned areas. With TL’s special consent only</td>
</tr>
<tr>
<td></td>
<td>to %80</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>-25°C to +45°C</td>
<td>to %100</td>
<td>For use on masts, with the additional influence of salt mist and temperature inundation are to be expected</td>
</tr>
<tr>
<td></td>
<td>to %100</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>-25°C to +45°C</td>
<td>to %100r</td>
<td>2,3 g</td>
</tr>
<tr>
<td>H</td>
<td>According to manufacturer’s specification only in combination with environmental categories A – G</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Columns with vibrations not valid for fixed offshore installations
2. At the open deck area other temperature ranges may be agreed if an offshore installation/unit shall be applied only in certain climate zones
3. Definition of Curves 1 and 2 is given in Table 1.7

## Table 1.7  Definition of curves 1 and 2

<table>
<thead>
<tr>
<th>Curve</th>
<th>Frequency range</th>
<th>Displacement</th>
<th>Acceleration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 (+3 / -0) Hz ÷ 13,2 Hz</td>
<td>± 1,0 mm</td>
<td>–</td>
</tr>
<tr>
<td>1</td>
<td>13,2 Hz ÷ 100 Hz</td>
<td>–</td>
<td>0,7 g</td>
</tr>
<tr>
<td>2</td>
<td>2 (+3 / -0) Hz ÷ 25 Hz</td>
<td>± 1,6 mm</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>25 Hz ÷ 100 Hz</td>
<td>–</td>
<td>4 g</td>
</tr>
</tbody>
</table>
### Table 1.8 Voltage and frequency variations for a.c. distribution systems

<table>
<thead>
<tr>
<th>Quantity in operation</th>
<th>Variations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>permanent</td>
</tr>
<tr>
<td>Frequency</td>
<td>±5%</td>
</tr>
<tr>
<td>Voltage</td>
<td>+6%,-10%</td>
</tr>
</tbody>
</table>

### Table 1.9 Voltage variations for d.c. distribution Systems

<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</td>
<td>10%</td>
</tr>
<tr>
<td>(a.c. r.m.s. over steady d.c. voltage)</td>
<td></td>
</tr>
</tbody>
</table>

### Table 1.10 Voltage variations for battery systems

<table>
<thead>
<tr>
<th>Systems</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 ripple voltage from the charging device, may be considered.

3.5 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. The connection of the return conductor to the hull shall be made somewhere easy to check and not in compartments with isolated bulkheads, e.g. chill/cold rooms.

4. **Systems with Earthed Neutral**

In systems with earthed neutral, resistors or other current-limiting devices for the connection of the neutrals to the hull shall be provided for each section where the systems are split.

4.1 If the selectivity is required in view of the shut-off of earth faults and additional current-limiting devices are mounted between the generator neutral-point and the ship’s hull, this shall not impair the selective shut-off of faulty circuits.

4.2 Where generators with earthed neutral are operated in parallel, it has to be considered that high-frequency equalizing currents can occur, especially when machines of different design are used.

4.3 A system shall normally be earthed at one point only. The earth connection shall be easily accessible and checkable. For the performance of insulation measurements it is recommended that the earth connection is disconnectable. Where an earthed system is divided into two or more sections, means for neutral earthing shall be provided for each section.

4.4 For voltages above 1000 V reference is made to IEC 61892-2.

4.5 For high voltage earthed neutral Systems see Sec. 6.C.
Section 1 – General Requirements and Instructions

5. Instructions Regarding Systems with Nonearthed Neutral

5.1 In systems which are not effectively earthed, generator neutrals shall not be connected.

5.2 The insulation resistance for non-earthed distribution systems is to be monitored, and a visual and audible alarm is to be given at a manned position if the insulation falls too low.

H. Voltages and Frequencies

The use of standardized voltages and frequencies is recommended. The maximum permitted rated mains voltages shall be as shown in Table 1.11.

I. Visual and Acoustical Signalling Devices

1. The colours used for visual signalling devices shall conform to Table 1.12.

2. The use of monochrome screens is permissible, provided that clear recognition of the signals is guaranteed.

3. Reference is made to the IMO-Resolution A.1021 (26) "Code on Alerts and Indicators", 2009.

4. General Platform Lights

It is recommended to symbolize the shut-down levels with easily observable lamps of different colours at the working platform. The definitions shall be agreed with TL.

J. Materials and Insulation

1. General

1.1 The materials used for electrical machines, switchgear and other equipment shall be resistant to sea air containing moisture and salt, seawater and oil vapours. They shall not be hygroscopic and shall be flame-retardant and self-extinguishing. 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.

1.2 The evidence of flame-retardation shall be according to IEC publication 60092-101 or other standards, e.g. IEC publications 60695-11-10 or UL 94. Cables shall correspond to the IEC publication 60332-1.

1.3 The usage of halogen-free materials is strongly recommended

1.4 Units of standard industrial type may be used in areas not liable to be affected by salty sea air subject to appropriate proof of suitability.

1.5 Materials with high tracking resistance are to be used for the supports of live parts.

Insulation shall be applied to live parts in order to provide basic protection against electric shock.

Independent insulation shall be applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of basic insulation. Insulation that comprises both basic insulation and supplementary insulation.

A single insulation system shall be applied to live parts providing a degree of protection against electric shock equivalent to double insulation.

2. Air Clearance and Creepage Distances

2.1 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.

2.2 For the clearance and creepage distances of low voltage main-busbars in main, emergency and propulsion switchboards, see Section 5, F.3.
For the clearance and creepage distances of high voltage main-busbars in main, emergency and propulsion switchboards, see Section 6, B.3.

For semiconductor converters in Sec.7.  

2.3 Creepage distance is the shortest distance along the surface of a solid insulating material between two conductive parts.

**Clearance is the** shortest distance in air between two conductive parts. This distance can be measured along a string stretched the shortest way between these conductive parts.

Clearance and creepage distances shall be as required in relevant product standards. When product standards not give such requirements (e.g. for generators, motors and transformers) the values given in Sec.5 shall be complied with.

2.3 Smaller air and creepage distances may be accepted by TL provided less pollution is proven (degree of protection).

2.4 Creepage distances between live parts and between live parts and earthed metal parts shall be according to 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.

K. **Protective Measures**

Each part of the electrical installation shall be provided with a degree of protection appropriate to the location, as a minimum the requirements of IEC Publication 61892-2.

The degree of protection of enclosures of rotating electrical machines shall be at least IP 23. The degree of protection of terminals shall be at least IP 44. For motors fitted in areas accessible to unqualified personnel, a degree of protection of at least IP 4X is required.

The degree of protection of metal enclosed switchgear, control gear assemblies and static convertors shall be at least IP 32. For switchgear, control gear assemblies and static convertors fitted in areas accessible to unqualified personnel, a degree of protection of at least IP 4X is required.

1. **Protection Against Foreign Bodies and Water**

1.1 The protection of electrical equipment against foreign bodies and water shall be appropriate to the particular place of installation.

The minimum degrees of protection for low-voltage switchgear are listed in Table 1.13.

The grade of protection of the equipment shall also be ensured during operation. Covers fitted at the place of installation are also regarded as a means of protection.

1.2 Exceptions to the indications in Table 1.13:

- high-voltage equipment, see Section 6, Table 6.3

- The minimum degree of protection of the terminal boxes of machines in wet operating spaces is IP 44.

- In drain wells and other installation places, where temporary flooding has to be assumed, the minimum degree of protection required for all electrical equipment is IP 56.

- Spaces subject to an explosion or fire hazard shall additionally comply with the provisions of 3.

1.3 Pipe work and air ducts shall be so arranged that the electrical systems are not endangered.

1.4 If the installation of pipes and ducts close to the electrical systems are unavoidable, the pipes shall not have any flanged or screwed connections in this area.
1.5 Are flanged or screwed connections installed, if e.g. heat exchanger as integrated components of the electrical equipment are used, the flanged or screwed connections shall be protected with a shield or screen against leakage and condensed water.

1.6 The water supply lines and recirculating lines shall be fitted with shut-off valves.

1.7 Heat exchangers are preferably to install outside rooms containing major electrical equipment such as switchboards, transformer, etc.

1.8 If possible the piping for cooler and heat exchangers shall be installed through the deck under the heat exchanger.

1.9 The flow rate and leakage of coolants of machines and static converters with closed cooling systems in electric cabinet rooms shall be monitored and alarmed. The air ducts shall be provided with inspection holes for visual observation of the heat exchanger.

1.10 A failure of cooling shall be alarmed.

1.11 It is ensure that leakage or condensation of water does not cause an electrical failure to the liquid cooled power equipment. Leakage and condensation of water shall be monitored. The cooling medium of direct cooled systems shall be monitored regarding their insulating capacity.

1.12 The supply air to draught-ventilated machines shall be as far as practicable free of moisture, oil vapours and dust. If required filters shall be provided.

1.13 Further requirements in Section 2, E.1.2 Section 7, D and Ch. 5 Section 13, H.2 are to be observed.

2. Precautions against shock, fire and other hazards of electrical origin

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 shall be earthed (grounded) unless the machines or equipment are: supplied at a voltage not exceeding 55 V direct current or 55 V, root mean square between conductors; automatic transformers are not be used for the purpose of achieving this voltage; or

- supplied at a voltage not exceeding 250 V by safety isolating transformers supplying only one consuming device; or

- constructed in accordance with the principle of double insulation.

Additional precautions shall be taken for portable electrical equipment for use in confined or exceptionally damp spaces where particular risks due to conductivity may exist.

All electrical apparatus are to be so constructed and so installed that it does not cause injury when handled or touched in the normal manner.

Where not obtained through normal construction, arrangements are to be provided to effectively earth (ground) all permanently installed machinery, metal structures of derricks, masts and helicopter decks.

Switchboards shall be so arranged as to give easy access, where needed, to apparatus and equipment, in order to minimize danger to personnel. The sides and backs and, where necessary, the fronts of switchboards are to be suitably guarded. Exposed live parts having voltages to earth (ground) exceeding a voltage to be specified by the Administration should not be installed on the front of such switchboards. There are to be non-conducting mats or gratings at the front and rear, where necessary.

When a distribution system, whether primary or secondary, for power, heating or lighting, with no connection to earth is used, a device capable of continuously monitoring the insulation level to earth and of giving an audible or visual indication of abnormally low insulation values should be provided.

Except as permitted by TL in exceptional circumstances, all metal sheaths and armour of cables are to be electrically continuous and shall be earthed (grounded). All electric cables and wiring external to equipment shall be at least of a flame-retardant type and shall be so installed as not to impair their original flame-retarding properties (Refer to the recommendations published by
the International Electrotechnical Commission concerning flame-retarding properties of bunched cables and characteristics of cables of a fire-resistant type). Where necessary for particular applications, the Administration may permit the use of special types of cables such as radio frequency cables, which do not comply with the foregoing.

Cables and wiring serving essential or emergency power, lighting, internal communications or signals are, so far as practicable, be routed clear of galleys, machinery spaces of category A and their casings and other high fire risk areas. Cables connecting fire pumps to the emergency switchboard are to be of a fire-resistant type where they pass through high fire risk areas. Where practicable all such cables are to be run in such a manner as to preclude their being rendered unserviceable by heating of the bulkheads that may be caused by a fire in an adjacent space (Refer to the recommendations published by the International Electrotechnical Commission concerning flame-retarding properties of bunched cables and characteristics of cables of a fire-resistant type).

Cables and wiring are to be installed and supported in such a manner as to avoid chafing or other damage.

Terminations and joints in all conductors should be so made that they retain the original electrical, mechanical, flame-retarding and, where necessary, fire-resisting properties of the cable.

Each separate circuit is to be protected against short circuit and against overload, except as permitted Electric and electrohydraulic steering gear or where the Administration may exceptionally otherwise permit.

The rating or appropriate setting of the overload protection device for each circuit is to be permanently indicated at the location of the protection device.

Lighting fittings 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. Accumulator batteries are be suitably housed, and compartments used primarily for their accommodation are to be properly constructed and efficiently ventilated. Electrical or other equipment which may constitute a source of ignition of flammable vapours is not to be permitted in these compartments except as permitted in paint lockers, acetylene stores, and similar spaces.

Accumulator batteries, except for batteries of self-contained battery-operated lights, are not to be located in sleeping quarters. Administrations may grant exemptions from or equivalencies to this provision where hermetically sealed batteries are installed.

In paint lockers, acetylene stores, and similar spaces where flammable mixtures are liable to collect as well as any compartment assigned principally to accumulator batteries, no electrical equipment shall be installed unless the Administration is satisfied that such equipment is:

- essential for operational purposes;
- of a type which will not ignite the mixture concerned;
- appropriate to the space concerned; and
- appropriately certified for safe usage in the vapours or gases likely to be encountered.

Electrical apparatus and cables are, where practicable, to be excluded from any compartment in which explosives are stored. Where lighting is required, the light shall come from outside, through the boundaries of the compartment. If electrical equipment cannot be excluded from such a compartment it shall be so designed and used as to minimize the risk of fire or explosion.

Where spilling or impingement of liquids could occur upon any electrical control or alarm console, or similar electrical enclosure essential to the safety of the unit, such equipment shall have suitable protection against the ingress of liquids (Refer to IEC 60529 – Degrees of protection provided by enclosures (IP Code)). Other arrangements for the enclosures of electrical components may be fitted provided the Administration is satisfied that an equivalent protection is achieved).

3. Explosion Protection

3.1 Hazardous Areas

Hazardous areas definitions and considerations for electrical equipment and installations are stated in Sec 13.
4. Electromagnetic Compatibility (EMC)

4.1 Electrical and electronic equipment shall not be impaired in their function by electromagnetic energy. General measures are to extend with equal importance over:

- decoupling of the transmission path between source of interference and equipment prone to interference
- reduction of the causes of interference sources
- reduction of the susceptibility to interference

4.2 All electrical and electronic appliances installed on the bridge and vicinity of the bridge other than mandatory navigation and communication equipment having been type tested according to IEC 60945:2002, as well as loose equipment placed on board by the builders or owners shall have been EMC tested for Conducted and Radiated Emission.

Bridge and vicinity of the bridge covers deck and bridge zone, i.e.

- The wheelhouse including bridge wings.
- Control rooms, characterized by equipment for inter-communication, signal processing, radio communication and navigation, auxiliary equipment.
- Area in close proximity to receiving and/or transmitting antennas and large openings in the metallic structure (equipment beyond 5 meters need not be considered for this purposes).

4.2.1 The following are acceptable for the bridge and deck zone test standards:

- IEC 60945:2002
- IEC 60533:2015

Equipment need be tested for Conducted and Radiated Emission only.

Note: Equipment having been type tested for EMC in accordance with other appropriate standards will have to be considered. In particular the level of radiated emission in the frequency band from 156 to 165 MHz and the location of the equipment shall be evaluated.

4.2.2 Passive-EM equipment, defined below, which is excluded from the scope of the EMC since it is considered not liable to cause or be susceptible to disturbances need not to be tested but shall be provided with an exemption statement.

Equipment is considered a passive-EM equipment if, when used as intended (without internal protection measures such as filtering or shielding) and without any user intervention, it does not create or produce any switching or oscillation of current or voltage and is not affected by electromagnetic disturbances.

Example of equipment which include no active electronic part:

- Cables and cabling systems, cables accessories.
- Equipment containing only resistive loads without any automatic switching device; e.g. simple domestic heaters with no controls, thermostat, or fan.
- Batteries and accumulators.

4.3 The requirements for electrical and electronic equipment regarding immunity and emissions of electromagnetic influence can be taken from TL Rules, Additional Rules and Guidelines, Test Requirements for Electrical / Electronic Equipment and Systems.

5. Lightning Protection

All offshore units with masts or topmasts made of non-conductive material shall be provided with lightning protection in the form of a lightning conductor.

Reference is made to IEC publication 60092-401.
Table 1.11  Maximum permitted rated mains voltages

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Types of electrical installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>17500 V (1)</td>
<td>for permanently installed power plants</td>
</tr>
<tr>
<td>750 V</td>
<td>for power circuits</td>
</tr>
<tr>
<td>500 V</td>
<td>- for permanently installed power and control circuits</td>
</tr>
<tr>
<td></td>
<td>- for devices with plug-and socket connections which are earthed either via their mounting or</td>
</tr>
<tr>
<td></td>
<td>through a protective earth conductor</td>
</tr>
<tr>
<td></td>
<td>- the power supply to system requiring special electric shock prevention measures shall be</td>
</tr>
<tr>
<td></td>
<td>provided via earth-leakage circuit breaker ≤ 30 mA (not applicable to essential equipment)</td>
</tr>
<tr>
<td>250 V</td>
<td>- for installations and devices, as laid down for 500 V, see above</td>
</tr>
<tr>
<td></td>
<td>- for permanently installed lighting systems</td>
</tr>
<tr>
<td></td>
<td>- for permanently installed control, monitoring and safety systems</td>
</tr>
<tr>
<td></td>
<td>- for devices supplied via plug-and-socket and requiring special electric shock prevention measures, the power supply is to take place via a protective isolating transformer, or the device must be double insulated</td>
</tr>
<tr>
<td>50 V</td>
<td>- for portable devices for working in confined spaces where special electric shock prevention</td>
</tr>
<tr>
<td>safety voltage</td>
<td></td>
</tr>
</tbody>
</table>

(1) Higher voltages are to be discussed with TL.

Table 1.12  Colour code for signalling devices

<table>
<thead>
<tr>
<th>Colour</th>
<th>Meaning</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Danger or alarm</td>
<td>Warning of danger or a situation which requires immediate</td>
</tr>
<tr>
<td>Yellow</td>
<td>Caution</td>
<td>Chance or impending change of conditions</td>
</tr>
<tr>
<td>Green</td>
<td>Safety (normal operating and normal working conditions)</td>
<td>Indication of a safe situation</td>
</tr>
<tr>
<td>Blue</td>
<td>Instruction/information (specific meaning assigned according to the need in the case considered, e.g. operational readiness)</td>
<td>Blue may be given meaning which is not covered by the three above colours: red, yellow and green</td>
</tr>
<tr>
<td>White</td>
<td>No specific meaning assigned (neutral)</td>
<td>General information, e.g. for confirmation.</td>
</tr>
</tbody>
</table>
## Table 1.13  Minimum degrees of protection against foreign bodies and water

<table>
<thead>
<tr>
<th>Example of location</th>
<th>Condition of location</th>
<th>Design according to degree of protection</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Switchboards</td>
<td>Generators</td>
</tr>
<tr>
<td>Tankers a Ammonia plant rooms</td>
<td>Danger of explosion Certified safe-type b</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Battery rooms</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Paint stores Stores for welding-gas bottles</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Holds classified as hazardous</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tunnels for pipe containing oil with a flash-point of 60 °C of below</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Dry accommodation spaces Dry control rooms Dry rooms</td>
<td>Danger of touching live Parts only</td>
<td>IP20</td>
<td>X</td>
</tr>
<tr>
<td>Control rooms (navigation bridge)</td>
<td>Danger of dripping liquid and/or Moderate mechanical damage</td>
<td>IP22</td>
<td>X</td>
</tr>
<tr>
<td>Engine and boiler rooms above floor</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Steering-gear rooms</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Refrigerating machinery rooms (excluding ammonia plants)</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Emergency machinery rooms</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>General store rooms</td>
<td></td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Pantries</td>
<td></td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Provision rooms</td>
<td></td>
<td>X</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 1.13  Minimum degrees of protection against foreign bodies and water (continued)

<table>
<thead>
<tr>
<th>(1) Example of location</th>
<th>(2) Condition of location</th>
<th>(3) Design according to degree of protection</th>
<th>(4) Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Switchboards</td>
<td>Generators</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control gear</td>
<td>Generators</td>
</tr>
<tr>
<td>Bathrooms and showers</td>
<td>Increased danger of liquid and/or mechanical damage</td>
<td>IP34</td>
<td>-</td>
</tr>
<tr>
<td>Engine and boiler rooms below floor</td>
<td>IP44</td>
<td>-</td>
<td>IP44</td>
</tr>
<tr>
<td>Closed fuel oil separator rooms</td>
<td>IP44</td>
<td>-</td>
<td>IP44</td>
</tr>
<tr>
<td>Closed lubricating oil separator rooms</td>
<td>IP44</td>
<td>-</td>
<td>IP44</td>
</tr>
<tr>
<td>Ballast pump rooms</td>
<td>Increased danger of liquid and mechanical damage</td>
<td>IP44</td>
<td>X</td>
</tr>
<tr>
<td>Refrigerated rooms</td>
<td>-</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Galleys and laundries</td>
<td>X</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Shaft or pipe tunnels in double bottom</td>
<td>Danger of liquid spraying</td>
<td>IP55</td>
<td>X</td>
</tr>
<tr>
<td>Holds for general cargo</td>
<td>Presence of cargo dust</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Serious mechanical damage</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Open decks</td>
<td>Danger of liquid massive quantities</td>
<td>IP56</td>
<td>X</td>
</tr>
</tbody>
</table>

**Key**

X: complies with column (3)

-: not recommended

Where the protection is not achieved by the equipment itself, other means or the location where it is installed shall ensure the degree of protection required in the table.

a For tankers, see IEC 60092-502.

b Certified safe-type equipment referred to in IEC 60079-0 may need additional enclosure requirements for spaces on open decks or other spaces where wet conditions are expected. The examples above may be used as guidelines.

c Socket-outlets shall not be installed in machinery spaces below the floor, closed fuel and lubricating oil separator rooms or spaces requiring certified safe-type equipment.

d For hazardous dust, an appropriate degree of protection is IP66 or certified safe-type.
### Table 1.14 Cross-sections for earthing conductors

<table>
<thead>
<tr>
<th>Type of earthing connection</th>
<th>Cross-sectional area of associated current carrying conductor</th>
<th>Minimum cross-sectional area of copper earthing connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PE conductor in flexible cable or flexible cord</td>
<td>up to 16 mm²</td>
<td>same as current-carrying conductor</td>
</tr>
<tr>
<td></td>
<td>above 16 mm²</td>
<td>one-half of current-carrying conductor but at least 16 mm²</td>
</tr>
</tbody>
</table>
| 2. PE conductor incorporated in fixed cable  
  a) insulated PE conductor  
  b) bare PE conductor in contact with metallic covering | up to and including 16 mm²  
  over 16 mm²  
  1 mm² to 2,5 mm²  
  4 mm² to 6 mm² | same as current-carrying conductor up to and including 16 mm²  
  but at least 1,5 mm²  
  50 % of the current-carrying conductor but at least 16 mm²  
  1 mm²  
  1,5 mm² |
| 3. Separate fixed earthing conductor  
  not exceeding 3 mm²  
  exceeding 3 mm² but not exceeding 125 mm²  
  exceeding 125 mm² | | same as current-carrying conductor subject to minimum of 1,5 mm² for stranded earth conductor, or 3 mm² for solid earth conductor  
  one-half of the cross-sectional area of the current-carrying conductor, subject to a minimum of 3 mm²  
  64 mm² |
SECTION 2

ARRANGEMENT of ELECTRICAL FACILITIES

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A. Power Generation

1. General

1.1 Electrical installations should be such that:

1.1.1 all electrical services necessary for maintaining the unit in normal operational and habitable conditions will be assured without recourse to the emergency source of power;

1.1.2 electrical services essential for safety will be assured in case of failure of the main source of electrical power;

1.1.3 electromagnetic compatibility of electrical and electronic equipment is assured; and

1.1.4 the safety of personnel and unit from electrical hazards will be assured.

2. Main Generators

2.1 Main generators with their own prime movers, independent of a unit’s main propulsion plant

The main generators are to be installed in the main engine room or in separate auxiliary engine rooms, e.g. within the space bounded by the watertight main bulkheads. Partition bulkheads between these main bulkheads are not considered as separations provided they have access openings.

On mobile units generators shall not be installed forward of the collision bulkhead below the bulkhead deck.

Definitions:
Main generating station is the space where the main source of electrical power is situated.

Main source of electrical power is a source intended to supply electrical power to the main switchboard for distribution to all services necessary for maintaining the unit in normal operational and habitable condition.

Machinery space, is to be taken as extending from the moulded base line to the margin line and between the extreme main transverse watertight bulkheads, bounding the spaces containing the main and auxiliary propulsion machinery, boilers serving the needs of propulsion, and all permanent coal bunkers. In the case of unusual arrangements, the Administration may define the limits of the machinery space.

2.2 The arrangement must ensure faultless operation under all ambient conditions, even in heavy weather, particularly with regard to the supply of fresh air and the removal of exhaust air.

The aggregates must be capable of being started, connected, disconnected and monitored from the main switchboard.

2.3 The power of these sets should be such that it is still possible to ensure the functioning of all electrical services necessary for maintaining the unit in normal operational and habitable conditions, except for power servicing drilling operations, in the event of any one of these generating sets being stopped.

2.4 The main source of electrical power should comply with the following:

2.4.1 The arrangement of the unit’s main source of power should be such that the services referred to in paragraph 1.1.1 can be maintained regardless of the speed and direction of the main propelling engines or shafting.

2.4.2 The generating plant should be such as to ensure that with any one generator or its primary source of power out of operation, the remaining generator or generators will be capable of providing the electrical services necessary to start the main propulsion plant from a dead ship condition. The emergency generator may be used for the purpose of starting from a dead ship condition if its capability either alone or combined with that of any generator is sufficient to provide at the same time those services required for emergency lighting.

2.4.3 For electrically self-propelled units the application of paragraph 1.3 need only include for propulsion sufficient power to ensure safe navigation when underway.
2.4.4 Where electrical power is necessary to restore propulsion, the capacity should be sufficient to restore propulsion to the unit in conjunction with other machinery, as appropriate, from a dead ship condition within 30 min after blackout.

3. Main Switchboards

3.1 Under normal conditions main switchboards shall be so placed relative to the main generators that, as far as practicable, the normal supply with electrical power may be affected only by a fire or other incidents arising in the same space.

An environmental enclosure for the main switchboard, such as may be provided by a machinery control room placed within the main boundaries of the space, is not to be accounted as separating switchboards from generators.

The main generating station shall be placed within the machinery space such as within the extreme main transverse watertight bulkheads.

3.2 The installation of the switchboard in a control room in the same fire section or in a room separated by a partition bulkhead with sufficient access opening is not to be considered as separating the switchboard from the generators.

3.3 The main switchboard shall be located as close as practicable to the main generators, within the same machinery space and the same vertical and horizontal A 60 fire boundaries.

A non-required subdivision bulkhead, with enough access, placed between the switchboard and generators, or between two or more generators, shall not be regarded as separating the equipment.

3.4 The main switchboard is to be so placed relative to one main generating station that, as far as is practicable, the integrity of the normal supply may be affected only by a fire or other casualty in one space. An environmental enclosure for the main switchboard, such as may be provided by a machinery control room situated within the main boundaries of the space, is not to be considered as separating the switchboards from the generators.

3.5 In every unit where the total installed electrical power of the main generators is in excess of 3 MW, the main busbars should be subdivided into at least two parts which should normally be connected by removable links or other approved means; so far as is practicable, the connection of generators and any other duplicated equipment should be equally divided between the parts. Equivalent alternative arrangements should be permitted.

4. Distribution Switchboards

Distribution switchboards supplying essential equipment and associated transformers, converters and similar equipment may be installed, if:

- The conditions as required for main generators/main switchboards are fulfilled,
- They are installed in the same fire section respectively in the same watertight compartment like the essential equipment itself.

5. Emergency Source of Electrical Power

5.1 Arrangement

5.1.1 Every unit is to be provided with a self-contained emergency source of electrical power.

5.1.2 The emergency source of power (i.e. generator, battery, etc.), associated transforming equipment, emergency switchboard, emergency lighting switchboard and transitional source of emergency power shall be located above the worst damage waterline and be readily accessible. It shall not be located within the assumed extent of damage referred to in Chapter 60, Section 7, F or forward of the collision bulkhead, if any.

The room, in which the emergency generator is installed, shall be accessible from the open deck and shall be so located that the operation of the emergency generator is not impaired by a fire or another incident:

- in a room containing the main generator and/or the main switchboard, or
- in any Category A machinery space.
As far as is practicable, the room containing the emergency source of power, the associated transformers, converters if any, the transitional source of emergency power and the emergency switchboard shall not adjoin the boundary surfaces of Category A machinery spaces or of those spaces containing the main power source, the associated transformers, converters if any, or the main switchboard.

If a location adjoining the above mentioned areas or areas in Zone 1 or Zone 2 is unavoidable, the boundary surfaces shall be gastight and conform to type A 60.

5.1.3 The location of the emergency source of power, the transitional source of emergency power and emergency switchboard in relation to the main source of electrical power should be such as to ensure to the satisfaction of the TL that a fire or other casualty in the space containing the main source of electrical power or in any machinery space of category A will not interfere with the supply or distribution of emergency power. As far as practical, the space containing the emergency source of power, the transitional source of emergency power and the emergency switchboard should not be contiguous to boundaries of machinery spaces of category A or of those spaces containing the main source of electrical power. Where the emergency source of power, the transitional source of emergency power, and the emergency switchboard are contiguous to the boundaries of machinery spaces of category A or to those spaces containing the main source of electrical power, or to spaces of zone 1 or zone 2, the contiguous boundaries should be in compliance with structural fire protection.

5.1.4 For units 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 the other spaces and such that a fire or other casualty in any one of the spaces will not affect the power distribution from the others, or to the services under paragraph 5.4.6, the provisions of paragraph 5.4.1 may be considered satisfied without an additional emergency source of electrical power, provided that the Administration is satisfied that:

5.1.4.1 There are at least two generating sets, meeting the provisions of Sec. 5, D 1.11 and each of sufficient capacity to meet the provisions of Sec. 3, D 2.1.2, in each of at least two spaces;

5.1.4.2 The arrangements under paragraph 5.1.4.1 in each such space are equivalent to those under 4.3. and Sec. 3, D 1.6 and starting arrangements for emergency generators given in Sec. 3 so that a source of electrical power is available at all times to the emergency services given in Sec. 3;

5.1.4.3 The location of each of the spaces referred to in paragraph 5.1.4.1 is in compliance with paragraph 5.1.2 and the boundaries meet the provisions of paragraph 5.1.3 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.

5.2 Deviations of arrangement requirements

The aforementioned arrangement of the emergency generator sets and the provision of an emergency power supply using an independent emergency power source in accordance with Section 3 may be dispensed with, if

- the main generators including their switchboards are distributed between at least two rooms, and

- the systems can be operated with complete functional independence of each other, and

- each room contains at least 2 sets, each one meeting the output, availability and functional criteria laid down for an emergency generator set in Section 3, and

- the rooms in which the equipment is installed conform to this Section and are so arranged in relation to each other that a fire or other accident in one of these rooms does not impair power generation in the other room.

In any case, deviations from these requirements have to be approved by TL.
5.3 Emergency switchboard

5.3.1 The emergency switchboard shall be arranged as near as is practicable to the emergency source of power and where the emergency source of electrical power is a generator, the emergency switchboard shall be placed in the same space unless the operation of the emergency switchboard would thereby be impaired.

5.3.2 No accumulator battery fitted in accordance with this requirement for emergency or transitional power supply shall be installed in the same space as the emergency switchboard, unless appropriate measures to the satisfaction of TL are taken to extract the gases discharged from the said batteries. An indicator shall be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries constituting either the emergency source of power or the transitional source of power are being discharged.

5.3.3 The emergency switchboard shall be supplied in normal operation from the main switchboard by an interconnector feeder which shall be adequately protected at the main switchboard against overload and short circuit. The arrangement at the emergency switchboard shall be such that the interconnector feeder is disconnected automatically at the emergency switchboard upon failure of the main power supply. Where the system is arranged for feedback operation, the interconnector feeder shall also be protected at the emergency switchboard at least against short circuit.

5.3.4 In order to ensure ready availability of emergency supplies, arrangements shall be made where necessary to disconnect non-emergency circuits automatically from the emergency switchboard to ensure that power is available automatically to the emergency circuits.

5.3.5 Provision should be made for the periodic testing of the complete emergency system. This should include the testing of transitional sources and automatic starting arrangements.

B. Storage Batteries

1. Installation

The provisions of this Section apply to storage batteries that are permanently placed (not to portable batteries).

Storage batteries may be lead-acid or nickel-alkaline, with the suitability for any given application being carefully considered. Other types of storage batteries with a proven design (e.g. silver/zinc) may be allowed if the TL determines that they are suitable for shipboard use.

1.1 Storage batteries are to be installed in such a way that persons cannot be endangered and equipment cannot be damaged by exhaust gases or electrolytes leaking out.

1.2 Storage batteries are to be so installed as to ensure accessibility for changing cells, inspection, testing, topping-up and cleaning. Storage batteries shall not be installed in the accommodation area or in store rooms. An exception may be granted for gastight cells, such as those used in emergency lamps, where charging does not result in the development of harmful gases.

1.3 Storage batteries shall not be installed in positions where they are exposed to excessively high or low temperatures, water spray or other influences liable to impair their serviceability or shorten their service life.

1.4 When installing storage batteries, attention is to be paid to the capacity of the associated chargers. The charging power is to be calculated as the product of the maximum charger current and the rated voltage of the storage battery.

Depending on the operating mode, application and duty of the storage battery to be charged, and on the mode of charging (charger characteristic), and by agreement with TL, the calculation of the charging capacity need not be based on the maximum current. Where a number of storage batteries are grouped together, the total sum of charging power is to be taken into account.
1.5 Storage batteries with a charging capacity of up to 2 kW may be installed unenclosed below deck in a well ventilated battery cubicle or container. The unenclosed installation of storage batteries in well ventilated positions in machinery spaces is permitted.

1.6 Storage batteries with a charging capacity of more than 2 kW installed below deck are to be accommodated in an enclosed cubicle/container or room with means of ventilation to the open deck, see also 3.

1.7 On mobile units storage batteries shall be prevented from sliding. The constraints shall not hinder ventilation.

1.8 Battery maintenance

When batteries are installed for essential and emergency services, a battery schedule shall be compiled and maintained. The TL shall review the timetable, which must include at least the following information about the batteries:

- maintenance and replacement cycle dates
- date of last maintenance and replacement
- for replacement batteries in storage, the date of manufacture and shelf life

Procedures will be implemented to verify that when batteries are replaced, they are of the same performance type.

When vented type batteries replace valve-regulated sealed types, appropriate ventilation shall be provided, and the TL's Rules for the location and installation of vented type batteries shall be followed. Details of the schedule and procedures shall be included into the unit's safety management system and incorporated into the unit's operational maintenance routine as needed, with the TL surveyor verifying the information.

2. Battery Systems

A battery system is an interconnection of storage batteries wired in series, parallel or as a combination of both connections. These systems are installed in cabinets or battery rooms.

2.1 Only storage batteries of same electrochemical characteristics, type, brand and year of construction shall be connected to a battery system. The selected configuration of a battery system shall not be changed.

2.2 The maximum permitted voltage of a battery system is 1500V DC.

2.3 Only authorised personal shall have access to locked cabinets or battery rooms. Safety measures are to be taken against electric shock.

2.4 Storage batteries shall withstand internal- and external short circuits. The level of expected short circuit current shall be considered for the DC network design and its switching and protection devices.

2.5 Disconnecting devices shall be provided to isolate conductors of battery systems from circuits and if applicable from protected earth.

2.6 Battery systems for redundant installations shall not be installed in the same cabinet or battery room. The requirements of redundancy shall be applied to the auxiliary systems and cooling systems as well.

2.7 Battery systems for emergency supply shall not be installed in the same cabinet or battery room as storage batteries for other consumers.

2.8 Battery systems shall be labelled. Access hatches or other openings to cabinets or battery rooms shall give instructions to personnel safety.

2.9 Cooling system

2.9.1 No additional heat sources shall be installed in spaces of storage batteries. Cabinets or battery rooms shall be equipped with controlled heating systems if applicable.

2.9.2 Redundant cooling or ventilation systems shall be provided including monitoring and alarm in case of abnormal operation.
2.9.3 Preferably air- or liquid flow monitoring devices shall be provided. Differential pressure indicators are not recommended.

2.10 Protection

2.10.1 A ground fault detection system shall be provided for the DC network.

2.10.2 Management-, monitoring- and protection systems shall be provided. These systems are subject to TL type approval and shall include the following functions at least:

- Control and monitoring during charging, discharging and operation
- Protection against overcharging, discharging and against deep discharge

2.10.3 An independent temperature monitoring system shall be provided. This monitoring shall give an alarm if temperature difference between the inner of cabinets or battery rooms and the environmental is too large.

2.10.4 A documentation shall be submitted to verify safe operation of the battery system and relating to the personal protection.

2.11 Installation and maintenance

2.11.1 The manufacturer instructions regarding installation, maintenance, operation and cooling of the battery system are to be observed.

2.11.2 Positive (+) and negative (-) wiring shall have equal wire length.

2.11.3 It is recommended to check periodically cable connections and to use e.g. an infrared (IR) camera to detect hot spots in the battery system if any.

3. Equipment in Cabinets and Battery Rooms

3.1 During charging, discharging or internal failures storage batteries could generate and release explosive gases.

.2 Only explosion-protected lamps, switches, fan motors and space-heating appliances shall be installed in battery rooms. The following minimum requirements shall be observed:

- Explosion group II C
- Temperature class T1

Other electrical equipment is permitted only with the special approval of TL.

3.3 Where leakage is possible, the inner walls of battery-rooms, boxes and cupboards, and all supports, troughs, containers and racks, shall be protected against the injurious effects of the electrolyte.

3.4 Electrical equipment shall be installed in cabinets or battery rooms only when it is unavoidable for operational reasons.

4. Ventilation of Spaces Containing Batteries

4.1 General requirements

All battery-installations, except for gastight batteries, in rooms, cabinets and containers shall be constructed and ventilated in such a way as to prevent the accumulation of ignitable gas mixtures.

Gastight NiCd-, NiMH- or Li- batteries need not be ventilated.

4.2 Batteries installed in switchboards with charging power up to 0.2 kW

Lead batteries with a charging power up to 0.2 kW may be installed in switchboards without separation to switchgear and without any additional ventilation, if:

- the batteries are valve regulated (VRLA), provided with solid electrolyte, and
- the battery cases are not closed completely (IP 2X is suitable), and
- the charger is regulated automatically by an IU-controller with a maximum continuous
4.3 Ventilated spaces with battery charging power up to 2 kW

Batteries may be installed in ventilated cabinets and containers arranged in ventilated spaces (except rooms mentioned in 1.2).

The unenclosed installation (IP 12) in well ventilated positions in machinery spaces is permitted.

Otherwise batteries shall be installed in ventilated battery cabinets or containers.

The charging power for automatic IU-charging shall be calculated as follows:

\[ P = U \cdot I \]

- \( I = 8 \cdot K/100 \) for Pb-batteries
- \( I = 16 \cdot K/100 \) for NiCd-batteries

\( P \) = charging power [W]
\( U \) = rated battery voltage [V]
\( I \) = charging current [A]
\( K \) = battery capacity [Ah]

The gassing voltage shall not be exceeded. If several battery sets would be used, the sum of charging power has to be calculated.

The room free air volume shall be calculated depending on battery size as follows:

\[ V = 2.5 \cdot Q \]
\[ Q = f \cdot 0.25 \cdot I \cdot n \]

\( V \) = room free air volume [m³]
\( Q \) = air quantity [m³/h]

\( f \) = 0.03 for lead batteries with solid electrolyte
\( f \) = 0.11 for batteries with fluid electrolyte

If several battery sets would be installed in one room, the sum of air quantity shall be calculated.

Where the room volume or the ventilation is not sufficient, enclosed battery cabinets or containers with natural ventilation into suitable rooms or areas shall be used.

The air ducts for natural ventilation shall have a cross-section as follows, assuming an air speed of 0.5 m/s:

\[ A = 5.6 \cdot Q \]

\( A \) = cross-section [cm²]

The required minimum cross-sections of ventilation ducts are shown in Table 2.1.

Small air ducts and dimensions of air inlet and outlet openings shall be calculated based on lower air speed.

4.4 Ventilated rooms with battery charging power more than 2 kW

Batteries exceeding charging power of 2 kW shall be installed in closed cabinets, containers or battery rooms forced ventilated to the open deck area. Lead batteries up to 3 kW may be ventilated by natural means.

Battery rooms shall be arranged according to 2.

The ventilation arrangements for installation of vented type batteries which have charging power higher than 2 kW are to be such that the quantity of air expelled is at least equal to:

\[ Q = 110 \cdot n \cdot I \] where

\( Q \) = air quantity [m³/h]
\( n \) = Number of cells in series
\( I \) = Maximum current delivered by the charging equipment during gas formation, but not less than 25 per cent of the maximum obtainable charging current in amperes
4.5 Ventilation requirements

Ventilation inlet and outlet openings shall be so arranged to ensure that fresh air flows over the surface of the storage battery.

The air inlet openings shall be arranged below and air outlet openings shall be arranged above.

If batteries are installed in several floors, the free distance between them shall be at least 50 mm.

In battery rooms devices which obstruct the free passage of air, e.g. fire dampers and safety screens, shall not be mounted in the ventilation inlet and outlet ducts of battery rooms. If necessary, weather tight closures shall be carried out otherwise.

Air ducts for natural ventilation shall lead to the open deck directly.

Openings shall be at least 0.9 m above the cupboard/boxes. The inclination of air ducts shall not exceed 45° from vertical.

Battery room ventilators are to be fitted with a means of closing whenever:

- The battery room does not open directly onto an exposed deck, or

- The ventilation opening for the battery room is required to be fitted with a closing device according to the Load Line Convention (i.e. the height of the opening does not extend to more than 4.5 m (14.8 feet) above the deck for position 1 or to more than 2.3 m (7.5 feet) above the deck in position 2), or

- The battery room is fitted with a fixed gas fire extinguishing system.

Where a battery room ventilator is fitted with a closing device, then a warning notice stating, for example "This closing device is to be kept open and only closed in the event of fire or other emergency – EXPLOSIVE GAS", is to be provided at the closing device to mitigate the possibility of inadvertent closing.

4.6 Forced ventilation

The ventilation of battery compartments shall be independent of ventilation systems for other spaces.

If natural ventilation is not sufficient or required cross-sections of ducts according to Table 2.1 are too big, forced ventilation shall be provided.

The air quantity Q shall be calculated according to 3.3. The air speed shall not exceed 4 m/s.

Where storage batteries are charged automatically, with automatic start of the fan at the beginning of the charging, arrangements shall be made for the ventilation to continue for at least 1 h after completion of charging.

Wherever possible, forced ventilation exhaust fans shall be used.

The fan motors shall be either a certified safe type with a degree of protection IIC T1 and resistant to electrolyte or, preferably, located outside of the endangered area.

Near the floor of battery rooms or the bottom of lockers or boxes, adequate air inlets (whether connected to ducts or not) shall be supplied (except for that of small batteries).

The air inlet might come from the outside or from another room (e.g. machinery spaces).

Fans are to be of non-sparking construction.

Ducts shall be made of a corrosion-resisting material or their interior surfaces are to be painted with corrosion-resistant paint.
The ventilation systems shall be independent of the ventilation systems serving other rooms. Air ducts for forced ventilation shall be resistant to electrolyte and shall lead to the open deck.

5. Emergency Power Supply

The location in which storage batteries for the emergency power supply are installed shall fulfil the same conditions as required for the installation of the emergency generator, see A.4.

6. Installation of Sealed Batteries in Switchboard Rooms on Fixed Offshore Installations

The installation of sealed batteries in switchboard rooms on fixed offshore installations is to be discussed and agreed with TL. Reference is made to EN 50272-2.

Note

The calculation of ventilation and safety distance based on EN 50272-2 has to be carried out with a safety factor 10 and the total number of cells independently of being wired in parallel or in series.

7. Batteries for Starting of Internal Combustion Engines

7.1 Batteries for starting of internal combustion engines shall be installed near the engine, so as to minimize the voltage drop in the power lines.

7.2 For the rating of batteries reference is made to Chapter 63, Section 3, H.

8. Caution Labels

The doors or the covers of battery rooms, cupboards or boxes shall be fitted with caution labels prohibiting the exposure of open flames and smoking in, or close to, these spaces.

9. Recording of the Type, Location and Maintenance Cycle of Batteries

9.1 Where batteries are fitted for use for essential (TL- I SC 134) and emergency services a schedule of such batteries is to be compiled and maintained. The schedule, which is to be approved by TL during plan approval or the newbuilding survey, is to include at least the following information regarding the battery(ies):

- 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 (1)

9.2 Procedures are to be put in place to ensure that where batteries are replaced that they are of an equivalent performance type.

9.3 Where vented (2) type batteries replace valve-regulated sealed (3) types, it is to be ensured that there is adequate ventilation (4) and that the TL requirements relevant to the location and installation of vented types batteries are complied with.

(1) 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.

(2) 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.

(3) 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.

(4) For the ventilation arrangements for installation of vented type batteries which have charging power higher than 2kW, Item C.4.4 shall be applied.
9.4 Details of the schedule and of the procedures are to be included in the ship’s safety management system and be integrated into the ship’s operational maintenance routine as appropriate (Refer to IMO ISM Code Section 10) to be verified by the TL’s surveyor.

C. Power Transformers

Dry type transformers shall comply with IEC Publication 60076-11.

Liquid cooled transformers shall comply with IEC Publication 60076.

Oil immersed transformers shall be provided with the following alarms and protection:

- liquid level (Low) - alarm
- liquid temperature (High) - alarm
- gas pressure relay (High) – trip
- liquid level (Low) - trip or load reduction
- liquid temperature (High) - trip or load reduction.

1. Transformers shall be installed in adequately ventilated compartments, accessible only to authorized personnel. The one exception to this rule is that on fixed offshore installations air-cooled transformers provided with means of protection against accidental contact with live parts need not be installed in special compartments, compare IEC 61892-6, 7.2.1.

2. The use of oil filled transformers is limited to fixed offshore installations and has to be agreed with TL. Beneath oil filled transformers special precautions have to be taken to collect spilled oil in case of leakage. If the insulation oil is liable to burn, reliable facilities for extinguishing the burning oil shall be provided. Spilled oil shall not be drained into the unit’s water drainage system.

3. A fire detector and a suitable fire extinguisher system shall be installed in the vicinity of the transformer.

If a water spray system is provided as the fire extinguishing system, it must be ensured that the transformer is switched off before the water spray system is activated, or that the transformer is designed with the corresponding degree of protection.

4. The installation of transformers in stores and accommodation areas is not permitted.

Power transformers shall be provided with overload and short circuit protection.

5. The location in which transformers for the emergency power supply are installed shall satisfy the same conditions as apply to the installation of the emergency generator.

The primary winding side of power transformers shall be protected against short-circuit and overload by means of multipole circuit-breakers or switches and fuses.

D. Electronics

1. Power electronics equipment and computerized equipment are to be installed in readily accessible and adequately ventilated dry spaces.

2. The heat developed in the equipment is to be carried off by suitable means. The amount of dissipated heat is to be specified by the manufacturer. Where electronic equipment is installed in engine rooms or other spaces with enhanced danger of pollution and corrosion, air filters are to be provided where necessary.

E. Low Voltage Switchboards (up to 1000 V AC resp. 1500 V DC)

1. Main Switchboards

A main switchboard is a switchboard directly supplied by the main source of electrical power or power transformer and intended to distribute electrical energy to the unit’s services.

1.1 The main switchboard and one main generator
shall be placed in the same fire zone so that, as far as practicable, the power supply may be affected only by fire or other incidents in the same fire zone.

The installation of the switchboard in a control room in the same fire section or in a room separated by a partition bulkhead with sufficient access opening is not to be considered as separating the switchboard from the generators.

The main switchboard shall be located as close as practicable to the main generators, within the same machinery space and the same vertical and horizontal A 60 fire boundaries.

1.2 Pipework and air ducts are to be run in such a way that the switchgear is not endangered in the event of leaks. If the installation of these pipes and ducts close to the switchboard is unavoidable, the pipes shall not have any flanged or screwed connections in this area.

1.3 The heat generated in the switchgear shall be removed.

1.4 The walkway in front of the main switchboard shall be at least 0.9 m wide. An ample view shall be provided for the operation of the board.

Where free-standing panels are required to be accessible from behind for operation and maintenance, a walkway at least 0.6 m wide is to be provided. The distance may be reduced to 0.5 m in the area of reinforcements and frames.

1.5 The floor in front of, and where necessary behind, main switchboards with an operating voltage of more than 50 V shall be provided with an insulating covering, or insulating gratings or mats are to be supplied.

1.6 The operational space behind open switchboards shall take the form of a locked electrical service room. A label notifying this fact shall be fitted.

Technical requirements for functionality and construction of main switchboard, apply also to emergency switchboards.

The tests of main switchboards, emergency switchboards or switchboards rated above 100 kW shall be attended by a TL surveyor.

### Table 2.1 Cross-section of ventilation ducts

<table>
<thead>
<tr>
<th>Battery charging power [W]</th>
<th>Lead battery solid electrolyte VLRA</th>
<th>Lead battery fluid electrolyte</th>
<th>Nickel-Cadmium battery</th>
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<tr>
<td>&lt; 500</td>
<td>40</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>500 &lt; 1000</td>
<td>60</td>
<td>80</td>
<td>120</td>
</tr>
<tr>
<td>1000 &lt; 1500</td>
<td>80</td>
<td>120</td>
<td>180</td>
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<tr>
<td>1500 &lt; 2000</td>
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<td>240</td>
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<tr>
<td>2000 &lt; 3000</td>
<td>80</td>
<td>240</td>
<td>forced ventilation</td>
</tr>
<tr>
<td>&gt; 3000</td>
<td>forced ventilation</td>
<td></td>
<td></td>
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</tbody>
</table>
2. Emergency Switchboards

An emergency switchboard is a switchboard that is directly supplied by the emergency source of electrical power and/or the transitional source of emergency power in the event of a failure of the main electrical power supply system and is intended to distribute electrical energy to emergency power consumers.

Switchboards that are not directly supplied by an emergency power source may be considered emergency switchboards when this is considered to be relevant from a system and operational standpoint.

The emergency switchboard shall be arranged close to the emergency generator and/or the emergency battery. The requirements of B. shall be observed. The place of installation shall satisfy the same conditions as apply to the installation of the emergency generator. The installation of the emergency switchboard is subject to the same conditions as those stated in 1.2, 1.3, 1.5 and 1.6 for the main switchboard.

F. Appliances for High Voltages (> 1 kV AC)

Higher voltages than 17.5 kV are to be discussed with TL.

1. Arrangement

1.1 Facilities should preferably be installed in locked electrical service rooms. The following variants are permitted for installation, if the degree of protection corresponds to the location.

1.2 Where equipment with a degree of protection lower than that stated in Section 6, Table 6.3 is installed, the access doors are to be locked in such a way that they can be opened only when the equipment has been switched off and earthed.

1.3 The degrees of protection stated in Section 6, Table 6.3 are to be adhered to for equipment in service rooms.

1.4 If during operation the protection against accidental arcing at the place of installation or in their vicinity not ensured, the hazarded areas are to be blocked off by appropriate means and to be marked with warning labels. The continuous stay of personal in the hazarded areas shall be avoided. Therefore control panels, device for vocal communication, etc. may not be installed in this area.

2. Access Doors to Service Rooms

The access doors to spaces in which high-voltage equipment is installed shall be provided with warning labels.

3. Switchgear

Switchgear and controlgear assemblies are to be constructed in accordance with IEC Publication 62271-200.

Switchgear shall be of metal-enclosed type in accordance with IEC Publication 62271-200 or of the insulation enclosed type in accordance with IEC Publication 62271-201.

3.1 Pressure release

3.1.1 If the gas pressure resulting from accidental arcs within the switchboard is to be vented via pressure-release flaps, the installation space shall be as specified by the switchgear manufacturer and shall have an adequate volume. Suitable measures shall be taken to ensure that the overpressure occurring within the space is limited to physiologically acceptable limits. The overpressure shall be taken into account for the structural design of the room. It is recommended to lead the accidental-arc gases by ducts of sufficient cross-section out of the place of operation.

3.1.2 If the switchboard is designed so that the gas pressure caused by accidental arcs is also, or only, released downwards, the floor shall be constructed so that it can withstand this pressure. Care must be taken to ensure that sufficient volumes of space are available below the floor for the expansion of the accidental-arc gases. Combustible materials and low-voltage cables are not admissible in the endangered area.
3.2 SF6 switchgear

3.2.1 SF6 switchgear shall only be installed in spaces which are adequately ventilated. It shall be ensured that SF6 is prevented from flowing down to lower spaces.

Note

It must be taken into consideration that the coming out gases in case of accidental arcing have toxic and corrosive effects.

The SF6 cylinders shall be stored in a separate space with its own venting arrangements. Measures shall be taken to ensure that, in the event of leakage, no gas can flow unnoticed into any lower spaces.

3.3 Insulation of locations in front of/behind switchgear

3.3.1 For locations in front of switchboards, or if accessible from the rear behind the switchboard, insulation shall be provided.

3.3.2 The insulation shall be done by an approved insulating mat.

Note

An insulation mat with a thickness of 2.5 mm can be considered as sufficient.

3.3.3 It shall be impossible to touch the front of the switchboard or other places of operation from outside of this insulating mat.

All switchgear shall be loaded and, when found necessary by the attending TL Surveyor; the operation of overcurrent protective devices shall be verified. The workshop test is in general regarded sufficient to ensure that such apparatus shall carry out as needed during in operation.

4. Safety Equipment

At least the following safety equipment has to be provided for high-voltage facilities:

- a voltage detector for the rated voltage of the equipment
- a sufficient number of earthing cables, together with insulated fitting tools,
- an insulating floor cover appropriate to the test voltage of the equipment
- a sufficient number of warning labels bearing the words "Do not operate switch"

5. Marking

All parts of high voltage installations are to be fitted with permanent warning labels drawing attention to the voltage level and the danger.
# SECTION 3

**POWER SUPPLY INSTALLATIONS**

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A. **General Design Requirements**

1. The primary plant is to be designed in accordance with the requirements set out in Section 1.

B. **Power Demand**

1. **Power Balance**

   1.1 A power balance of the electrical equipment has to be submitted to prove, whether the rating of equipment for the generation, storage and transformation of electrical energy is sufficient.

   1.2 The maximum power requirement for the type of duty performed by the unit, e.g. as a drilling, production or process platform, is to be determined.

   1.3 Separate power balances are to be established for parts of installations/units having their own generating plant, e.g. drill drives, electric propeller drives, and especially, the emergency power supply.

   1.4 Extreme environmental conditions, e.g. arctic or tropical conditions, according to the installation’s/ unit’s area of operation are also to be taken into account.

   1.5 In compiling the power balance, all installed electrical consumers are to be tabulated, together with an indication of their power ratings.

2. For each relevant operating condition, consideration shall be given to the following items:

   - The full power demand of all consumers continuously required for operation, except for those consumers which remain on standby and are used only when a similar consumer fails.

   - The power demand of all temporarily used consumers multiplied by a diversity factor. The diversity factor may be applied only once during the calculation.

   - The full power demand of consumers with high power consumption relative to the primary plant, e.g. lateral thrusters of mobile units.

   - Short time peak loads caused e.g. by automatic start of large motors.

C. **Main Power Supply**

1. **Design**

1.1 Every installation/unit is to be provided with a main source of electrical power of sufficient capacity. This main source of electrical power shall consist of at least two separate independent generating sets.

1.3 Where transformers, storage batteries, static converters, etc. constitute an essential part of the main electrical supply system, the availability of the entire supply system stipulated in 1.2 shall be ensured should any one system part fail.

1.4 In individual cases exemptions may be granted in consultation with the competent national authorities for units with a restricted area of operation or for special-purpose units.

1.5 The power generating plant shall be so designed that it can be started and put into operation, even if main and emergency sources of electrical power are not in operation and no power is available to start-up the main source of electrical power.

1.6 The emergency source of electrical power may be used for a short period for starting-up the main source of electrical power, provided that its capacity is at the same time sufficient to supply the necessary emergency power consumers.

1.7 The main source of electrical power should comply with the following:

   1.7.1 Where the electrical power can normally be supplied by one generator, suitable load-shedding arrangements should be provided to ensure the integrity of supplies to services required for propulsion and steering as well as the safety of the unit. In the case of
loss of the generator in operation, adequate provision should be made for automatic starting and connecting to the main switchboard of a stand-by generator of sufficient capacity to ensure safe navigation when underway and to ensure the safety of the unit with automatic restarting of the essential auxiliaries including, where necessary, sequential operations. The Administration may dispense with these provisions where the power necessary to ensure the functioning of the service referred to in paragraph 1.2, except for power servicing drilling operations, is 250 kW or less.

1.7.2 If the electrical power is normally supplied by more than one generator simultaneously in parallel operation, provision should be made, for instance, by load shedding to ensure that, in case of loss of one of these generating sets, the remaining ones are kept in operation without overload to ensure safe navigation when underway and to ensure the safety of the unit.

1.7.3 Where the main source of electrical power is necessary for propulsion of the unit, the main busbar should be subdivided into at least two parts which should normally be connected by circuit breakers or other approved means; so far as is practicable, the connection of generating sets and other duplicated equipment should be equally divided between the parts.

2. Rating of Main Generators

2.1 Apparent power

The apparent power of three-phase generators shall be such that no inadmissible voltage drops occur in the installation's/unit's mains due to the normal starting currents of motors. The start-up of the motor with the greatest starting current shall not give rise to a voltage drop causing other consumers to malfunction. Where a number of generators operate in parallel, this condition must continue to be met when the largest generator is not in operation.

2.2 Waveform

The waveform of the line-to-line no-load voltage shall be as close as possible to sinusoidal. The deviation from a sinusoidal fundamental shall at no time exceed 5 % relative to the peak value of the fundamental. The RMS values of the phase voltages shall not differ from each other by more than 0.5 % under balanced load conditions.

If the star points of generators running in parallel are earthed, the waveforms of the phase voltages should coincide. It is to ensure that the transient current due to harmonics in the starpoint connection does not exceed 20 % of the rated current of the machine with the lowest output.

2.3 Exciter equipment

Generators and their exciters are to be rated in such a way that:

- the generator can be loaded for two minutes at 150 % of its rated current with a power factor of 0.5 lagging (inductive) and still deliver approximately its rated voltage

- the equipment is short-circuit-proof even having regard to the time lag of the generator circuit breakers necessary to the selectivity of the system

2.4 Regulating conditions

Under balanced load conditions, three-phase generators and their exciters are required to meet the following conditions.

2.4.1 Steady regulating conditions

With the generator running at rated speed, the voltage shall not deviate from the rated value by more than ± 2.5 % from no-load up to the rated output and at the rated power factor after the transient reactions have ceased.

2.4.2 Transient regulating conditions

With the generator running at rated speed and rated voltage, the voltage shall neither fall below 85 % nor exceed 120 % of the rated value when symmetrical loads of specified current and power factor are suddenly applied or removed. The voltage shall regain its rated value ± 3 % in 1.5 seconds.
If no particular requirements are specified for the load changes, the above conditions are to be satisfied when the generator, running idle and excited to its rated voltage, is suddenly loaded to 60 % of its rated current with a power factor of < 0.4 (lagging), and, after steady-state operation has been achieved, the load is suddenly switched off again.

Subject to TL’s approval, such voltage regulation during transient conditions may be calculated values based on the previous type test records, and need not to be tested during factory testing of a generator under title 2.4.2 in the last line.

2.4.3 **Steady short-circuit current**

With a terminal short circuit on three phases, the steady short-circuit current shall not be less than three times or not greater than six times the rated current. The generator and its exciter must be capable of withstanding the steady short-circuit current for two seconds without damage.

2.5 **Load sharing during parallel operation**

Where generators of the same output are operated in parallel, the reactive load of each machine shall not differ from its proportionate share by more than 10 % of its rated reactive power when the active load is shared equally.

In the case of generators running parallel with different ratings, the deviation from the proportionate share shall not exceed the lesser of the following values, assuming proportionately equal sharing of the active load:

- 10 % of the rated reactive power of the largest machine
- 25 % of the rated reactive power of the smallest machine

2.6 **Direct-current generators**

Compound generators or shunt wound generators with automatic voltage regulators are to be preferred for sets supplying the installation’s/unit’s mains. Technical details and limiting values are to be agreed with TL.

3. **Design and Equipment of Prime Movers**

3.1 The design and equipment of the prime movers of generators and starters are to conform to Chapter 63, Machinery, Section 3 – Internal Combustion Engines and Air Compressors and Section 4 – Gas Turbines and Exhaust Gas Turbochargers.

3.2 Each prime mover of generators supplying the installation’s/unit’s mains shall be equipped with a speed controller enabling synchronization to be effected in a sufficiently short time.

3.3 **Electric/electronic governors**

3.3.1 If electric/electronic governors are fitted, these as well as the control elements of the engine are to be approved by TL.

3.3.2 The engine shall not assume a dangerous operating condition in the event of faults in the control system.

3.3.3 Where engines have electric starters, the governor may be supplied from the battery allocated to the engine.

Where engines are not started electrically, each governor including the control element is to be provided with a separate battery and charger.

The capacity of each battery shall be sufficient to enable the governor and control elements to operate for at least 60 minutes without recharging.

Each charger shall be capable of supplying, for a short period, the likely maximum current of the system.

3.3.4 When an engine is taken out of service, the supply to its governor is to be automatically disconnected.

3.3.5 If the battery voltage falls below the minimum permissible value, this shall trip a visual and audible alarm.
3.4 Load Switching

3.4.1 Regarding further requirements see Chapter 4 - Machinery, Section 2.F

3.4.2 Load cutting in

If the load switching in two steps is provided, it is to be realised as follows: immediately from 'no load' to 50 %, followed by the remaining 50 % of the generator output while remaining within the permissible speed-change limits.

Load switching in more than two steps is permissible provided that:

- The design of the ship's mains makes possible the operational application of such units,

- Load switching in several steps has been given appropriate consideration at the design stage of the ship's mains and is approved through the drawing checks,

- Proof of unobjectionable functioning is provided in the course of the on-board tests. This is to include consideration of the loading of the ship's mains under stepped switching-in of essential equipment following breakdown and reconstruction of the ship's mains,

- Furthermore, safety of the ship's mains under parallel operation of the generators is to be proved.

3.5 Parallel operation

3.5.1 The speed characteristics of prime movers shall be linear over the entire output range.

The governing characteristics of prime movers of units of the same output operating in parallel must ensure that, over the range from 20 % to 100 % of the total active power, the share of each machine does not deviate from its proportionate share by more than 15 % of its rated active power.

3.5.2 Where the units are differently rated, the deviation from the proportionate share within the stated load range shall not exceed the lesser of the following values:

- 15 % of the rated active power of the largest machine

- 25 % of the rated active power of the smallest machine

3.6 Cyclic irregularity

The permissible cyclic irregularity is to be agreed between the manufacturers of the prime movers and the generators. The following points have to be ensured:

- Faultless parallel operation of three-phase generators

- Load variations shall not give rise to fluctuations in active power output exceeding 10 % of the rated output of the machine concerned.

4. Generator Driven by the Main Propulsion Plant (e.g Shaft-Driven Generators)

4.1 Generators driven by the main propulsion plant may be deemed to constitute part of the main electrical power supply in accordance with C.1 provided they can be operated under all weather-, navigating and manoeuvring conditions, including stopped ship by supplying the sufficient load. The operating conditions for frequency stated in Section 1, F shall be fulfilled.

Voltage and load sharing shall be in the limits acc. to 2.1, 2.2, 2.4.1, 2.4.2 and 2.5 (only to be observed in case of parallel operation) based on IEC 60092-301AMD2:1995.

4.1.1 It is an essential requirement that, should any generator or its prime mover fail, the conditions stated in 1.2 shall be satisfied, and it shall also be possible to start the main propulsion plant in accordance with 1.9, 1.10 and C. 1.4.

4.1.2 Provision shall be made for decoupling generators not lying in the line of the propeller shaft.
4.1.3 The short circuit current of the generator/generator system is sufficient to trip the generator/generator system circuit-breaker taking into account the selectivity of the protective devices for the distribution system.

Protection is to be arranged in order to safeguard the generator/generator system in case of a short circuit in the main bus bar. The generator/generator system is to be suitable for further use after fault clearance.

4.1.4 Standby sets are started in compliance with

4.2 Generators which are driven by the main propulsion plant but which fail to conform to the conditions stated in 4.1 are not considered to constitute part of the main electrical power (1) supply, although they may be used as additional generators and on occasion maintain the entire power supply function provided the following conditions are met:

4.2.1 Where main propulsion plants are not driven at constant speed, regulators should be fitted enabling the generator plant to deliver an adequate output over a speed range of the main engine from at least 75 % to 100 %.

(1) Such generator systems are those whose operation does not meet the requirements of IEC 60092-201:2019, paragraph 8.1.1.

4.2.2 There are sufficient and adequately rated additional generators fitted, which constitute the main source of electrical power required by SOLAS, meeting the requirements of IEC 60092-201:2019 paragraph 8.1.1.

4.2.3 Arrangements are fitted to automatically start one or more of the generators, constituting the main source of electrical power required by SOLAS, in compliance with item 5.2.4 and also upon the frequency variations exceeding ± 10% of the limits specified in 4.2.4.

4.2.4 Frequencies are to be kept within the limits stated in Section 1, F. For voltage and load sharing (only in case of parallel operation) furthermore the conditions stated in 2.1, 2.4.1, 2.4.2 and 2.5 based on IEC 60092-301 AMD2:1995 are to be fulfilled.

4.2.5 The short circuit current of the generator and/or generator system is sufficient to trip the generator/generator system circuit-breaker taking into account the selectivity of the protective devices for the distribution system.

4.2.6 Where considered appropriate, load shedding arrangements are fitted to meet the requirements of 5.2.

4.2.7 On ships with remote control of the main engine from the bridge, it is necessary to ensure that, when manoeuvres preventing the continued operation of the shaft-driven generator plant are initiated, the supply to essential equipment is maintained from the shaft-driven generator plant until the load has been shifted to a standby generator to avoid a blackout situation.

Note: A ‘blackout situation’ means that the main and auxiliary machinery installations, including the main power supply, are out of operation but the services for bringing them into operation (e.g. compressed air, starting current from batteries etc.) are available.

4.3 In case of frequency deviations exceeding 10 %, the generator is to be disconnected within 10-30 seconds.

D. Emergency Power Supply

1. General Requirements

1.1 An independent emergency source of electrical power is to be provided on all offshore installations/units. The emergency source of electrical power shall be able to take over the supply of the emergency consumers, should the main power supply fail.

1.2 Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances, the emergency generator may be used exceptionally and for short periods to supply non-emergency circuits.
Exceptionally, whilst the vessel is at sea, is understood to mean conditions such as:

- Blackout situation
- Dead-ship situation
- Routine use for testing
- Short-term parallel operation with the main source of electrical power for the purpose of load transfer.

1.3 The electrical power available from the emergency source shall be sufficient to supply all those services which are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously, also taking into account starting currents and transitory nature of certain loads.

1.4 A suitable indicator shall be installed on the main switchboard or machinery control room to indicate when the batteries providing the emergency source of electrical power or the transitional source of emergency electrical power are being discharged.

1.5 When non-emergency consumers are supplied by the emergency source of power, it shall either be possible to supply all consumers simultaneously, or automatic disconnection of non-emergency consumers upon start of the generator shall be arranged.

1.6 The emergency source of electric power may be either a generator or an accumulator battery.

1.6.1 Where the emergency source of electrical power is a generator set, it shall be driven by a suitable prime mover with its own independent fuel supply, having a flashpoint of not less than 43°C and with an independent cooling system. The set shall start automatically if the main source of electrical power fails, and shall automatically take over the supply to the emergency consumers unless a transitional source of emergency power in accordance with 1.7 is available. The emergency power supply shall be connected not later than 45 seconds after the failure of the main power supply.

1.6.2 Where the emergency source of electrical power is an accumulator battery, it shall be capable, in the event of failure of the main source of electrical power, of automatically and immediately supplying power to the consumers listed in 1.7 for the stipulated period without intermediate recharging. During this period the battery voltage shall remain within ±12 % of the rated voltage.

1.7 The transitional source of emergency electrical power shall be an accumulator battery which, in the event of failure of the main power supply, automatically and immediately supplies the consumers listed below until the emergency generator set described in 1.6.1 is in operation and connected. Its capacity shall be sufficient to supply the consumers without intermediate recharging for the period specified below. During that time the battery voltage shall remain within ±12 % of the rated voltage.

Where their operation depends upon an electrical source, the following services are to be supplied:

- for a period of half an hour, the emergency lighting, lamps and lights specified in 2.1.2 and 2.1.3 together with all the services required by 2.1.4 (except item 2 of the list) unless such services have an independent supply for the prescribed period from their own emergency accumulator batteries.

- for mobile units, power for closing the watertight doors
- though simultaneous closure of all doors is not required
- together with power for their indicators and warning signals.

1.8 For all equipment forming part of the emergency source of electrical power provision shall be made for periodic functional tests, including especially testing of the automatic switching and starting devices. Such testing shall be possible without interference with other aspects of the offshore installation’s/ unit’s operation.

1.9 Ventilation of the space containing the emergency source of electrical power or ventilators for the radiator of the emergency generator engine shall comply with the requirements in TL Ship Rules (e.g. Chapter 28), and it shall not be necessary with any
closing arrangement. If any closing arrangements are installed, they shall be fail safe to open position.

1.10 Cooling arrangement for the emergency source of power, e.g. pipes, pumps and heat exchangers, shall be located in the same space as the emergency generator. Heat exchangers may be accepted outside, in close vicinity to the emergency source of power.

1.11 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 up to the maximum angle of heel in the intact and damaged condition, as determined in accordance with Chapter 60, Section 7.

In no case need the equipment be designed to operate when inclined 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.

1.12 For the rating and control of emergency generators, the same principles apply as for the main generators in accordance with C.2., but with the following exception. Voltage deviations of ± 3.5 % under steady conditions and ± 4 % under transient conditions after 5 s are acceptable.

1.13 For units 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 the other spaces and such that a fire or other casualty in any one of the spaces will not affect the power distribution from the others, or to the services under paragraph 2.1, the provisions of paragraph 1.1 may be considered satisfied without an additional emergency source of electrical power, provided that:

1.13.1 there are at least two generating sets, one in each of at least two spaces, that complies with paragraph 1.11 and has the capacity to fulfill consumers 2.1;

1.13.2 that the arrangements outlined in paragraph 1.13.1 in each of these spaces are equal to those outlined in paragraphs 1.6.1, Sec.2, A.4.3.1 to 4.3.4, and 4 to ensure that the services outlined in paragraph 2.1 always have access to a source of electrical power;

1.13.3 each of the spaces mentioned in paragraph 1.13.1 is located in accordance with Sec.2.A.4.1, and the spaces’ borders adhere to Sec.2.A.4.1’s requirements. However, contiguous boundaries should be made of a "A-60" bulkhead and a cofferdam, or a steel bulkhead with class "A-60" insulation on both sides.

2. Scope of the Emergency Power Supply

2.1 Services to be supplied

2.1.1 The emergency source of electrical power shall be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the services listed under 2.1.2 to 2.1.8, for the periods specified, if they depend upon an electrical source for their operation.

2.1.2 For a period of 18 hours, emergency lighting

- at all lifesaving appliances launching stations on deck and along the sides of the installation/unit as stipulated in the International Convention for the Safety of Life at Sea and in the IMO MODU Code

- in all service and accommodation alleyways, on stairways, at exits, in personnel lift cars and in lift shafts

- in machinery spaces and main generating stations including their control positions

- in all control stations of the drilling and/or process plant, the machinery control rooms, the emergency remote shut-down stations and at each main and emergency switchboard

- at all escapes

- at all stowage positions for firemen’s outfits
- in the steering gear compartment, the CO₂ room, the galleys, the day rooms, messes and hospital

- at the emergency fire pump, the sprinkler pump and the emergency bilge pump and at the starting position of their motors

- on the helicopter landing area, including the boundary lighting and the wind sock lighting

2.1.3 For a period of 18 hours, navigation lights of mobile units

Navigation lights and other lights of units required by the current national and international regulations for preventing collisions at sea.

2.1.4 For a period of 18 hours, communications and alarms, etc.

Unless these items of equipment can be independently supplied during these 18 hours by their own emergency storage battery

- all internal signalling and communications equipment required in an emergency

- radio, direction-finding and other navigation aids of mobile units where required by national authorities or by regulation V/12 of the 1974 SOLAS Convention

- fire detection and fire alarm system
- gas detection and gas alarm system

- intermittent operation of the daylight signalling lamp, the alarm sirens, the manually operated fire alarms and all the internal signals required in an emergency, e.g. general alarm, CO₂ alarm

- the power for closing the blow-out preventer and for isolating the unit from the well, if electrically operated

- the power to operate all the electrically driven valves of the process and production plant which have to be closed or opened in an emergency and all emergency remote shut-downs.

2.1.5 For a period of 18 hours, pumps and other equipment

- one of the required fire pumps, if dependent upon the emergency generator for its source of power

- the automatic sprinkler pump

- for mobile units, the emergency bilge pump and all the equipment essential for operation of electrically powered remote-controlled bilge valves

- the auxiliary equipment for the emergency diesel unit

- permanently installed diver’s equipment, where this depends on the installation’s/unit’s electrical power supply

- the steering gear of mobile units (for a period of 10 minutes the steering gear shall be operated by power for maximum steering angles at the Standard time)

2.1.6 For 4 days, signals

- all signal lights and

- sound signal transmitters which are necessary of the identification of offshore structures (see also the “Recommendations for the Warning off Offshore Structures", International Association of Lighthouse Authorities - IALA).

2.1.7 For half an hour, emergency systems

- all watertight doors with remote-controlled power operation together with their indicators
and warning signals; but not necessarily all of them simultaneously, unless an independent temporary source of stored energy is provided

- emergency arrangements to bring the personnel lift cars to the nearest exit point for escape purpose. Where more than one personnel lift car is provided, these may be brought to the escape station in succession in an emergency.

- emergency shut-down system(s)

2.1.8 For a period of 18 hours, column-stabilized units

- ballast control and indicating systems at the central ballast control station

- ballast pumps, only one of the connected pumps need to be considered to be in operation at any time

2.1.9 Emergency source of power shall provide:

2.1.9.1 For a period of 18 hours, emergency lighting at the steering gear

2.1.9.2 For a period of 18 hours:

- Navigational aids as required by SOLAS Chapter V

- Intermittent operation of the daylight signalling lamp and the unit’s whistle

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.

2.1.9.3 For a period of 30 min or lesser period as permitted by SOLAS Regulation II-1/29.14, the steering gear.

3. Emergency Consumers for the Protection of Important Equipment

Where necessary, the rating of the emergency source of electrical power shall take account of other consumers which are needed to protect important equipment in case of a failure of the main electrical power supply. This category may include, for example, the emergency lubricating oil supply. The measures to be taken are to be agreed with TL in each individual case.

4. Starting Arrangements for Emergency Generators

4.1 Emergency generators should be capable of being readily started in their cold condition down to a temperature of 0°C. If this is impracticable, or if lower temperatures are likely to be encountered, consideration should be given to the provision and maintenance of heating arrangements, acceptable to the Administration, so that ready starting will be assured.

4.2 Each emergency generator which is arranged to be automatically started should be equipped with starting arrangements acceptable to the Administration with a storage energy capability of at least three consecutive starts. A second source of energy should be provided for an additional three starts within 30 min unless hand (manual) starting can be demonstrated to be effective.

4.3 Provision should be made to maintain the stored energy at all times.

4.4 Electrical and hydraulic starting systems should be maintained from the emergency switchboard.

4.5 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 energized by the emergency switchboard.

4.6 All of these starting, charging and energy storing devices should be located in the emergency generator room; these devices should not be used for any purpose other than the operation of the emergency generator set. This does not preclude the supply to the air receiver of the emergency generator set from the main or auxiliary compressed air system through a non-return valve fitted in the emergency generator room.
4.7 When automatic starting is not required by these provisions and where it can be demonstrated as being effective, hand (manual) starting is permissible, such as manual cranking, inertia starters, manual hydraulic accumulators, or powder cartridges.

4.8 When hand (manual) starting is not practicable, the provisions in paragraphs 4.2 and 4.3 to 4.6 should be complied with, except that starting may be manually initiated.
SECTION 4

INSTALLATION PROTECTION and POWER DISTRIBUTION

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A. Three-Phase Main Generators

1. General

The main generators supply the relevant main switchboard, either individually or in parallel.

1.1 Single operation

Independent operation means that each generator supplies a busbar system assigned to it. Where this method is used, it shall be possible to connect the consumers or consumer groups to at least two different busbar systems or generators by means of selector switches.

1.2 Parallel operation

In parallel operation, the generators supply a common busbar system of the main switchboard, to which the consumer feeders are connected.

2. Protection Equipment

2.1 General

2.1.1 Generators shall be at least protected against damage due to short circuits and overloads.

2.1.2 Protection equipment for generators is to be arranged within the switchgear field of the generator to be protected and supplied from the generator side.

2.1.3 Short-circuit protection and overload protection equipment is to be provided in every non-earthed conductor.

2.2 Short-circuit protection

2.2.1 The short-circuit protection is to be set at an overcurrent of more than 50%, but at a value less than the steady short-circuit current. It shall have a short time delay compatible with the selectivity of the system (from 300 up to about 500 ms).

2.2.2 The short circuit protection shall not be disabled by undervoltage.

2.2.3 Generators with a rated output of 1500 kVA or more are to be equipped with a suitable protective device which in the event of a short circuit inside the generator or in the cable between generator and circuit-breaker opens the breaker and de-energises the generator.

Examples of suitable protective equipment are differential protection or generator-neutral-point monitoring.

2.3 Overload protection

2.3.1 The overload protection, which is to be set to a value between 10% and 50% overcurrent, shall trip the generator circuit breaker with a time delay of not more than 2 minutes. A setting above 50% overcurrent may be allowed, where this is required by the working conditions and is compatible with the generator characteristics. The overload protection shall not impair immediate reconnection of the generator.

2.3.2 A device shall be installed which, when the generator’s rated current is exceeded, cause a warning signal after about 5 seconds and automatically disconnects the non-essential and if necessary the secondary essential equipment.

On installations/units with unattended machinery spaces the automatic disconnection of non-essential consumers is mandatory.

2.4 Reverse-power protection

2.4.1 Generators from 50 kVA output upwards provided for parallel operation are to be protected by a delayed reverse-power release.

2.4.2 The protection shall be selected and set in accordance with the characteristics of the prime mover. Setting guidance values are: for turbogenerators 2% to 6%, for diesel generators 8% to 15% of the rated output delayed from 2 to 5 seconds. The setting should, if possible be at 50% of the tractive power of the prime mover. Should the operating voltages decrease to 50% of the rated value, the reverse-power protection shall remain effective within the limits stated.
2.5 **Undervoltage protection**

Generator circuit-breakers are to be provided with undervoltage protection. In the event of a decrease of the voltage to 70 % - 35 % of the rated voltage, the generator circuit-breaker shall open automatically. Undervoltage releases shall have a short-time delay adapted to the short circuit protection.

2.6 **Overvoltage protection**

The mains shall be protected against overvoltage. The voltage shall be limited to 130 % \( U_N \) and max. 5 s, even in the case of failure of the voltage regulators.

2.7 **Underfrequency protection**

2.7.1 In the event of a continuous frequency drop of more than 10 %, the non-essential and, where necessary, the secondary essential equipment shall be tripped within 5 to 10 s. If this fails to establish normal operating condition, the supplying generators shall be disconnected from the power supply so that the stand-by unit can cut in.

2.8 **Testing**

See Section 16, E.2.

3. **Switchgear**

3.1 **General**

Construction is to be in accordance with IEC Publication 60092-302.

3.1.1 Each non-earthed conductor shall be switched and shall be protected against short circuit and overload.

3.1.2 When tripped due to overcurrent, generator circuit breakers shall be ready for immediate reconnection. The use of thermal bi-metallic release for generators used to supply essential consumers is not permitted.

3.1.3 Generator circuit breakers shall be provided with a reclosing inhibitor which prevents automatic reclosure after tripping due to a short circuit.

3.1.4 In the design of the contactor to supply primary essential consumers the low voltage switching devices shall be dimensioned in accordance with IEC publication 60947-4-1 “type 2”.

3.1.5 Is the personnel security ensured and the selective protection of the electrical system by devices in series guaranteed in this case the low voltage switching devices for supplying secondary essential and less important consumers could be dimensioned in accordance with IEC publication 60947-4-1 “type 1”.

3.2 **Single operation**

The following devices are to be provided:

- a three-pole circuit breaker with time-delayed overcurrent- and short-time-delayed short-circuit release

- for generators with a rated output below 50 kVA, fuses and load switches or fuses with contactors are also permitted

All generator contactors that may be used are to be provided with a dropout delay (up to approx. 500 ms) and shall be rated for double of the generator current.

3.3 **Parallel operation**

3.3.1 The following devices are to be provided:

- for each generator, a three-pole circuit breaker with delayed overcurrent- and short-time-delayed short-circuit and undervoltage release

- In the case of generators intended for parallel operation, the generator switch is to be provided with undervoltage protection which prevents closing of the switch if the generator is dead.

3.3.2 A single-fault event in the synchronization circuit or in the black-out monitoring shall not lead to an asynchronous connection.
4. Synchronizing Equipment

Generators intended for parallel operation must be equipped with a synchronizer in accordance with 4.1 and 4.2.

4.1 Equipment to prevent faulty synchronizations

Generators intended for parallel operation shall be provided with automatic synchronizing equipment. Instead of automatic equipment, manual synchronizing equipment combined with a check synchronizer may be provided. The conditions of Section 15, E. must be complied with in order to prevent faulty synchronization.

4.2 Manual synchronization

Manual synchronization (e.g. synchronizing dark method installed within sight of the generator-switch actuating position) shall be possible if the appliances listed in 4.1 fail.

B. Emergency Three-Phase Generators

Emergency generators supply the emergency switchboards and the connected emergency consumers.

1. Protective Equipment and Switchgear

Generator protection shall consist of at least:

- short circuit protection
- overload protection
- under voltage protection

However it is permissible for the overload protection not to disconnect the generator automatically but instead to trigger an optical and acoustical warning signal at the emergency switchboard and at the main switchboard.

2. Overload Shedding

If the emergency generator is overloaded, consumers temporarily supplied from the emergency switchboard which are not emergency consumers shall be automatically disconnected in order to safeguard the supply to the emergency circuits.

C. Direct Current Generators

1. Single Operation

The following devices are to be provided:

- for each generator, a circuit breaker which simultaneously switches all non-earthed poles, with a delayed overcurrent release and a short-time-delayed short-circuit release, or a fuse in each nonearthed pole and a spring-operated load-switch with sufficient breaking capacity
- circuit breakers are always to be used for generators with outputs of 50 kW and over.

2. Parallel Operation

The following facilities are to be provided:

- for each generator, a circuit breaker which simultaneously switches all non-earthed poles, with a delayed overcurrent release and a short-time-delayed short-circuit release, together with a reverse-current protection and short-time-delayed undervoltage protection
- for compound generators, the switch shall contain a switching element for the equipotential line which, when switching on, closes simultaneously or earlier and, when switching off, opens simultaneously or later, and is rated for at least half the rated current.
- a polarity-reversing facility for each generator

D. Power Transformers

The design of transformers shall in general comply with the requirements of IEC 60092-303 and relevant parts of IEC 60076.
Dry type transformers are to comply with IEC Publication 60076-11.

Liquid cooled transformers are to comply with IEC Publication 60076.

Transformers shall be double wound. Starting transformers and transformers feeding single consumers, as long as the secondary consumer has the same insulation level as the primary side, may be of autotransformer type.

1. Transformers intended for parallel operation shall be so designed that over the whole load range the load on no transformer deviates by more than 10 % of its nominal current from the percentage share calculated for it.

Each transformer required is to be located as a separate unit with separate enclosure of equivalent, and is to be served by separate circuits on the primary and secondary sides.

Each primary circuit is to be provided with switch-gear and protection devices in each phase.

Each of the secondary circuits is to be provided with a multipole isolating switch. Transformers supplying bow thruster are excluded.

Transformers supplying secondary distribution systems for general use shall normally have a maximum 2.5% voltage drop from no load to full load at resistive load.

2. Power transformers are to be provided with overload and short circuit protection. When transformers are connected in parallel, tripping of the protective devices at the primary side has to automatically trip the switch connected at the secondary side.

In installations where feedback is possible transformers shall be switchable at both, the primary and secondary side.

Transformers shall be constructed to withstand a primary or secondary terminal short circuit with a duration of minimum 1 s, with rated primary voltage and frequency, without damage to internal parts or enclosure.

3. Each power transformer shall be provided with nameplate of durable material, giving the following information:
   - make, type, serial no.
   - performance standard
   - rated values for: output apparent power, voltage, frequency, current
   - duty type, if other than S1
   - thermal classification of insulation
   - IP code of enclosure and termination box vector group of windings
   - maximum permissible cooling medium temperature
   - short circuit impedance value
   - liquid type, when applicable
   - total mass.

E. Storage Batteries

Storage batteries shall be suitably housed, and compartments such as rooms, lockers or boxes utilised primarily for their accommodation shall be properly constructed and efficiently ventilated in order to prevent accumulation of flammable gas.

Storage batteries are to be provided with overload and short-circuit protection nearby where they are installed. Exceptions are made for batteries for preheating and starting of internal combustion engines, but their cabling shall be made short-circuit proof.

F. Power Electronics

1. Power electronics facilities are to be protected against overload and short circuits.
2. Inverters intended for the supply of emergency consumers from the emergency battery shall be designed for continuous operation.

G. Shore Connection

1. Shore Connection for Mobile Units

If mobile units are in a harbour, it shall be possible to supply electrical energy from the shore to the unit. The supply connection has to meet the following requirements.

1.1 Terminal boxes for shore supply shall be linked to the unit's system by permanently laid cables.

1.2 A device for connecting a protective conductor or a potential equalizer has to be provided, if required.

1.3 Switching-on of the shore supply shall only be possible if the switches of the main generators have been shut-off. Short-term parallel operation of the unit's mains and the shore mains for load transfer is permissible.

1.4 The shore connection shall be switchable and it shall be protected against short circuit and overload. The terminal box for shore connection shall be provided at least with short-circuit protection.

1.5 A voltage indicator shall be provided in the main switchboard.

1.6 Facilities shall be provided to compare the polarity (in the case of direct current) and the phase sequence (in the case of three-phase alternating current) of the shore supply with those of the unit's mains.

1.7 The following details shall be indicated on a plate fitted to the shore connection box: voltage system and rated voltage, and the frequency in the case of alternating current.

2. Supply of Electrical Power from the Shore for Fixed Installations

For fixed offshore installations which are situated near the shore it may be possible to avoid a main power generation on the installation itself, but to get the main energy via underwater cables from the shore. Such a solution has to meet the following requirements.

2.1 The supply centre on the shore shall be able to satisfy the power demand of the fixed installation under all circumstances, if the fixed installation is not equipped with a main power generation.

2.2 The supply cable shall be laid in a way on the seabed that damage by environmental influences, ship traffic, etc. can safely be avoided.

2.3 The terminal at the fixed installation shall be switchable and it must be protected against short circuit and overload. The terminal switchboard for shore connection shall be provided at least with short-circuit protection.

2.4 A direct communication line between the supply centre on the shore and the fixed installation has to be permanently established.

2.5 An emergency source of electric power has still to be provided on the fixed installation for the case that the cable connection from the shore is damaged or out of function. The performance of the emergency power supply has to be in accordance with the requirements defined in Section 3, D.

H. Consumer Protection Equipment

For electrical protection equipment see Section 5, E

I. Power Distribution

1. Electrical Supply Systems

1.1 Regarding permissible supply systems see Section 1, G.

1.2 Supply systems with hull/main structure return

1.2.1 All final supply circuits shall have all-pole insulation. The return conductors are to be connected in
the associated distribution switchboard to an insulated busbar, which is connected to the hull.

1.2.2 The connections to the hull/main structure shall have at least the same cross-section as the supply cable.

Bare wires shall not be used. Casings or their mounting bolts shall not be used as return conductors or to make their connection.

1.3 Up to 3 distribution switchboards may be supplied by a common supply cable.

2. Load Balancing in Three-phase Systems

Where, in three-phase systems, AC-consumers are connected between two outer conductors or one outer conductor and the neutral, the consumers are to be distributed in such a way that, under normal operating conditions, the loads on the individual outer conductors do not differ from each other by more than 15 %, for special requirements for hull return see Section 11, C.5.

3. Essential Supply Cables

3.1 Primary and secondary essential equipment shall be preferably supplied directly from the main or emergency switchboard in accordance with the Rules. Supply via distribution panels is only permissible, if an equivalent safety of supply is guaranteed, see also Section 2, A.3.

3.2 Primary and secondary essential equipment for the same function (e.g. main and stand-by lubricating oil pumps) are to be fed via two separate cables from the main switchboard or from two independent sub-distribution panels.

Regarding supply to steering gear see Section 12, A.

4. Emergency Supply Cables

4.1 Emergency consumers shall be supplied directly from the emergency switchboard or via sub-distribution panels, to which only consumers in the relevant fire zone are connected.

4.2 In normal operation, the emergency switchboard shall be supplied by an interconnection feeder from the main switchboard. The feeder is to be protected against overcurrent and short circuits at the main switchboard, and the feeder must be automatically disconnected in the emergency switchboard if the supply from the main switchboard fails.

4.3 A return supply from the emergency switchboard to the main switchboard, e.g. when starting operation from dead ship condition or under observance of Section 3, D. is permitted. For return supply operation, the automatic feeder disconnection called for in 4.2 may be temporarily overridden.

5. Supply of Lighting Systems

5.1 Main lighting installations shall be supplied from the main switchboard, emergency lighting installation from the emergency switchboard.

5.2 The number of lighting points (lamps) connected to one final circuit shall not exceed:

- 10 lamps for voltages up to 55 V
- 14 lamps for voltages over 55 V
- 24 lamps for voltages over 125 V

5.3 Switches shall simultaneously switch all nonearthed conductors. Single-pole switching of final circuits for lighting in systems with all conductors insulated is permitted only in the accommodation area.

5.4 Sockets outside the accommodation area shall be connected to separate circuits. When calculating the permissible connected load, one socket is equivalent to two lighting points.

5.5 In the areas listed below, the lighting shall be supplied by at least two separate fused circuits

- main engine rooms, service spaces and control stations
- large galleys
5.6 The lighting fixtures shall be so arranged that sufficient illumination for orientation is maintained should one circuit fail.

6. Navigation and Signalling Lights

6.1 The masthead, side and stern lights of units respectively the lights prescribed for installations are to be supplied separately from the navigation lights panel. Each circuit shall be protected against overload and short circuit.

Masthead light(s), sidelights and a sternlight shall be duplicated or be fitted with duplicate lamps. The individual main and reserve lights may have separate circuits in a common cable.

Navigation lights are to be connected separately to a distribution board specially reserved for this aim.

Each navigation light is to be controlled and protected in each insulated pole by a double-pole switch and a fuse or, alternatively, by a double-pole circuit-breaker, fitted on the distribution board.

6.2 The navigation lights panel may be extended for the supply of the signalling lights specified in the "International Regulations for Preventing Collisions at Sea" (COLREG).

Other consumers shall not be connected to this panel.

6.3 Navigation- and signal light controller shall be supplied from the main- and emergency electrical power source. An automatic switch over to the alternative source of power is permitted and to be alarmed.

6.4 A navigation lights controller should facilitate ON/OFF controls of individual Navigation lights

6.5 A navigation lights controller should provide visual indications of "ON"/"OFF" status of Navigation lights.

6.6 Pre-programmed navigation lights group settings may be provided.

6.7 The navigation lights controller shall be provided with a device for each light which gives optical and acoustical alarm if the light disappears.

Where the monitoring device is connected in series with the navigation light, it shall be ensured that a failure of the device does not cause the navigation light to disappear.

6.8 A navigation lights controller shall present the status of all navigation lights in a logical presentation, meeting the requirements set out in IMO Resolution MSC.191(79).

6.9 All indicators of an navigation lights controller shall be dimmable. The brightness of a display, if fitted, shall be controllable.

6.10 To prevent shortage of luminous intensity of LEDs (Light Emitting Diodes) an alarm function should be activated to notify the Officer of the Watch that the luminous intensity of the light reduces below the level required by COLREGs or LEDs shall only be used within the lifespan (practical term of validity) specified by the manufacturer to maintain the necessary luminous intensity of LEDs. The specifications in the certificate of conformity for navigation lights are to be observed.

6.11 Where navigation lights are supplied from the main source of electrical power, the voltages at the lamp-holders shall not permanently deviate by more than 5 % above or below the rated voltage.

Where, in the event of a failure of the main electric power, navigation lights are supplied from the emergency source of electrical power, the voltages at the lamp-holders may temporarily deviate by up to 10 % above or below the rated voltage.
6.12 Each navigation light shall be provided with an automatic indicator giving audible and/or visual warning in the event of failure of the light. If an audible device alone is installed, it shall be connected to a separate source of supply from that of the navigation lights, for example a storage battery.

If a visual signal is utilised connected in series with the navigation light, means shall be provided to prevent the extinction of the navigation light due to the failure of the visual signal.

A minimum level of visibility shall be assured in the case of use of dimmer devices.

7. Control, Monitoring and Safety Systems

The supply of control-, monitoring- and safety systems shall comply with the following requirements (see additionally Section 9):

7.1 These systems shall be supplied by their own circuits.

Provision shall be made for the selective disconnection of the separate circuits in case of a short circuit.

7.2 A common distribution network with back-up batteries may be used to supply systems which are required to remain operative even if the main source of electrical power fails. Such a network must have two supply units comprising either:

7.2.1 a power supply unit with a capacity sufficient for all the connected consumers together with a charger which, acting in buffer operation with the back-up battery, is capable of supplying continuously all the connected consumers and maintain the battery in the charged condition or

7.2.2 two chargers, which meet the conditions stated in 7.2.1.

7.3 With regard to residual ripple, the supply facilities specified in 7.2.1 and 7.2.2 shall be designed to ensure trouble-free operation of the connected systems even when the battery is temporarily disconnected.

7.4 One of the power supply units or chargers shall be supplied directly from the main switchboard.

7.5 Failure of the power supply units and chargers shall be signalled visually and audibly.

7.6 Battery chargers with a charging capacity of $P \geq 2 \text{ kW}$ shall be tested at the maker's works in the presence of a TL-Surveyor.

8. Emergency Shutdown Facilities

Emergency shutdown facilities placed outside the sites at which the equipment is installed are to be provided for the following consumers. The consumers may be arranged in group, provided that redundant consumers are allocated to at least two electrically independent groups.

For emergency shutdown facility that is generally de-energized (i.e., normally open circuits), a wiring break monitoring device is to be supplied.

The design of the emergency shutdown system is to be such that no single failure will cause loss of essential equipment such as fuel and lubricating oil pumps which may cause loss of main power generation or main propulsion.

Emergency shutdown facilities are to be provided for e.g.

- Fuel pumps,
- Lubrication oil pumps,
- Oil burner plants,
- Separators,
- Fan motors,
- Boiler blowers,
- Auxiliary blowers for main engines,
- Thermal oil pumps,
power to operate the radio equipment and to charge all reserve power sources for the radio equipment.

9.1.2 The radio and navigational equipment shall be directly supplied from both the main source of electrical power and the emergency source of electrical power by separate power supply circuits.

9.1.3 The power distribution for radio equipment shall be independent of that for the navigational equipment. The circuits from both the main and the emergency source of electrical power shall be terminated either in one or two distribution panels. If one distribution panel is used, the two circuits supplying the panel shall be provided with splitter feeding into two separate bus bars, one for the radio equipment and one for the navigational equipment. The panel(s) shall be located at the navigating bridge or other suitable position on the bridge deck.

9.1.4 Facilities shall be provided in each distribution panel for changing over between the main source of electrical power and the emergency source of electrical power. It is preferable that change-over be initiated automatically. If a single distribution panel is used for both the radio and the navigational equipment, separate change-over switches shall be provided.

9.1.5 Failure of any power supply shall initiate an alarm at the navigational bridge.

9.1.6 Each consumer should be individually connected to the distribution panel bus bar and individually provided with short circuit protection.

9.1.7 An indicator should be mounted in a suitable place to indicate when batteries of the reserve source of energy are being discharged visible for responsible member of the crew.

9.1.8 For examples of power supply for equipment operated by AC, see TL-G 52.

9.1.9 Power supply for equipment operated by DC (See TL-G 52 for examples)

9.1.9.1 Where the equipment is fed via converters, separate converters should be provided and these should be located on the supply side of changeover facility.

9.1.9.2 The radio equipment and the navigation equipment should be provided with separate converters.

9.1.10 Power supply for equipment operated by either AC or DC (See TL-G 52 for examples)

9.1.10.1 Each consumer should be individually connected to the main source of electrical power and to a distribution bus bar of the panel which is fed from the emergency source of electrical power and also, in case of the radio equipment, from the reserve source of energy (radio batteries). These two circuits should be separated throughout their length as far as practicable.

9.1.10.2 The radio equipment and the navigation equipment should be provided with separate converters

9.2 Radio equipment

9.2.1 The design of the radio equipment is in every case subject to the relevant national regulations. If no regulations exist, the requirements of these Rules apply.

9.2.2 A reserve source or sources of energy shall be provided to supply radio equipment, for the purpose of conducting distress and safety radio communications, in the event of failure of the installation’s/unit’s main and emergency sources of electrical power.

9.2.3 For units further stipulations for the reserve source of energy are to be taken from the SOLAS Convention, Chapter IV and relevant IMO guidelines. For fixed installations the requirements of national regulations are to be observed.

9.3 Navigational equipment of mobile units

9.3.1 Where radio equipment requires an uninterrupted input of information from the unit’s navigational equipment, it will be necessary for the equipment providing the data to be supplied from the same distribution board bus bar serving the radio equipment.
9.3.2 Where duplicated equipment is installed, it has to be arranged that each equipment can be permanently assigned to the main respectively to the emergency source of electrical power.

10. Sound Signaling System

The ship’s sound signaling system shall remain operative if the electrical main power supply fails.

11. Harmonic Distortion for Ship Electrical Distribution System Including Harmonic Filters (1)

11.1 Scope

The requirements of this item apply to ships where harmonic filters are installed on main busbars of electrical distribution system, other than those installed for single application frequency drives such as pump motors.

11.2 General

The total harmonic distortion (THD) of electrical distribution systems is not to exceed 8%.

This limit may be exceeded where all installed equipment and systems have been designed for a higher specified limit and this relaxation on limits is documented (harmonic distortion calculation report) and made available on board as a reference for the surveyor at each periodical survey.

11.3 Monitoring of harmonic distortion levels for a ship including harmonic filters

The ships are to be fitted with facilities to continuously monitor the levels of harmonic distortion experienced on the main busbar as well as alerting the crew should the level of harmonic distortion exceed the acceptable limits. Where the engine room is provided with automation systems, this reading should be logged electronically, otherwise it is to be recorded in the engine log book for future inspection by the surveyor.

11.4 Mitigation of the effects of harmonic filter failure on a ship’s operation

Where the electrical distribution system on board a ship 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 ship 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.

11.5 Protection arrangements for harmonic filters

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 should be arranged as a three phase unit with individual protection of each phase. The activation of the protection arrangement in a single phase shall result in automatic disconnection of the complete filter. Additionally, there shall 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 should take into account the type of capacitors used.

(1) Aligned with TL- R E 24.
SECTION 5
LOW-VOLTAGE SWITCHGEAR ASSEMBLIES

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A. General

1. The requirements of this Section apply to low-voltage switchgear with operating voltages of up to 1000 V AC or 1500 V DC.

2. Electrical installations are to be protected against damage due to overloading and short-circuit.

3. The thermal and electro-dynamic stresses due to overcurrents shall not cause damage to parts of the system during the response time of protective devices or during the total operating time of switches.

4. Overcurrent protective devices are to be selected on the basis of the following criteria:
- overload current
- short-circuit current
- reclosing capability

5. Regarding design, construction and testing of low-voltage switchgear assemblies, attention is drawn to IEC publication 60092-302.

6. For further notes see Section 4.

B. Calculations

1. Calculation of Short-circuit Currents

1.1 Short-circuit current calculations are to be carried out in accordance with a standard accepted by TL, e.g. IEC 61363-1.

1.2 When calculating the maximum short-circuit currents to be expected, the following installations are to be taken into account:
- all generators which operate in parallel to provide the maximum power demand
- all motors whose simultaneous operation must be expected

All data used for the short-circuit current calculation are to be submitted.

To be determined are:
- the peak short-circuit current \( i_p \)
- the initial symmetrical short-circuit current \( I''_k \)

1.3 Roughly, the short-circuit currents at the main busbar can be calculated as follows:

1.3.1 \( I''_k = \frac{100}{x_d''} \)

1.3.2 \( I''_M = 6 \cdot I_M \)

1.3.3 The total initial symmetrical short-circuit current can be calculated by summation of the individual component currents.

1.3.4 The value of the peak short-circuit current \( i_p \) can be calculated by multiplying the total initial symmetrical short-circuit current \( I''_k \) by the factor 2.3.

1.4 The short-circuit calculation shall consider all possible short circuits necessary for an evaluation of the system. The following types of short circuits are to be investigated in all cases:
- generator short circuits
- short circuits on main busbars
- short circuits on the busbars of emergency switchboards and main distribution panels

All data used for the short-circuit current calculation are to be submitted.

To be determined are:
- the peak short-circuit current \( i_p \)
- the initial symmetrical short-circuit current \( I''_k \)
1.5 The short-circuit current calculation shall be accompanied by a list of the proposed switching devices and their characteristic data.

The rated making capacity, the rated breaking capacity and the power factor of the switching appliances shall be stated.

1.6 TL reserve the right also to request proof of the minimum short-circuit currents to be expected.

2. Heat Losses (heat balance)

Switchgear assemblies shall be so designed that under operational conditions the permissible temperature rise limits in accordance with IEC 60092-302 are not exceeded.

TL reserve the right to request proof of the heat balance.

3. Dynamic and Thermal Loading

3.1 Switchgear assemblies shall be so designed that no permanent damage to busbars, busbar mountings and wiring is caused by the dynamic and thermal loading arising in the event of a short circuit.

TL reserve the right to request proof of the dynamic and thermal stability in the event of a short circuit.

3.2 For systems with a peak current above 220 kA (I\text{pk}) evidence shall be given for the rated peak withstand current (I_p) and the rated short-time withstand current (I_{cw}) by a test according to IEC publication 61439-1 Paragraph 9.3 or equivalent standard.

C. Construction

1. General

1.1 All instruments and operating devices shall be permanently identified by name plates. Wherever possible, text should be used. Fuse current ratings are to be stated. The setpoints of adjustable protective devices are to be marked. The rated operating parameters of all measuring instruments shall be marked in red either on the scales or on plates fixed nearby.

1.2 All screwed joints and connections shall be secured against self-acting loosening.

1.3 All conductors shall be vibration proof and are to be kept away from sharp edges. Conductors leading to equipment mounted in doors are to be laid tension-free.

1.4 On mobile units main and emergency switchboards shall be fitted with insulated hand rails or handles.

1.5 All components including their connections have to be accessible for the purposes of maintenance, repair and replacement.

1.6 Hinged doors in switchboards shall be fitted with arresting devices.

1.7 Electrical components mounted in the doors of switchboards, e.g. switchgear, measuring devices and fuses for voltages over 50 V, shall be safeguarded against accidental contact. Such doors are to be earthed.

1.8 Where fuses are fitted above switchgear or bare connecting wire or leads, measures are to be taken to ensure that falling parts (e.g. fuse cartridges) cannot come into contact with live components.

1.9 Operating devices and fuses must be safely accessible.

1.10 For circuit breakers and load-switches, the minimum distances above the arc chutes specified by the manufacturers are to be maintained.

1.11 Knife-type fuses for supply circuits are only permitted if they can be safely withdrawn and inserted.

1.12 Where access is required inside cubicles during operation, protection must be provided to prevent accidental contact with live parts.

2. Main Switchboards

A main switchboard is a switchboard directly supplied by the main source of electrical power or power transformer and intended to distribute electrical energy to the unit’s services.
Switchboards not being directly supplied by the main source of power will be considered as Main Switchboards when this is found relevant from a system and operational point of view.

Technical requirements for functionality and construction of Main Switchboard, apply also to Emergency Switchboards.

2.1 Observation of the measuring and indicating devices and operation of the switchgear must be possible from the front side of the switchboard with the doors closed.

2.2 If the total installed power of all generators exceeds 3 MW, the generator panels shall be separated from each other by arc-resistant partitions. Busbar penetrations shall be flame-retardant and self-extinguishing.

2.3 In plants of mobile self-propelled units, where the main source of the electrical power is necessary for the propulsion, the main busbar shall be capable to be subdivided into at least two parts which shall normally be connected by circuit breakers or other approved means.

Other approved means can be achieved by:
- Circuit breaker without tripping mechanism, or
- Disconnecting link or
- Switch

by which bus bars can be split easily and safely. Common bolted links between single busbar or switchboard sections (e.g. for transportation) do not fulfill these requirements.

2.4 A single disconnecting device is sufficient if this device is provided within separate switchboard panel without other installations or in an equivalent bounded section, see Fig. 5.1. Otherwise two disconnecting devices are required in different switchboard panels, see Fig. 5.2.

2.5 In case of removable or movable links, these devices shall be easily accessible and simple to handle. Tools for operating shall be located nearby.

2.6 As far as is practicable, the connection of generating sets and other duplicated consumers shall be equally divided between the main bus bar sections.

2.7 The consumers may for instance, be grouped as follows:

<table>
<thead>
<tr>
<th>Consumers 1</th>
<th>Consumers 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lubricating oil pump 1</td>
<td>Lubricating oil pump 2</td>
</tr>
<tr>
<td>Cooling water pump 1</td>
<td>Cooling water pump 2</td>
</tr>
<tr>
<td>Lighting 1 etc.</td>
<td>Lighting 2 etc.</td>
</tr>
</tbody>
</table>

Fig. 5.1 Example for arrangement of a main busbar connection and division of consumers

Fig. 5.2 Example for arrangement of two disconnecting devices and division of consumers

2.8 Switchgear and synchronizing equipment for generators

See Section 15, A.
2.9 Measuring and monitoring devices for generators

2.9.1 Where circuit breakers are used, the following shall be provided:
- 1 indicating light: circuit breaker connected
- 1 indicating light: circuit breaker released

2.9.2 The following is required for each three-phase alternator:
- 1 voltmeter which can, if necessary, be switched to the other alternators
- 1 ammeter, switchable to all phases
- 1 frequency meter which can, if necessary, be switched to the other alternators

2.9.3 The following is required for each direct-current generator:
- 1 voltmeter
- 1 ammeter

2.9.4 The following circuits shall be supplied from the generator side, and shall be separately protected against short circuits:
- generator protection devices, and an undervoltage trip of the generator circuit breaker
- measuring instruments
- indicating lights
- diesel engine speed-adjusting equipment
- motor drive for circuit breaker

2.9.5 A manual operation is to provide for generator circuit breaker. It shall be independent and overriding.

2.10 Switchgear and fuses for equipment

2.10.1 Each supply line run from the main switchboard shall be provided with a circuit breaker with over-current and short-circuit protection, or with a fuse for each non-earthed conductor and an all-pole switch, or with a contactor with control switch. Where fuses and switches are used, the sequence busbar-fuse-switch is to be used. The specified sequence may be changed where motor switches of utilization category AC-23A are used as load switches, provided that the switches are weldproof in the event of a short circuit, see B.3.

The rated peak withstand current (dynamic limiting current) of switches shall be greater than the cut-off current of the associated fuse in the event of a short circuit.

2.11 Measuring instruments

The main switchboard and the main distribution panel have to be fitted with ammeters for major consumers, unless these are already mounted on the consumers themselves. It is permissible for one ammeter to be switched over to a number of circuits.

3. Emergency Switchboards

An emergency switchboard is a switchboard, which in the event of failure of the main electrical power supply system, is directly supplied by the emergency source of electrical power and/or the transitional source of emergency power and is intended to distribute electrical energy to the emergency power consumers.

Switchboards not being directly supplied by the emergency source of power may be considered as Emergency Switchboards when this is found relevant from a system and operational point of view.

3.1 The requirements for main switchboards apply in analogous manner to emergency switchboards.

3.2 Control and supply circuits of the emergency power plant must be so switched and protected that interruptions or short circuits caused by fire or another event,
- in a space housing the main generators and/or the main switchboards, or
- in a category A machinery space

do not impair the operating ability of the emergency source of electrical power. Where necessary, the emergency switchboard has to be fitted with isolating switches.

4. Distribution Panels

4.1 Distribution panels are to be equipped with the necessary devices for the protection of the connected circuits and for the supply of consumers, see Section 4.

4.2 Feeder circuits with fuses must be switched with load switches. In the case of feeder circuits with fuses up to 63 A, load switches may be dispensed with, if each connected equipment can be disconnected by a switch fitted nearby.

4.3 For navigation light panels, see Section 12, K.

4.4 For container connections, see Section 10, B.3.

5. Motor Starters

5.1 Each motor shall be provided with its own switching device.

5.2 It shall be indicated whether the motor is switched on.

5.3 If the switching device does not disconnect all of the live conductors, additional measures are to be taken for the protection of personnel.

5.4 Motors are to be provided with starters if:
- currents or voltage drops higher than those permissible for the system are liable to occur, if connected directly
- this is necessary for the start-up of the motor or the driven machine
- this is required by the design of the generators

5.5 Starting shall only be possible from the zero position of the starter.

D. Selection of Switchgear

1. General

1.1 Every non-earthed conductor is to be switched and to be protected against short circuit and overload.

Switchgear assembly shall be designed and constructed to facilitate inspection site installation cleaning, repair and maintenance and to ensure absolute safety during operation, inspection and maintenance. All components shall be easily accessible.

1.2 Switchgear shall conform to IEC publications, or to another standard approved by TL.

1.3 Switchgear shall be selected with regard to its rated currents, its rated voltage, its thermal and dynamic stability and its switching capacity.

The following must be observed:

1.3.1 The rated short-circuit making capacity shall be not less than the calculated peak short-circuit current \( i_P \) at the place of installation.

1.3.2 The rated service short-circuit breaking capacity shall be not less than the AC component of the short-circuit \( I_{ac}(t) \) at the moment

\[
t = T / 2
\]

2. Circuit Breakers

Circuit breakers with electrical closing and opening devices shall have a manual and motor charged stored energy mechanism release.

Circuit breakers with automatic closing facility shall be provided with anti-pumping facilities. Unless otherwise specified, circuit breakers for distribution feeders will be operated manually from the front of the switchgear assembly. In case of tripping coil use, this shall be of energised to trip type unless otherwise stated by safety requirements.
Circuit breakers for incomers and the bus tie of a same switchgear assembly shall be identical.

2.1 Circuit breakers are distinguished according to the utilization categories of IEC publication 60947-2 into:

2.1.1 Utilization category A

These are circuit breakers not designed for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, e.g. without intentional short-time delay for selectivity under short-circuit conditions, and therefore do not need proof of the rated short-time withstand current ($I_{cw}$).

Application examples:

As consumers circuit breakers and distribution feeders.

2.1.2 Utilization category B

These are circuit breakers which are designed for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, e.g. with intentional short-time delay for selectivity under short-circuit conditions. Such circuit breakers must have proof of the rated short-time withstand current ($I_{cw}$). Utilization category B circuit breakers must be able to withstand the short-circuit current to be expected where they are fitted, for the duration of at least 500 ms.

Application example:

As generator circuit breakers.

2.2 Additional requirements for generator circuit breakers:

- Following tripping due to an overcurrent, the breaker must immediately be ready for reclosing. For this reason thermal tripping devices are not permitted.

- A reclosing block must prevent automatic remaking of the breaker onto a still persisting short circuit following tripping due to a short circuit.

2.3 Additional requirement for circuit breakers in IT systems:

- Testing as described in Annex H of IEC 60947-2 is required.

3. Load Switches

3.1 The current rating of load switches must be at least equal to that of the fuse protecting the circuit, and they must have a making/breaking capacity in accordance with AC-22 A or DC-22 A (IEC 60947-3).

3.2 The sequence busbar - fuse - switch should be maintained.

3.3 If the sequence busbar - switch - fuse is chosen, the making/breaking capacity shall match category AC-23 A or DC-23 A (IEC 60947-3), and attention is to be paid to increased insulation quality of the switching unit.

4. Fuses

Fuses shall normally comply with one of the following standard:

- IEC 60269 for low voltage fuses.

4.1 Fuse links shall have an enclosed fusion space. They shall be made of ceramic or other material recognized by TL as equivalent.

4.2 Fuses may be used for overload protection only up to a rating of 315 A.

Exceptions to this rule are subject to approval by TL.
E. Choice of Electrical Protection Equipment

1. General

Protective devices shall be co-ordinated with each other in such a way that, in the event of a fault, the defective circuit is disconnected and the power supply to essential equipment is maintained.

2. Short-circuit Protection Equipment

2.1 The rated short-circuit breaking capacity Icn of a switching device shall not be less than the maximum current to be broken in the event of a short circuit at the place where the protective device is fitted.

2.2 The rated short-circuit making capacity Icm of a circuit breaker shall not be less than the maximum instantaneous asymmetric short-circuit current at the place where it is fitted.

2.3 The peak short-circuit strength of a switching unit and its components shall correspond to the maximum short-circuit current which can arise at the place where it is fitted.

2.4 Circuit breakers whose making/breaking capacities are less than the anticipated maximum short-circuit currents are to be protected by back-up fuses of sufficient breaking capacity.

2.5 The circuit breakers are to be selected on the basis of their rated service short circuit breaking capacity Ics as follows:

- All circuit breakers which are directly connected to main or emergency switchboard
- All circuit breakers which are installed in the feeder lines for essential services or emergency consumers.

Equivalent protection schemes require special approval by TL.

3. Selective Arrangement

3.1 The short-circuit protection of essential equipment shall be selective and has to ensure that only the switching device nearest to the fault initiates disconnection of the defective circuit. For this purpose:

- the tripping time of protective devices connected in series shall be carefully co-ordinated
- the switching devices being capable of carrying the short-circuit current during the total break time of the device plus the time lag required for selectivity
- Exceptions may be permitted in the case of circuits feeding redundant plants or non-essential equipment if selectivity relative to the generator switch is maintained.

4. Overcurrent Protection Devices

The current-time characteristics of overcurrent protection devices shall be compatible with the system components to be protected, and with the requirements of selectivity.

5. Allocation of Short-circuit and Overcurrent Protection Devices

5.1 Short-circuit protection is required for every non-earthed conductor.

5.2 Overcurrent protection is required for at least one conductor in insulated DC and single-phase AC circuits.

Overcurrent protection is required for at least two phases in insulated, load-balanced three-phase circuits.

5.3 Overcurrent protection is required for each non-earthed conductor in earthed systems. The continuity of earthed conductors shall not be interrupted by short-circuit or overcurrent protection devices, except in the case of multipole disconnection devices which simultaneously interrupt all the conductors, whether earthed or not.

5.4 Determined for the overcurrent protection of the entire circuit (switchgear, switchboard wiring, supply cables and equipment) according to regulations is the
rated current In of the connected equipment or in the
case of grouped supply cables the evaluated total rated
current.

6. **Motor Protection**

6.1 Motors with a power rating of more than 1 kW
shall be individually protected against overloads and
short circuits. For steering-gear motors, see Section 12,
A.

6.1.1 The protective devices shall be compatible with
the mode of operation of the motors and have to provide
reliable protection against thermal overload.

6.1.2 If the current/time characteristic of the overload
protection device does not correspond to the starting
conditions of a motor, provision may be made to
suppress operation of the device during the start-up
period. The short-circuit protection shall remain
operative.

6.2 The switchgear of motors whose simultaneous
restarting on restoration of the supply voltage might
endanger operation shall be provided with undervoltage
protection which prevents automatic restart.

6.3 Where necessary, the start-up of motors which
are required to restart automatically following restoration
of the voltage is to be staggered in such a way that the
starting currents do not overload the installation/unit’s
mains.

7. **Control Circuits**

7.1 The control circuits of essential systems have to
be independent of other control circuits.

7.2 Common control circuits for groups of
consumers are permitted only when this is required by
functional relationships.

7.3 For emergency shutdowns see Section 9, E.

7.4 Control-power transformers have to be
protected against short circuit and overload. Fuses may
be used on the secondary side as overload protection.

Where the rated current on the secondary side is less
than 2 A, the overload protection may be omitted.

Current and voltage transformers shall be of dry
insulation type (complete coating of thermosetting
synthetic resin).

Voltage transformers shall be of the encapsulated type.
Three voltage transformers shall be provided with star
connection and neutral earthed.

7.5 Switching elements shall not be located in the
earthed part (N) of an earthed control circuit.

8. **Measuring and Signalling Circuits**

Current loops for signalling and measuring equipment
and also indication lamps shall be protected against
short circuit and overload in each non-earthed conductor.

Excepted are indicating lamps with operating voltage ≤
24 V or if measures are taken to prevent influence on
control and power circuits in case of short circuit.

9. **Exciter Circuits**

Exciter circuits and similar circuits whose failure could
endanger operation may be protected only against short
circuit.

10. **Monitoring of Insulation Resistance**

Insulating materials shall be tracking resistant in
accordance with IEC 60112. A tracking index of at least
175 V will be required for low voltage equipment. For high
voltage equipment the tracking index shall be minimum
300 V.

Each non-earthed primary or secondary system serving
power, heating or lighting installations shall be fitted with
an equipment which monitors the insulation resistance
relative to the unit’s hull / installation’s main structure and
gives an optical and audible alarm if the insulation
resistance value is abnormally low, see also Section 15,
E.

Insulation monitoring devices may be dispensed with in
the case of secondary systems such as control circuits.
11. Testing of Protection Devices for Generators and Large Consumers on Board

Electronic or computerised protection devices for generators and large consumers shall be so designed that the function of the protection equipment can be tested on board, see Section 9, D.

Especially attention shall be given to:

- arrangements to readily identification of the last final settings, in the event of possible change
- facilities and instructions for testing the settings and functions on board

F. Conductors and Busbar Carriers

1. Busbars, Bare or Painted

1.1 General

Busbars shall be installed in compartments separated from the switchgear and without transverse partitions at the level of each cell except at bus section(s). Insulating screens shall be installed between horizontal and vertical busbars. In event of internal fault, the damage shall be confined to that unit.

1.1.1 Busbars shall be made of copper or copperplated aluminium, or corrosion-resistant aluminium.

Main busbars shall allow an easy expansion at its two extremities (holes already drilled).

1.1.2 The dimensions of main busbars and section busbars made of copper shall conform to Table 5.1 as a function of their permitted load.

The temperature rise shall not exceed 45 K and shall not have any harmful effect on adjacent components.

1.1.3 Parallel-run busbars of the same phase are to be installed not less than one bar thickness apart. Earth conductors, neutral conductors of three-phase mains and equalization lines between compound-wound generators shall have at least half the cross section of the phase conductor.

1.2 Connections to equipment

Cross sections of connection bars and wires to equipment shall be of such size as to avoid thermal overloading of the equipment at full load as well as in the event of a short circuit.

2. Busbar Carriers

Busbars are to be mounted in such a way that they withstand the stresses caused by short circuit currents and maintain the required clearance and creepage distances relative to other voltage-carrying or earthed components.

3. Clearance and Creepage Distances

3.1 The values indicated in Table 5.2 apply to main busbars and the associated non-fused connection bars of main, emergency and control switchboards.

3.2 Lower values than those indicated in Table 5.2 may be approved by TL, if the following conditions are met:

- switchgear of standard design
- quality system approved by TL
- reduction of pollution by appropriate installation and degree of protection
4. Insulated Wires

4.1 Insulated wires shall be of the stranded type, and shall satisfy the requirements for cables and wires set out in Section 11. The cross section of the conductor shall be at least sufficient for the rated current of the connected equipment. Conductors are to be selected in accordance with Table 5.3.

4.2 Non-fused conductors leading from the main busbar to fuses and circuit breakers shall be as short as possible, but not longer than 1 m. These wires shall not be run and mounted together with other wires.

4.3 Control wires for essential equipment shall be run and protected in such a way that they cannot be damaged by short circuit arcs if at all possible.

G. Measuring Instruments and Instrument Transformers

1. Measuring Instruments

1.1 The measuring error of switchboard instruments shall not exceed 1.5 % of the full scale value.

Instruments with directional response are to be used for DC generators and batteries.

1.2 Voltmeters must have a scale range of at least 120 % of the rated voltage, and ammeters a scale range of at least 130 % of the maximum anticipated continuous service current. Ammeters are to be so rated that they are not damaged by motor starting currents.

1.3 The scale range of power meters shall be at least 120 % of the rated power.

For generators connected in parallel, the scale range must also register at least 15 % reverse power. Where power meters have only a single current path, all generators shall be measured in the same phase. If the total value of all consumers connected to a single phase exceeds 10 % of the power of the smallest generator, the power meters have to be equipped with multiple movements in order to record the unbalanced load on the outer conductors.

1.4 Frequency meters shall be capable of registering deviation of ± 5 Hz from the rated frequency.

2. Current and Voltage Transformers

2.1 Current and voltage transformers shall conform to class 1 as a minimum requirement.

2.2 Current transformers for protective devices shall not have a current error of more than 10 % in the expected over-current range.

H. Testing of Switchboards and Switchgear

Inspection and tests shall be performed in accordance with IEC standards.

1. Type-Approvals

Type tests in accordance with the referenced standards shall have been carried out on Manufacturer’s similar equipment and the type test certificates shall be provided with the quotation. When appropriate type test certificates do not exist, tests shall be made at the time of manufacture of the equipment to which this standard refers, subject to TL approval.

For mandatory type approval of devices and components see Section 16, E.2.

2. Tests in Manufacturer’s Works

2.1 All switchboards are to be tested in the manufacturer’s works.

The routine tests in accordance with the IEC 61439-1 and IEC 61439-2 shall be performed.
### Table 5.1 Permissible loading of copper main busbars of rectangular cross-section at 45 °C ambient temperature (45 K temperature rise)

<table>
<thead>
<tr>
<th>Width x Thickness [mm]</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>painted (matt-black)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maximum permissible loading [A] with 50/60 Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of bars</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>15 X 3</td>
<td>230</td>
<td>390</td>
<td>470</td>
<td>-</td>
<td>200</td>
<td>350</td>
<td>445</td>
</tr>
<tr>
<td>20 X 3</td>
<td>290</td>
<td>485</td>
<td>560</td>
<td>-</td>
<td>250</td>
<td>430</td>
<td>535</td>
</tr>
<tr>
<td>20 X 5</td>
<td>395</td>
<td>690</td>
<td>900</td>
<td>-</td>
<td>340</td>
<td>620</td>
<td>855</td>
</tr>
<tr>
<td>20 X 10</td>
<td>615</td>
<td>1145</td>
<td>1635</td>
<td>-</td>
<td>530</td>
<td>1020</td>
<td>1460</td>
</tr>
<tr>
<td>25 X 3</td>
<td>355</td>
<td>580</td>
<td>650</td>
<td>-</td>
<td>300</td>
<td>510</td>
<td>615</td>
</tr>
<tr>
<td>25 X 5</td>
<td>475</td>
<td>820</td>
<td>1040</td>
<td>-</td>
<td>405</td>
<td>725</td>
<td>985</td>
</tr>
<tr>
<td>30 X 3</td>
<td>415</td>
<td>670</td>
<td>735</td>
<td>-</td>
<td>350</td>
<td>590</td>
<td>700</td>
</tr>
<tr>
<td>30 X 5</td>
<td>555</td>
<td>940</td>
<td>1170</td>
<td>-</td>
<td>470</td>
<td>830</td>
<td>1110</td>
</tr>
<tr>
<td>30 X 10</td>
<td>835</td>
<td>1485</td>
<td>2070</td>
<td>-</td>
<td>710</td>
<td>1310</td>
<td>1835</td>
</tr>
<tr>
<td>40 X 5</td>
<td>710</td>
<td>1180</td>
<td>1410</td>
<td>-</td>
<td>595</td>
<td>1035</td>
<td>1350</td>
</tr>
<tr>
<td>40 X 10</td>
<td>1050</td>
<td>1820</td>
<td>2480</td>
<td>3195</td>
<td>885</td>
<td>1600</td>
<td>2195</td>
</tr>
<tr>
<td>50 X 5</td>
<td>860</td>
<td>1410</td>
<td>1645</td>
<td>2490</td>
<td>720</td>
<td>1230</td>
<td>1560</td>
</tr>
<tr>
<td>50 X 10</td>
<td>1260</td>
<td>2130</td>
<td>2875</td>
<td>3655</td>
<td>1055</td>
<td>1870</td>
<td>2530</td>
</tr>
<tr>
<td>60 X 5</td>
<td>1020</td>
<td>1645</td>
<td>1870</td>
<td>2860</td>
<td>850</td>
<td>1425</td>
<td>1785</td>
</tr>
<tr>
<td>60 X 10</td>
<td>1460</td>
<td>2430</td>
<td>3235</td>
<td>4075</td>
<td>1220</td>
<td>2130</td>
<td>2850</td>
</tr>
<tr>
<td>80 X 5</td>
<td>1320</td>
<td>2080</td>
<td>2265</td>
<td>3505</td>
<td>1095</td>
<td>1795</td>
<td>2170</td>
</tr>
<tr>
<td>80 X 10</td>
<td>1860</td>
<td>2985</td>
<td>3930</td>
<td>4870</td>
<td>1535</td>
<td>2615</td>
<td>3460</td>
</tr>
<tr>
<td>100 X 10</td>
<td>2240</td>
<td>3530</td>
<td>4610</td>
<td>5615</td>
<td>1845</td>
<td>3075</td>
<td>4040</td>
</tr>
<tr>
<td>120 X 10</td>
<td>2615</td>
<td>4060</td>
<td>5290</td>
<td>6360</td>
<td>2155</td>
<td>3545</td>
<td>4635</td>
</tr>
</tbody>
</table>

**Note**

The maximum permissible loading applies to switchboards not closed at the rear. In the case of fully enclosed switchboards adequate ventilation is to be ensured, or the loading values stated are to be reduced.

### Table 5.2 Clearance and creepage distances

<table>
<thead>
<tr>
<th>Rated service voltage [V] (AC/DC)</th>
<th>Minimum clearance [mm]</th>
<th>Minimum creepage distance [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 125</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>&gt; 125 ≤ 250</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>&gt; 250 ≤ 690</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>&gt; 690</td>
<td>25</td>
<td>35</td>
</tr>
</tbody>
</table>
Table 5.3  Current rating of wires in switchgear

<table>
<thead>
<tr>
<th>Nominal cross-section of conductor – total cross-section in the case of conductors connected in parallel</th>
<th>Bunched, exposed or in conduits</th>
<th>One power circuit together with its associated measuring and control wires</th>
<th>Wires run singly, at least one conductor diameter apart</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>1.5</td>
<td>12</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>2.5</td>
<td>16</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>27</td>
<td>34</td>
</tr>
<tr>
<td>6</td>
<td>26</td>
<td>35</td>
<td>42</td>
</tr>
<tr>
<td>10</td>
<td>36</td>
<td>48</td>
<td>58</td>
</tr>
<tr>
<td>16</td>
<td>48</td>
<td>65</td>
<td>78</td>
</tr>
<tr>
<td>25</td>
<td>66</td>
<td>86</td>
<td>102</td>
</tr>
<tr>
<td>35</td>
<td>82</td>
<td>107</td>
<td>125</td>
</tr>
<tr>
<td>50</td>
<td>104</td>
<td>133</td>
<td>157</td>
</tr>
<tr>
<td>70</td>
<td>130</td>
<td>164</td>
<td>194</td>
</tr>
<tr>
<td>95</td>
<td>157</td>
<td>198</td>
<td>231</td>
</tr>
<tr>
<td>120</td>
<td>186</td>
<td>231</td>
<td>272</td>
</tr>
</tbody>
</table>

Note
The current ratings shown applies to conductors with a maximum permissible operating temperature [T] on the conductor of 70 °C and an ambient temperature of 45 °C. For conductors with a maximum permissible operating temperature [T] deviating from 70 °C, the current rating is to be determined by applying the correction factor [F].

<table>
<thead>
<tr>
<th>T</th>
<th>60 °C</th>
<th>65 °C</th>
<th>70 °C</th>
<th>75 °C</th>
<th>80 °C</th>
<th>85 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>0.77</td>
<td>0.89</td>
<td>1.00</td>
<td>1.10</td>
<td>1.18</td>
<td>1.26</td>
</tr>
</tbody>
</table>
The following installations are subject to testing in the presence of a TL Surveyor:

- main switchboards
- emergency switchboards
- distribution switchboards with connected power ≥ 500 kW
- switchboards for electrical propulsion plants
- starters and controls for boiler and thermal oil systems

A test report of the acceptance tests shall be issued.

TL reserve the right to stipulate a factory test for other switchboards.

### 2.3 Scope of test

#### 2.3.1 Visual inspection

Checking of manufacture against the approved drawings. The components and materials used shall conform to the Rules.

Visual check for aspect, painting, finish, welding, sheet metal, lifting ring, assembly bolt torque, busbar bolt torque, conformity of torque values for main connections, lining up of measuring apparatus, handling devices, remote control and signalling, labels shall be carried out.

#### 2.3.2 Functional test

Testing of functional performance on the basis of a test schedule and of the approved drawings, as far as it is feasible.

Minimum functional tests including start/stop, remote alarms, intertrip, automatic sequences if any, etc shall be performed.

### 2.3.3 High-voltage test

The test voltage specified in Tables 5.4 and 5.5 is to be applied between the conductors, and between the conductors and the switchboard frame. The duration of the test is one minute in each case.

Measuring instruments and other auxiliary apparatus may be disconnected during the test.

#### Test voltage for main circuits:

For main circuits the test has to be carried out with the values according to Table 5.4.

#### Test voltage for auxiliary circuits:

For auxiliary circuits the test has to be carried out with the values according to Table 5.5.

#### Test voltage for type-approved switchgear:

For the verification of the dielectric properties of type-approved switchgear the test voltage for routine tests may be reduced to 85% of the values according to Tables 5.4 and 5.5.

### 2.3.3 Insulation resistance measurement

The voltage test is to be followed by measurement of the resistance of insulation. The insulation resistance measurement is to be performed at a DC voltage of at least 500 V.

In large installations, the switchboard may be divided into a number of test sections for this purpose. The insulation resistance of each section shall be at least 1 MOhm.
### Table 5.4 Test voltage for main circuits

<table>
<thead>
<tr>
<th>Rated insulation voltage $U_i$ DC and AC [V]</th>
<th>Test voltage (AC) (rms) [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U_i \leq 60$</td>
<td>1000</td>
</tr>
<tr>
<td>$60 &lt; U_i \leq 300$</td>
<td>2000</td>
</tr>
<tr>
<td>$300 &lt; U_i \leq 690$</td>
<td>2500</td>
</tr>
<tr>
<td>$690 &lt; U_i \leq 800$</td>
<td>3000</td>
</tr>
<tr>
<td>$800 &lt; U_i \leq 1000$</td>
<td>3500</td>
</tr>
<tr>
<td>$1000 &lt; U_i \leq 1500$ (1)</td>
<td>3500</td>
</tr>
</tbody>
</table>

(1) *Only for DC voltage*

### Table 5.5 Test voltage for auxiliary circuits

<table>
<thead>
<tr>
<th>Rated insulation voltage $U_i$ DC and AC [V]</th>
<th>Test voltage (AC) (rms) [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U_i \leq 12$</td>
<td>250</td>
</tr>
<tr>
<td>$12 &lt; U_i \leq 60$</td>
<td>500</td>
</tr>
<tr>
<td>$U_i &gt; 60$</td>
<td>$2U_i + 1000$ but at least 1500</td>
</tr>
</tbody>
</table>
SECTION 6

HIGH VOLTAGE INSTALLATIONS

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A. Scope

These rules also apply to a.c. three-phase system with nominal voltages of > 1 kV up to 15 kV

Note: Where necessary for special application, higher voltages may be accepted by TL.

B. General Provisions

1. Reference to Other Requirements

The general provisions of this Chapter also apply, as and where appropriate, to high voltage installations, except where more particular requirements are laid down in this Section.

2. Rated Main Voltages

Equipment with voltage above about 1 kV is not to be installed in the same enclosure as low voltage equipment, unless segregation or other suitable measures are taken to ensure that access to low voltage equipment is obtained without danger.

3. Clearances and Creepage Distances

3.1 Air Clearances

In general, for Non Type Tested equipment phase-to-phase air clearances and phase to-earth air clearances between non-insulated parts are to be not less than those specified in Table 6.1.

Intermediate values may be accepted for nominal voltages provided that the next higher air clearance is observed. In the case of smaller distances, appropriate voltage impulse test must be applied.

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.

Table 6.1 Minimum clearances for voltage installations

<table>
<thead>
<tr>
<th>Nominal Voltage [kV]</th>
<th>Minimum clearance [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3</td>
<td>55</td>
</tr>
<tr>
<td>6.6</td>
<td>90</td>
</tr>
<tr>
<td>10 – 11</td>
<td>120</td>
</tr>
<tr>
<td>15</td>
<td>160</td>
</tr>
</tbody>
</table>

ii) The equipment is subject to an impulse voltage test with test voltage values shown in Table 6.2 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 TL for review.

Table 6.2 Impulse Voltage Test Values

<table>
<thead>
<tr>
<th>Rated Voltage kV</th>
<th>Rated Impulse Withstand Voltage kV (peak value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6</td>
<td>40</td>
</tr>
<tr>
<td>7.2</td>
<td>60</td>
</tr>
<tr>
<td>12</td>
<td>75</td>
</tr>
<tr>
<td>15</td>
<td>95</td>
</tr>
</tbody>
</table>

3.2 Creepage distances

Creepage distances between live parts and between live parts and earthed metal parts are to be in accordance with IEC 60092-503:2007 for the nominal voltage of the system, the nature of the insulating material and the transient developed by switch and fault conditions.

3.2.1 Insulators shall conform to IEC publication 60168 and 60273.

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.
3.2.2
a) The minimum creepage distances for main switchboards and generators are given in the Table 6.3.

<table>
<thead>
<tr>
<th>Nominal Voltage V</th>
<th>Minimum Creepage Distance for Proof Tracking Index mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>300V</td>
</tr>
<tr>
<td>1000-1100</td>
<td>26 (1)</td>
</tr>
<tr>
<td>&lt; 3300</td>
<td>63</td>
</tr>
<tr>
<td>&lt; 6600</td>
<td>113</td>
</tr>
<tr>
<td>≤ 11000 (2)</td>
<td>183</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.

b) The minimum creepage distances for equipment other than main switchboards and generators are given in the Table 6.4.

<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</td>
</tr>
<tr>
<td>&lt;3300</td>
<td>42</td>
</tr>
<tr>
<td>&lt;6600</td>
<td>83</td>
</tr>
<tr>
<td>≤11000 (*)</td>
<td>146</td>
</tr>
</tbody>
</table>

Note:
(*) Creepage distances for equipment with nominal voltage above 11 kV shall be subject to consideration.
4. Degrees of Protection

4.1 Each part of the electrical installation is to be provided with a degree of protection appropriate to the location, as a minimum the requirements of IEC 60092-201:2019 and Table 6.5.

4.1.1 Rotating machines

The degree of protection of enclosures of rotating electrical machines is to be at least IP 23.

The degree of protection of terminals is to be at least IP 44. For motors installed in spaces accessible to unqualified personnel, a degree of protection against approaching or contact with live or moving parts of at least IP4X is required.

4.1.2 Transformers

The degree of protection of enclosures of transformers is to be at least IP23. For transformers installed in spaces accessible to unqualified personnel a degree of protection of at least IP4X is required.

For transformers not contained in enclosures 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.

4.1.3 Switchgear, controlgear assemblies and converters

The degree of protection of metal enclosed switchgear, controlgear assemblies and static convertors is to be at least IP32. For switchgear, control gear assemblies and static converters installed in spaces accessible to unqualified personnel, a degree of protection of at least IP4X is required.

4.2 If the required degree of protection is not fulfilled by the unit itself, adequate protection shall be ensured through appropriate structural measures.

4.3 Protective measures

4.3.1 An unacceptable hazard to persons through electrical shock and accidental arcs shall be avoided independently of the required protection against foreign bodies and water.

4.3.2 For switchgear installations it shall be proved that an internal arc test according to IEC 62271-200 Annex A had been passed. The criteria 1 to 5 shall be fulfilled.

4.3.3 Terminal boxes shall be equipped with a device for the calculated expansion of the accidental arc gases. Evidence shall be given to prove the effectiveness of the chosen design.

5. Equipotential Bonding

5.1 All conductive, but in normal operation non-live, components of a high voltage installation or equipment shall be provided with an electrically conductive connection to the hull respectively structure.

5.2 All metal components in the electrical operational compartments shall be included in the equipotential bonding.

6. Earthing

6.1 Metal parts shall be earthed if, in the event of a fault, there is a possibility to get in contact with live components either by direct contact or arc ing.

Attention shall be paid to adequate dimensioning of the earthing conductors (e.g. for copper conductors the current density shall not exceed a value of 150 A/mm² in the event of a fault).

Such earthing conductors shall have a minimum cross section of 16 mm².
<table>
<thead>
<tr>
<th>Example of Location</th>
<th>Condition of Location</th>
<th>Switchboards, Distribution Boards, Motor Control Centers and Controllers</th>
<th>Generators</th>
<th>Motors</th>
<th>Transformers, Converters</th>
<th>Junction/Connection Boxes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry control rooms</td>
<td>Danger of touching live parts only</td>
<td>IP32 N/A N/A IP23 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authorized Personnel Only</td>
<td></td>
<td>N/A N/A N/A IP42 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry control rooms</td>
<td>Danger of touching live parts only</td>
<td>IP32 N/A N/A IP23 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control rooms</td>
<td>Danger of dripping liquid and/or moderate mechanical damage</td>
<td>IP32 N/A N/A IP23 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authorized Personnel Only</td>
<td></td>
<td>IP42 N/A N/A IP44 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Rooms</td>
<td>Danger of dripping liquid and/or moderate mechanical damage</td>
<td>IP32 N/A N/A IP23 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above floor plates in machinery spaces</td>
<td>Increased danger of liquid and/or mechanical damage</td>
<td>IP32 IP23 IP23 IP23 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authorized Personnel Only</td>
<td></td>
<td>IP42 IP23 IP43 IP44 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above floor plates in machinery spaces</td>
<td>Increased danger of liquid and/or mechanical damage</td>
<td>IP32 IP23 IP23 IP23 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency machinery rooms</td>
<td>Increased danger of liquid and/or mechanical damage</td>
<td>IP32 IP23 IP23 IP23 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authorized Personnel Only</td>
<td></td>
<td>IP42 IP23 IP43 IP44 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency machinery rooms</td>
<td>Increased danger of liquid and/or mechanical damage</td>
<td>IP32 IP23 IP23 IP23 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below floor plates in machinery spaces</td>
<td>Increased danger of liquid and/or mechanical damage</td>
<td>IP32 IP23 IP23 IP23 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authorized Personnel Only</td>
<td></td>
<td>N/A N/A * * IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below floor plates in machinery spaces</td>
<td>Increased danger of liquid and/or mechanical damage</td>
<td>IP32 IP23 IP23 IP23 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ballast pump rooms Authorized Personnel Only</td>
<td>Increased danger of liquid and/or mechanical damage</td>
<td>IP44 N/A IP44 IP44 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ballast pump rooms</td>
<td>Increased danger of liquid and/or mechanical damage</td>
<td>IP44 N/A IP44 IP44 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holds for general cargo</td>
<td>Danger of liquid spray presence of cargo dust, serious mechanical damage, and/or aggressive fumes</td>
<td>IP44 N/A IP44 IP44 IP44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open decks (2)</td>
<td>Not exposed to seas</td>
<td>N/A IP56 IP56 IP56 IP56</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open decks (2)</td>
<td>Exposed to seas</td>
<td>N/A N/A * *</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*** indicates that equipment in excess of 1000V is not normally permitted in these locations.
6.2 Metal components that have permanent and electrically conductive connections to the hull need not be separately earthed.

Bolted connections for the fixing of units or components are not considered electrically conductive connections.

7. Selectivity

For essential systems, selectivity is to be ensured independently of the neutral point design.

Evidence shall be given to prove downstream selectivity of the complete grid (Low and high voltage) under all operating conditions.

This applies to short circuit, over current, and earth-fault tripping. Other protection equipment, also those not required by TL, may not interfere with this selectivity concept.

8. Isolating and Earthing Devices

A sufficient number of isolating links and earthing and short-circuit devices shall be provided to enable maintenance work to be performed safely on plant sections.

9. Control of Generator- and Bus Tie Circuit Breakers

A single-fault event in the synchronization circuit or in the black-out monitoring shall not lead to an asynchronous connection.

C. Network Design and Protective Equipment

1. Electrical Operating Systems

1.1 In principle, the following arrangements are permitted:

- 3 conductors, insulated from the structure
- 3 conductors with earthed neutral

Note:

In high voltage systems with insulated neutral, transient overvoltages relative to the hull / main structure may occur which are greater than in networks with earthed neutral. Even if these do not destroy the insulation, they shorten its service life.

1.2 High voltage systems are permitted only for permanently installed power plants.

1.3 It is to be possible to split the main switchboard into at least two independent sections, by means of at least one circuit breaker or other suitable disconnecting devices, each supplied by at least one generator. If two separate switchboards are provided and interconnected with cables, a circuit breaker is to be provided at each end of the cable.

Services which are duplicated are to be divided between the sections.

2. Systems with Earthed Neutral

2.1 The neutral point connection shall incorporate a resistance or other current limiting device, so that in case of a fault the earth-fault current is limited to the full-load current of the largest generator connected to the switchboard. However, the earth-fault current shall not be less than three times the minimum threshold current of the earth-fault monitor.

2.1.1 In order to fulfill the selectivity requirement expressed in B.7., measures shall be taken for installations with current-limited neutral earths to ensure selective disconnection of outputs in which an earth fault has occurred.

System earthing shall be effected by means independent of any earthing arrangements of the noncurrent-carrying parts.

Any earthing impedances shall be connected to the hull. The connection to the hull shall be so arranged that any circulating current in the earth connections do not interfere with radio, radar, communication and control equipment circuits. (Reference is made to TL- R E11 2.1.4)
If the system neutral is connected to earth, suitable disconnecting links or terminals shall be fitted so that the system earthing may be disconnected for maintenance or insulation resistance measurement. Such means shall be for manual operation only.

If the system is divided and neutral earthed, connection of the neutral to the hull is to be provided for each section.

If the system neutral is connected to earth at several points, equalising currents in the neutral earthing exceeding 20% of the rated current of connected generators or transformers is not acceptable. Transformer neutrals and generator neutrals shall not be simultaneously earthed in the same distribution system at same voltage level. On distribution transformers with star connected primary side, the neutral point shall not be earthed.

In any four wire distribution system the system neutral shall be connected to earth at all times when any consumer is connected. (Reference is made to IEC61892:2, sec. 5.4.2)

In case of earth fault in high voltage systems with earthed neutral, the current shall not be greater than full load current of the largest generator on the switchboard or relevant switchboard section and not less than three times the minimum current required to operate any earth fault protection relay.

Electrical equipment in directly earthed neutral or other neutral earthed systems shall withstand the current due to single phase fault against earth for the time necessary to trip the protection device.

2.1.2 In case of earth fault, the current is not to be greater than full load current of the largest generator on the switchboard or relevant switchboard section and not less than three times the minimum current required to operate any device against earth fault.

2.6 Design of the neutral point connection

2.6.1 All earthing impedances are to be connected to the hull.

The connection to the structure is to be so arranged that any circulating currents in the earth connections do not interfere with radio, radar, communication and control equipment circuits.

2.6.2 Generators for parallel operation may have a common connection for the neutral point.

For each isolatable busbar section directly supplied by generators, a separate neutral point connection shall be provided.
2.6.3 Earthing resistors shall be dimensioned for twice of the tripping time and shall be protected against overload and short circuit.

Short circuit protection is sufficient if the earthing resistor is dimensioned for continuous duty.

2.7 In the systems with neutral earthed, connection of the neutral to the hull is to be provided for each section.

3. Systems with Isolated Neutral Point

3.1 Since intermittent earth-faults can cause transient overvoltages in networks with an isolated neutral, endangered equipment shall be fitted with overvoltage protection for overvoltages of at least 3.3 times $U_n$.

3.2 All insulation (of cables, consumers, transformers, generators etc.) shall be designed for the phase-to-phase voltage, if earth-faults will not be isolated without delay.

4. Protection Equipment

The provisions of Sections 4 and 5 shall apply, as and where appropriate, to the selection of protective devices.

4.1 Faults on the generator side of circuit breakers

Protective devices are to be provided against phase-to-phase faults in the cables connecting the generators to the main switchboard and against interwinding faults within the generators. The protective device (differential protection) shall trip the generator circuit breaker and de-excite the generator.

In distribution systems with a neutral earthed, phase to earth faults are also to be treated as above.

4.2 Earth fault monitoring

Any earth fault in the system is to be indicated by means of a visual and audible alarm. In low impedance or direct earthed systems provision is to be made to automatic 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.

Note: Earthing factor is defined as the ratio between the phase to earth voltage of the health phase and the phase to phase voltage. This factor may vary between $(1/\sqrt{3})$ and 1.

A system is defined effectively earthed (low impedance) when this factor is lower than 0.8. A system is defined non-effectively earthed (high impedance) when this factor is higher than 0.8

4.3 Power transformers

4.3.1 The protective devices of power transformers are subject to the provisions of Section 4, D.

Power transformers are to be provided with overload and short circuit protection. When transformers are connected in parallel, tripping of the protective devices at the primary side has to automatically trip the switch connected at the secondary side.

4.3.2 Ship service transformers and transformers supplying the power section of a main propulsion drive shall be fitted with differential protection.

4.3.3 Transformers used for supplying primary essential consumers shall be fitted with winding temperature monitors.

4.3.4 Liquid-cooled transformers shall be fitted with protection against outgassing of oil.

4.3.5 The liquid temperature shall be monitored. An alarm shall be actuated before the maximum permissible temperature is attained. When the temperature limit is reached, the transformer shall be disconnected.

4.3.6 The liquid filling level shall be monitored by means of two separate sensors. The monitoring system shall actuate an alarm at the first stage and then cause disconnection at the second, when the permissible limit is exceeded.
4.3.7 Power transformers are to be provided with overload and short circuit protection. When transformers are connected in parallel, tripping of the protective devices at the primary side has to automatically trip the switch connected at the secondary side.

4.3.4 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.

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.

4.4 Voltage transformers for control and measuring purposes

4.4.1 Voltage transformers shall be protected on the secondary side against short-circuits and overload.

4.5 Fuses

Fuses are not to be used for overload protection.

4.6 Low-voltage networks

Low-voltage networks fed via transformers from a high-voltage network are to be protected against the overvoltages.

This may be achieved by;

- Direct earthing of the lower voltage system,

- Appropriate neutral voltage limiters,

- Earthed screen between the primary and secondary windings of transformers.

D. Electrical Equipment

1. General

1.1 Standstill heating

All equipment which may occasionally be taken out of service and is not located in heated and ventilated areas is to be equipped with a standstill heater. This heater should switch on automatically when the equipment is switched off.

1.2 Installation

See Section 2, F.

2. Switchgear

The space where high voltage switchboards are fitted shall be so arranged that hot gases escaping from the switchboard in case of an internal arc are led away from an operator in front of the switchboard.

Switchgear and controlgear assemblies are to be constructed according to the IEC 62271-200:2011 and the following additional requirements.

2.1 Mechanical Construction

Switchgear accessible for authorized persons only shall at least comply with accessibility type “A” of IEC 62271-200:2011; Annex AA; AA 2.2.

In accessible spaces by non-authorized persons, switchgear of accessibility type “B” shall be used. Besides this measures against unauthorized operation shall be provided.

Installation and location of the switchgear and controlgear shall correspond with its internal arc classification and classified sides (front, left and right).

2.1.1 Switchgear is to be of metal - enclosed type in accordance with IEC 62271-200:2011 or of the insulation
Switchgear supplying secondary essential or non-essential equipment may be of metal enclosed type.

Incorporated low voltage compartments for control and monitoring systems shall be separated from the high voltage part in such a way as to render impossible any contact with parts having a rated supply voltage of more than 1000 V.

For main high-voltage switchboards and distribution switchboards, type approval according to IEC publication 60298 shall be verified.

Switchgear supplying secondary essential or non-essential equipment may be of metal enclosed type.

### 2.1.2 Fully partitioned switchboards

All sections of an air-insulated high-voltage switchboard shall be partitioned with respect to each other and the surroundings so that they are arc-resistant. Continuous busbar compartments or switch compartments are inadmissible.

Each section shall be subdivided into at least three arc-resistant, partitioned function compartments: the terminal compartment, the switch compartment and the busbar compartment.

### 2.1.3 Partly partitioned switchboards

If the main high-voltage switchboard is subdivided into two independent and autonomous installations, a continuous busbar compartment is permissible, provided that a protection system (arc monitor, busbar differential protection) is installed which detects internal faults and isolates the affected part of the installation within 100 ms, respectively accidental arcing is reliably prevented by design measures (e.g. solidly insulated busbar systems).

### 2.1.4 Switchboards supplying primary essential consumers shall have the service continuity LSC 2 according to IEC 62271-200.

### 2.1.5 Evidence shall be provided that high-voltage switchboards have passed a type test according to IEC 62271-200. A modification of the construction of a switchboard requires re-testing. The same applies to modifications of the gas exhausting system.

### 2.1.6 Where drawout switchgear components are used, the following conditions shall be met:

- Functional testing and maintenance shall be capable of being performed in safety, even when the busbar is live.
- Withdrawable circuit breakers and switches are to be provided with mechanical locking facilities in both service and disconnected positions. For maintenance purposes, key locking of withdrawable circuit breakers and switches and fixed disconnectors is to be possible.
- Withdrawable circuit breakers are to be located in the service position so that there is no relative motion between fixed and moving portions.
- The fixed contacts of withdrawable circuit breakers and switches are to be so arranged that in the withdrawable position the live contacts are automatically covered.
- Shutters are to be clearly marked for incoming and outgoing circuits. This may be achieved with the use of colours or labels.

### 2.1.7 Doors which give access to high voltage are to be interlocked in such a way that they can be opened only after closing the earthing switch.

At the entrance of the spaces where high-voltage electrical equipment is installed, a suitable marking is to be placed which indicates danger of high-voltage. As regard the high-voltage electrical equipment installed out-side a.m. spaces, the 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 ceiling/deckhead above is to meet the requirements of the Internal Arc Classification according to IEC 62271-200:2011 (see 2.1).

Switchgear and controlgear assemblies shall be internal arc classified (IAC).

Where switchgear and controlgear are accessible by authorized personnel only Accessibility Type A is sufficient (IEC 62271-200:2011; Annex AA; AA 2.2). Accessibility Type B is required if accessible by non-authorised personnel.

Installation and location of the switchgear and controlgear shall correspond with its internal arc classification and classified sides (F, L and R).

2.1.8 For maintenance purposes an adequate number of earthing and short-circuiting devices is to be provided to enable circuits to be worked upon with safety.

Duplicated consumers shall be divided up amongst the isolatable switchboard sections.

Note:  
It is recommended that two different, spatially separated main switchboards, coupled via a transfer line, are used.

2.1.9 The partitioning of a gas insulated switchboard supplying primary essential equipment shall correspond with the requirements of an air insulated switchboard. Each gas volume shall be monitored.

A pressure drop shall be alarmed. Measures according to manufacturer’s instruction shall be initiated.

2.2 Auxiliary systems

2.2.1 Where electrical and/or mechanical energy is required for the operation of switches, a means of storing such energy must be provided, which is designed for at least two ON/OFF switching cycles of all the connected components.

In general, tripping due to overload, short circuit or undervoltage has to be independent of any stored electrical energy sources.

If shunt trip coils are used, the continuity of the tripping circuit has to be monitored. This does not preclude shunt tripping provided that alarms are activated upon lack of continuity in the release circuits and power supply failures.

2.2.2 Number of external supply sources

When external source of supply is necessary for auxiliary circuits, at least two external sources of supply are to be provided and so arranged that a failure or loss of one source will not cause the loss of more than one generator set and/or set of essential services.

The switch-over to the reserve source of energy shall be automatically and actuate an alarm. One uninterruptible power supply shall be fed from the emergency switchboard, and the other one from the main switchboard.

Where necessary one source of supply is to be from the emergency source of electrical power for the start up from dead ship condition.

2.3 Tests

2.3.1 A routine test in accordance with IEC 62271-200 shall be performed in the manufacturer’s works in the presence of a TL -Surveyor.

The manufacturer shall submit test results together with the final documentation for the equipment. The documentation shall give information on make, type, serial no., and all technical data necessary for the application of the switchboard or assembly, as well as the results of the required tests.

The following tests are required:

- function test: all basic functions, including auxiliary functions, shall be tested

- insulation resistance test
- high voltage test.

Switchboards and assemblies are subject to a visual inspection for verification of general workmanship, creepage and clearance distances, IP rating, ventilation and quality of materials and components.

A functional test of the interlocking conditions, protective functions, synchronization and the various operating modes shall be performed.

All circuits shall be verified installed as shown in the as- build documentation.

It shall be verified that supply transformers for control circuits without secondary side short circuit protection is sufficiently protected by the primary side protection. Such verification may be done by application of a short circuit on the secondary side.

Control and protection shall be tested for correct functioning.

A test schedule shall be compiled and submitted for approval.

2.3.2 It is recommended that a partial-discharge test is performed in accordance with IEC 62271-200, Annex B, if organic insulating materials or gas-insulated busbar penetrations are used.

2.3.3 High voltage test

A power-frequency voltage test is to be carried out on any switchgear and control gear assemblies. The test procedure and voltages are to be according to the IEC 62271-200:2011 section 7/ routine test.

A 1 minute high voltage test should be applied to a new and completed machine with all its parts in place under conditions equivalent to normal working conditions. The test should be in accordance with IEC 60034-1-9.2 "Withstand voltage test", and should be performed at the maker's works at the conclusion of the temperature-rise test.

For voltage levels to be employed, in normal (for ac windings of machines between 1 kW and 10 000 kW) the test voltage is 1 000 V + twice the rated voltage with a minimum of 1 500 V.

After rewinding or other extensive repair of a machine, it should be exposed to a high voltage test with a test voltage of at least 75% of that specified in IEC 60034-1-9.2.

On carrying out high-voltage test, it may be essential to short circuit semi-conductors to avoid damage of such parts.

2.4 Low voltage switchgear design

A low voltage switchboard shall be designed to withstand the short circuit forces for minimum 1 s, created by the short circuit current and magnitude at the particular point of the system without endangering the integrity of the outer switchboard enclosure.

2.4.1 If the unit/installation's low-voltage network is supplied from the high-voltage system, a circuit breaker for the longitudinal separation of the main busbar shall be provided.

The bus bar sections shall be supplied by circuit breakers suitable for isolation.

2.4.2 The arrangement of supply and consumer sections shall be in accordance with Section 5, C.2.

2.4.3 The feeder sections of the low-voltage switchboard shall be partitioned with arc-resistant segregations.

2.4.4 The unsynchronized connection of subnetworks and the feedback on the high-voltage side shall be prevented by means of interlocking.

2.4.5 Parallel operation of ship service transformers is only permissible for short-term load transfer, if also the high voltage sides of the transformers are connected. A forced splitting, independent of the automation system shall be provided.
**2.4.6** After black out of the supply of the main switchboard or a partial black out of bus bar sections in the low voltage main switchgear, the recovery of the power supply shall be performed automatically.

**2.4.7** If the black out of the supply is caused by a short circuit in the low voltage switchboard no automatic recovery shall be carried out.

**2.4.8** The manual connecting of the stand by supply shall be possible after the acknowledgement of short circuit trip.

**2.4.9** A stand by alarm shall be triggered, if components, necessary for the automatic recovery, are not available.

**2.4.10** A switching off of the high voltage circuit breaker shall cause the opening of the low voltage circuit breaker.

**2.4.11** The supply panels shall meet the requirements for generator panels of this Chapter analogously.

**2.4.12** The low voltage supply panels shall be equipped with a voltmeter and an ampere-meter. It shall be possible to display the currents and voltages of all three phases.

**2.4.13** The operation modes On, Off, Tripped and Ready shall be indicated by signal lights.

### 3. Switchboard Equipment

#### 3.1 General

Control circuit equipment is subject to the conditions laid down for low voltage switchgear (see Section 5).

#### 3.2 Circuit breakers

It shall be possible to operate the mechanical off of the circuit breaker having the doors closed.

Circuit breakers are to conform to IEC publication 62271-100.

### 3.2.1 Additional requirements

For drawout circuit breakers, see 2.1.5.

#### 3.2.2 Circuit breakers shall be interlocked with the associated earthing switch.

### 3.3 Load switch-disconnectors and isolating switches

Load switch-disconnectors and isolating switches shall conform to IEC publication 62271-102/103.

#### 3.3.1 Isolating switches shall be interlocked so that they can only be switched under no load. The use of load switch-disconnectors is recommended.

#### 3.3.2 Earthing switches shall have making capacity.

### 3.4 HVHRC fuses

Fuses shall normally comply with one of the following standards:

- IEC 60269 for low voltage fuses
- IEC 60282-1 for high voltage fuses.

HVHRC fuses shall conform to IEC publication 60282.

### 3.5 Power contactors

Power contactors shall conform to IEC publication 62271-106.

High voltage power contactor fuse combinations shall be dimensioned according to IEC publication 62271-106 subclause 5.107.3.4 damage classification “type c”.

Is the safety of the staff and the selective protection of the unit/installations grid ensured by connected upstream devices high voltage contactors supplying secondary or unessential consumers may be dimensioned according to “damage classification type a” of IEC publication 62271-106.
3.6 Current- and voltage transformers

3.6.1 Transformers shall conform to the following IEC publications:

- Current transformers, IEC publication 61869-2,
- Voltage transformers, IEC publication 61869-3.

3.6.2 Earthing of current- and voltage transformers

The secondary winding of every current- and voltage transformer shall be earthed by means of a copper conductor at least 4 mm² in cross-section.

Open delta windings shall only be earthed at one point.

3.7 Relays

Relays for measuring and protective devices shall conform to IEC publication 60255.

4. Electrical Machines

4.1 Design

4.1.1 Generator stator windings

Generator stator windings are to have all phase ends brought out for the installation of the differential protection.

4.1.2 Winding temperature monitoring

The stator windings of electrical machines are to be equipped with temperature detectors. Inadmissible temperature rises are to actuate visual and audible alarms. If embedded temperature detectors are used, means are to be provided to protect the circuit against overvoltage.

4.2 Terminal boxes

Terminals with operating voltages under 1000 V are to be provided with their own terminal boxes. Terminals are to be clearly marked.

4.3 Tests

In addition to the tests normally required for rotating machinery, a high frequency high voltage test in accordance with IEC 60034-15:2009 is to be carried out on the individual coils in order to demonstrate a satisfactory withstand level of the inter-turn insulation to steep fronted switching surges.

5. Power Transformers

For high voltage transformers, secondary side switchgear shall in general be interlocked with the switchgear on the primary side. This to ensure that the transformer will not be energised from the secondary side when the primary switchgear is opened. If backfeeding through transformers is arranged, special warning signs shall be installed on the primary side switchgear. Different generators shall not feed the different sides of transformers simultaneously (not locking generators in synchronism via a transformer).

5.1 Design

5.1.1 The design of power transformers shall conform to IEC publication 60076 relevant parts and the requirements of IEC 60092-303.

Transformers shall be double wound. Starting transformers and transformers feeding single consumers, as long as the secondary consumer has the same insulation level as the primary side, may be of autotransformer type.

5.1.2 In general dry-type transformers shall be used. They are to conform to IEC publication 60076-11. Where forced cooling is used, it shall be possible to operate at reduced power on failure of a pump or a fan. Exceptions are to be agreed with TL.

5.1.3 Only transformers with separate windings shall be used. Exceptions are auto-transformer starters.
All windings for air-cooled transformers shall be treated to resist moisture, sea air, and oil vapours.

5.1.4 Transformers producing a low voltage from a high voltage shall be equipped with an earthed shielding winding between the low voltage and high voltage coil.

5.1.5 If oil-cooled transformers are used, measures shall be taken to ensure that the windings are completely covered by oil, even for inclinations of 22.5°.

5.1.6 Oil immersed transformers are to be provided with the following alarms and protections:
- Liquid level (Low) - alarm
- Liquid temperature (High) - alarm
- Liquid level (Low) - trip or load reduction
- Liquid temperature (High) - trip or load reduction
- Gas pressure relay (High) – trip

5.2 Supply transformers

5.2.1 If the installation’s/unit’s low-voltage network is supplied from the high voltage network, at least two independent supply transformers, which fulfil the conditions expressed in Section 3, C.1., shall be installed.

5.2.2 Supply transformers shall be provided with instrumentation comprising a voltmeter and an amperemeter. It shall be possible to indicate the current and voltages of all three phases.

5.3 Tests

Power transformers shall be individually tested in the manufacturer’s works in the presence of a TL Surveyor.

5.3.1 The scope of the tests is as stated in Section 15, B and in the relevant IEC standard.

5.3.2 The test voltages shall be selected in accordance with Section 15, Table 15.7.

6. Cables

6.1 General

The construction of cables rated 1.8/3 kV for permanent installations shall normally comply with the requirements of IEC 60092-353:2016.

The construction and testing of high voltage cables rated above 1.8/3 kV for permanent installations shall normally comply with the recommendations of IEC 60092-354:2020.

6.1.1 High-voltage cables shall conform to IEC 60092-354:2020 or 60092-353:2016 or other equivalent standard.

6.1.2 High voltage cables are to be readily identifiable by suitable marking.

High voltage cables, in general, are to be installed on cable trays when they are provided with a continuous metallic sheath or armour which is effectively bonded to earth; otherwise they are to be installed for their entire length in metallic castings effectively bonded to earth.

Installation of high voltage cables in accommodation areas is not allowed unless required by the application. The necessity for special protection shall be assessed when high voltage cables are installed in accommodation areas, for prevention of harmful effects to personnel from cable short circuits, and strong electromagnetic fields. In accommodation spaces, high voltage cables are to be run in enclosed cable transit systems.

6.1.3 Segregation

High voltage cables are to be segregated from cables operating at different voltage ratings each other; in particular, they are not to be run in the same cable bunch, nor in the same ducts or pipes, or, in the same 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 given in Table 6.1.
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 and less.

6.1.4 Terminations

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).

6.2 Selection of cables

6.2.1 The rated voltage of a cable shall not be less than the rated operational voltage of the circuit in question.

6.2.2 In insulated-neutral networks, the phase-to-phase voltage (U) of the network shall be deemed to be the rated voltage (U₀) of the cable between one conductor and the hull respectively structure.

6.3 High voltage cable test after installation

Before a new high voltage cable installation, or an addition to an existing installation, is put into service a voltage withstand test is to be satisfactorily carried out on each complete cable and its accessories.

The test is to be carried out after an insulation resistance test.

For cables with rated voltage (U₀/U) above 1.8/3 kV (Uₘ=3.6 kV) an a.c. withstand test may be carried out upon advice from high voltage cable manufacturer. One of the following test methods to be used:

a) Test for 5 min with the phase-to-phase voltage of the system applied between the conductor and the metallic screen/sheath.

b) Test for 24 h with the normal operating voltage of the system. Alternatively, a d.c. test voltage equal to 4 U₀ may be applied for 15 minutes.

An insulation resistance test is then repeated.

The voltages for the high voltage test are indicated in Table 6.6.

E. Installation

1. General

See Section 2, F.

At the entrance of the spaces where high-voltage electrical equipment is installed, a suitable marking is to be placed which indicates danger of high-voltage. As regard the high-voltage electrical equipment installed out-side a.m. spaces, the similar marking is to be provided.

Where 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.

2. Cable Installation

2.1 Cable routes

High voltage cables shall not be run through the accommodation area. Cable layouts not adhering to this rule are to be approved by TL prior to the start of installation.
2.2 Separation of cables

Cables for high voltage systems are to be laid at a distance of at least 50 mm from low voltage cables.

Low voltage power cables shall not be bunched together with, or run through the same pipes as, or be terminated in the same box as, cables for high voltage.

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 and less.

(Reference is given to TL-R E11)

2.3 Installation design

2.3.1 High voltage cables laid in open cable trays must be provided with a continuous metal shield or armourings against mechanical damage; shields and armourings shall have an electrically conductive connection to the hull respectively structure.

2.3.2 High voltage cables without shield or armouring shall be laid in closed metal ducts or cable conduits, which are to have an electrically conductive connection to the hull respectively structure.

For the installation of single core cables for AC wiring the metal ducts shall be made of non magnetic material, unless the cables are installed in trefoil formation.

2.3.3 For bends, the minimum-bending radius permitted by the manufacturer shall be observed; if not specified then the bending radius shall be not smaller than 12 times of the outer diameters of the cables.

2.4 Marking of cable ducts and conduits

Ducts and conduits for high voltage cables are to be marked in accordance with Section 2, F.

2.5 Connections

2.5.1 As far as is feasible, all high voltage cable connections have to be covered with suitable insulating materials.

2.5.2 In terminal boxes, where the conductors are not insulated, the phases are to be separated from each other and from the structure’s potential by mechanically robust barriers of suitable insulating material.

2.5.3 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).

2.6 Sealing ends, joints and kits

2.6.1 For high voltage kits from 3.6 to 6 kV measures shall be taken to attenuate the electrical fields which occur at points where cable insulations are removed. (sealing ends)

2.6.2 The materials of sealing ends and joints shall be compatible to the corresponding cables.

2.6.3 The construction of joints has to permit the separate through-connection of all shields and armourings.

2.6.4 Sealing ends shall enable shields and armouring to be brought out.

2.6.5 The technical documentation and test Certificates of sealing ends and joints shall be submitted.

3 Tests

3.1 Tests following installation

When the installation work has been completed, high-voltage cables and its accessories are to undergo withstand tests in the presence of a TL Surveyor.

The test is to be carried out after an insulation resistance test.

Note: Compliance with the safety regulations for tests at high voltage is the responsibility of the person in charge.
3.2 Voltage withstand tests can be made using an a.c. or a d.c. voltage.

3.2.1 For cables with rated voltage (U0/U) above 1.8/3 kV (Um=3.6 kV) an a.c. voltage withstand test may be carried out upon advice from high voltage cable manufacturer. One of the following test methods to be used:

3.2.1.1 Test using the rated (phase-to-phase) voltage/frequency between conductor and the metallic screen/shield for a period of 5 minutes.

3.2.1.2 Test using the operating voltage of the system for a period of 24 hours.

3.2.2 D.C. voltage tests are divided according their rated voltage (U0/U) above and up to the value of 1.8/3 kV (Um = 3.6 kV) as below:

3.2.2.1 For cable with rated voltage above 1.8/3 kV (Um = 3.6 kV), d.c. test voltage equal to 4 U0 may be applied for 15 minutes.

3.2.2.2 For cable with rated voltage up to 1.8/3 kV (Um = 3.6 kV), d.c. voltage equal to 4 U0 shall be applied for 15 minutes.

3.3 The insulation resistance is to be measured before and after the high-voltage test (500 V /200 MΩ).

3.4 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.

An insulation resistance test is then repeated.
### Table 6.6  Test voltages for high voltage cables

<table>
<thead>
<tr>
<th>Max. system voltage $U_m$</th>
<th>kV</th>
<th>1,2</th>
<th>3,6</th>
<th>7,2</th>
<th>12</th>
<th>17,5</th>
<th>24,0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage $U_o/U$</td>
<td>kV/kV</td>
<td>0,6/1,0</td>
<td>1,8/3,0</td>
<td>3,6/6,0</td>
<td>6,0/10,0</td>
<td>8,7/15</td>
<td>12,0/20,0</td>
</tr>
<tr>
<td>AC test voltage</td>
<td>kV</td>
<td>3,5</td>
<td>6,5</td>
<td>11,0</td>
<td>15,0</td>
<td>22,0</td>
<td>30,0</td>
</tr>
<tr>
<td>DC test voltage</td>
<td>kV</td>
<td>8,4</td>
<td>15,6</td>
<td>26,4</td>
<td>36,0</td>
<td>52,8</td>
<td>72,0</td>
</tr>
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</table>

**Notes**

- $U_0$: rated voltage between conductor and earth or metal shield.
- $U$: rated voltage between the conductors for which the cable is designed.
SECTION 7

POWER ELECTRONICS

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A. **Scope/Definitions**

For power electronics in electrical propulsion plants, see Section 12.

B. **Construction**

1. The requirements set out in Section 5 – Low Voltage Switchgear are to be observed, wherever applicable.

2. Every power electronics system is to be provided with separate means for disconnection from the mains.

   In the case of consumers up to a nominal current of 315 A, combination fuse-contactors may be used. In all other cases a circuit breaker is to be provided on the mains side.

3. Equipment is to be readily accessible for purposes of measurement and repair. Devices such as simulator circuits, test sockets, indicating lights, etc. are to be provided for functional supervision and fault location.

4. Control and alarm electronics shall be galvanically separated from power circuits.

5. External pulse cables are to be laid twisted in pairs and screened, and kept as short as possible.

C. **Rating and Design**

1. Mains reactions of power electronics facilities are to be taken into consideration in the planning of the overall installation, see Section 1, F. and H. Attention is drawn to the TL Rules, Additional Rules and Guidelines, Guidelines for the Electromagnetic Compatibility of Electrical Equipment.

2. Rectifier systems shall guarantee secure operation even under the maximum permissible voltage and frequency fluctuations, see Section 1, F. In the event of unacceptably large frequency and/or voltage variations in the supply voltage, the system must shutoff or remain in a safe operating condition.

3. For the supply of mains, number and rating of electronic facilities are to be so scaled that in the event of failure of any one power electronics facility the remainder of the installation is sufficient to

   - feed all essential equipment which may be in simultaneous operation with the propulsion plant at full power
   - start the biggest consumer without exceeding the maximum permissible voltage and frequency variations

   To maintain the required availability, bypass switching may be resorted to.

4. Semiconductor rectifiers and associated fuse are to be so selected that their load current is at least 10% less than the limit current determined in accordance with the coolant temperature, the load and the mode of operation.

5. The permissible periodic peak blocking voltage of the individual component shall be greater by a factor of at least 1,8 than the peak value of the undistorted supply voltage. This value may be reduced for static converter circuits with separate power supplies.

6. Electrical charges in power electronics modules shall drop to a voltage of less than 50 V in a period of less than 5 s after disconnection from the mains supply. Should longer periods be required for discharge, a warning label is to be affixed to the appliance.

7. If the replacement of plug-in printed circuit boards while the unit is in operation can cause the destruction of components or the uncontrolled behaviour of drives, a caution label shall be notifying to this effect.

8. The absence of external control signals, e.g due to a circuit break, shall not cause a dangerous situation.
9. Control circuit supplies are to be safeguarded against unintended disconnection, if this could endanger or damage the plant.

10. It is necessary to ensure that, as far as possible, faults do not cause damage in the rest of the system, or in other static converters.

10.1 Special attention shall be paid to the following points:

- mutual interference of static converters connected to the same busbar system
- calculation of commutating impedances reacting to voltage distortion and to other consumers
- the selection of the ratio between the subtransient reactance of the system and the commutating reactance of the static converter
- consideration of reactions from rectifier installations on the commutation of DC machines
- consideration of voltage drops in the mains due to inverter operation
- influence by harmonics and high-frequency interference
- influence on the installation's/unit's mains by energy feeding back

10.2 Where filter circuits and capacitors are used for reactive current compensation, attention is to be paid to the following:

- reaction on the mean and peak value of the system voltage in case of frequency fluctuations
- inadmissible effects on the voltage regulation of generators

D. Cooling

1. Natural cooling should be chosen where possible.

Where electrical equipment depends on additional cooling, the following shall be complied with:

- an alarm shall be initiated when auxiliary cooling or ventilation motors stop running. Alternatively a flow monitoring alarm shall be initiated.
- the windings in the cooled equipment for essential services shall be fitted with temperature detectors for indication and alarm of winding temperature.
- the windings in the cooled equipment for important services shall be fitted with temperature detectors for alarm at high winding temperature.

Where the cooling of electrical equipment depends on general room ventilation only, temperature detectors in the equipment are not required.

2. The safety in operation is to be proven for liquid cooling and forced cooling.

3. An impairment of cooling shall not result in unacceptable over-temperatures; an over-temperature alarm shall be provided.

E. Control and Monitoring

1. Control, adjustment and monitoring shall ensure that the permissible operating values of the facilities are not exceeded.

2. The power supply to all control circuits is to be monitored for voltage failure.

3. For the monitoring of individual modules and assemblies of essential equipment, devices are to be provided which in the event of a fault facilitate its recognition.
4. The control shall be so engineered that the installation is protected from damage during the switching-on and switching-off sequence, dedication alterations and faulty operation.

F. Protective Equipment

1. Power electronics equipment shall be protected against exceeding of their current and voltage limits.

For protective devices, it shall be ensured that upon activating

- the output will be reduced or defective system parts will be selectively disconnected
- drives will be stopped under control
- the energy stored in components and in the load circuit cannot have a damaging effect, when switching off.

2. In equipment with a current rating of more than 100 A, each bridge arm or parallel-connected valve shall have a special semiconductor fuse. Exceptions are quenching circuits in self-regulating systems and converters operated with a load-independent current. For all other equipment, fuses on the input/output side may also be used.

3. Special semiconductor fuses are to be monitored. After tripping, the equipment has to be switched off, if this is necessary for the prevention of damage. Activating of a safety device shall trigger an alarm.

4. Equipment without fuses is permissible if a short circuit will not lead to the destruction of the semiconductor components.

G. Tests

1. General

Power electronics assemblies are to be individually tested at the maker’s works. A Works Test Report is to be provided for the tests carried out. Essential equipment from 50 kW/kVA upwards is to be tested in the presence of a TL Surveyor.

2. Extent of Routine Tests

2.1 Voltage test

Prior to the start of the functional tests, a high-voltage test is to be carried out. The RMS value of the alternating test voltage is:

\[ U = 2 \ U_n + 1000 \text{ V}, \text{ duration 1 minute,} \]

but at least 2000 V, where \( U_n \) is the maximum nominal voltage between any two points on the power electronics device.

For this purpose, switchgear in power circuits is to be bridged, and the input and output terminals of the power electronics devices and the electrodes of the rectifiers are to be electrically connected with each other. The test voltage is to be applied between the input/output terminals or between the electrodes and

- the cabinet
- the mains connection side, if the power electronics device is electrically isolated from the mains

2.2 Insulation resistance test

Following the voltage test, the insulation resistance is to be measured at the same connections as for the voltage test. The measurement is to be performed at a voltage of at least 500 V DC. Insulation resistance requirements see IEC 60140-1-1 or equivalent.

2.3 Operational test

Correct functioning is to be demonstrated as far as possible.

2.4 Testing of protection and monitoring devices

The response thresholds and the coordinated operation of the protective and monitoring devices are to be demonstrated.
## SECTION 8

### AUXILIARY EQUIPMENT

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A. **Auxiliary Equipment Installations**

1. **Fire Extinguishing Systems**

1.1 **Fire pumps**

1.1.1 The power supply to the fire pump motors and control systems with regard to both the assignment of power sources and the routing of power cables is to be so arranged that a fire in any fire zone does not render all the fire pumps unserviceable.

1.1.2 Automatically started fire pumps shall also be capable of being started by hand from the fire extinguishing control station.

If remote starting is provided for fire pumps, pump controls shall be so designed that in the event of failure of the remote control the local control remains operative. Regarding remote starting of fire pumps on installations/units with unattended engine room see Section 9.

1.2 **Sprinkler fire extinguishing systems**

1.2.1 For the design of sprinkler systems, see also Chapter 63, Section 10.

1.2.2 For automatic fire extinguishing systems, the pump and compressor drives shall be supplied via one direct power cable each from the main and from the emergency switchboard. Should the main power supply fail, the supply shall be automatically switched to the emergency switchboard.

1.2.3 If the hydraulic pressure in the system drops, the pressure water pump shall be started automatically.

1.2.4 Provision shall be made for supplying the associated fire alarm, fire detection and other systems both from the main generators and from the emergency power source.

The requirements of Section 9 are applicable in analogous manner to the design of the fire alarm system.

1.2.5 The switches on the main and emergency switchboards required for the power supply to all units forming part of the alarm and extinguishing systems shall be clearly marked.

1.2.6 The supply cables to the pumps should not be routed through galleys, engine rooms and other spaces with an increased fire hazard unless this is essential to connect them to the switchboards.

1.2.7 For cable laying, see Section 11, D, 1.

2. **Fans**

Electric motors driving fans shall be placed outside the ventilation ducts. Ventilation fans shall be of non-sparking type.

2.1 Power ventilation of accommodation spaces, service spaces, storerooms, control stations, machinery rooms, and hazardous areas shall be capable of being stopped from an easily accessible position outside the spaces being served and with maximum security against being cut off in case of fire.

The switches for disconnecting the power ventilation of the machinery spaces shall be separate from the switches for stopping the other fans.

2.2 It is recommended that one of the engine room fans should be supplied from the emergency power source to permit the extraction, should the need arise, of inert gases used for fire extinguishing.

3. **Fuel Pumps and Separators**

The drive motors of fuel pumps and fuel and lubricating oil separators shall be stopped from outside the spaces concerned. The control circuits are subject to the requirements of Section 4, I, 8.

4. **Bilge Pumps**

4.1 Where submersible bilge pumps are electrically driven, their motors and connecting cables shall be suitable for underwater operation. The cables are to be laid in one continuous length from a position above the highest anticipated waterline to the motor and are to enter the bell, if any, from below.
4.2 Bilge spaces shall in every case be equipped with a level alarm.

5. Pumps Discharging Overboard

The motors of pumps discharging overboard, whose outlets are located in the lifeboat launching area above the waterline, are to be equipped with emergency switches housed in a glass-covered box at the lifeboat or liferaft launching station. Control circuits are subject to the requirements of Section 5, E.

6. Turning Gear

6.1 See also Chapter 63, Section 1, D.10.

6.2 The turning gear shall be equipped with a device which prevents the diesel engine from being started as long as the turning gear is engaged.

6.3 The remote control of electrically driven turning gear shall be so designed that the gear motor stops immediately, if the switch or push-button is released.

6.4 A disconnecting switch shall be fitted near the drive unit.

B. Cargo Winches and Cranes

See Chapter 62, Section 8 – Crane and Crane Support Structures and the TL Rules, Chapter 50, Rules for Lifting Appliances.

National regulations are to be complied with, wherever applicable.

C. Free Fall Lifeboat Launching Equipment

If the lifeboat launching device operates without the force of gravity, stored mechanical energy or manual swinging effort, the device shall be connected to the installation’s/unit’s main and emergency source of electrical power. See also Chapter 60, Section 9 and Chapter 61, Section 5.

D. Electrical Heating Equipment and Heaters

1. Space Heating

Space heaters shall in general be of the convection type, and suitable for installation on bulkheads. Radiation heaters and other space heater types may be accepted after consideration in each case.

1.1 For the supply to heaters see Section 4; for the construction of heating appliances see Section 15, J.

1.2 Hooks or other devices on which garments can be hung may not be fitted above space heaters.

1.3 Where heaters are installed inside the bulkhead lining, a tray made of incombustible material shall be fitted behind the heater to prevent the accumulation of heat behind the lining.

1.4 Only heaters with IP 44 class enclosure as a minimum requirement may be used in washrooms, bathrooms, other wet rooms and machinery spaces.

1.5 In the case of ceiling-mounted heaters, it is essential to ensure that the heat is radiated downwards. An insulating layer of incombustible material shall be fitted above the heater. The heating elements are to be protected against accidental contact.

2. Oil and Water Heaters

Electric oil heaters shall normally be installed as separate units. Heating by electric heating elements in the offshore unit’s oil tanks is in general not allowed, but may be accepted after special design assessment of the arrangement in each case.

Water heaters shall in normal be insulated heating elements and shall be installed as separate units.

Oil and water heaters are subject to the requirements of Section 15, J.
SECTION 9

CONTROL, MONITORING and SAFETY SYSTEMS

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A. General Requirements

1. Scope

1.1 This Section contains requirements for the equipment and design of control, monitoring and safety systems necessary for the operation of offshore units and installations.

1.2 Alarms and indicators should be installed in accordance with the "Code on Alerts and Indicators, 2009", adopted by the Organization by resolution A.1021(26).

2. Design Criteria

2.1 The requirements laid down for each component and system depend on their use and the process-technological conditions. These Rules stipulate the minimum requirements for these.

2.2 If special operating conditions call for a particular system design, TL reserve the right to impose additional requirements, depending on the operational and system-specific considerations.

2.3 The design of safety measures, open and closed loop controls and monitoring of equipment shall limit any potential risk in the event of breakdown or defect to a justifiable level of residual risk.

2.4 Where appropriate, the following basic requirements shall be observed:

- Compatibility with the environmental and operating conditions

- Compliance with accuracy requirements

- Recognizability and constancy of the parameter settings, limiting and actual values

- Compatibility of the measuring, open and closed loop controls and monitoring systems with the process and its special requirements

- Non-critical behaviour in the event of power failure and power restoration

- Unambiguous operation

- Maintainability, traceability of faults and test capability

- Reproducibility of values

2.5 Automatic intervention shall be provided where damage cannot be avoided by manual intervention.

2.6 If danger to persons or to the safety of the installation/unit arising from normal operation or from malfunctions cannot be ruled out, safety devices or safety measures are required.

2.7 If danger to machinery and systems arising from faults or malfunctions in control, monitoring and measuring systems cannot be ruled out, protective measures are required.

2.8 Where mechanical systems or equipment are either completely or partly replaced by electric/electronic equipment, the requirements relating to mechanical systems and equipment according to Chapter 5 shall be met accordingly.

3. Construction

3.1 Alarm systems, protection and safety systems, together with open and closed loop control systems for essential equipment shall be constructed in such a way that faults and malfunctions affect only the directly involved function.

This applies also to measuring facilities.

3.2 For machinery and process systems which are controlled remotely or automatically, control and monitoring facilities shall be provided to permit manual operation.
3.3 After disturbances or shutdowns an automatic reset is prohibited. A local manual reset is required especially for process installations.

3.4 The design of safety devices is to be as simple as possible and must provide reliable operation.

Proven safety devices which are not depending on a power source should be preferred.

3.5 The suitability and function of safety devices shall be demonstrated in the given application.

3.6 Safety devices shall be designed so that potential faults such as loss of power or a broken wire do not create a hazard to human life or to the unit or installation. These faults as well as the tripping of safety devices shall be signalled by an alarm.

3.7 The adjustment facilities for safety devices have to be designed so that the last setting can be traced.

3.8 Where auxiliary energy is needed for the function of safety devices or systems, this has to be monitored and a failure has to be alarmed. An uninterruptible power supply has to be provided.

3.9 Safety systems as well as safety devices shall be independent of other systems of open and closed loop control and alarm systems. Faults in one system shall not affect other systems.

3.10 Safety systems shall be designed fail-safe, where applicable, i.e. the closed circuit principle has to be applied. Fail-safe conditions have to be determined before. In case of not defined fail-safe conditions, the monitored working current principle may be applied instead of the closed circuit principle, e.g. for propulsion systems of self-propelled units or control of fire extinguishing facilities (CO2).

4. Maintenance

4.1 Access must be provided to all facilities to allow measurements and repairs to be carried out. Facilities such as simulation circuits, test jacks, pilot lamps, etc. are to be provided to allow functional checks to be carried out and faults to be located.

4.2 The operational capability of other facilities shall not be impaired as a result of maintenance procedures.

4.3 Where the replacement of circuit boards in equipment which is switched on may result in the failure of components or in the critical condition of systems, a warning sign shall be fitted to indicate the risk.

4.4 Circuit boards and plug-in connections shall be protected against unintentional mixing up. Alternatively they shall be clearly marked to show where they belong to.

5. Tests

5.1 The suitability of systems and equipment is to be demonstrated by tests in the manufacturer’s works and on site.

5.2 Factory acceptance test

5.2.1 Manufacturers shall ensure that their products meet the specified requirements and shall carry out and keep records of quality control tests.

5.2.2 In the case of extensive systems, tests are to be carried out in the presence of a TL Surveyor on the basis of the approved technical documents, i.e. test procedure. These tests will be specified in each case depending on the application and scope of the system. Exception to this rule may be type-tested equipment as per TL requirement or another institution acknowledged by TL.

5.3 On Board / On Site tests

Tests are to be carried out on board / on site on the basis of approved documents in the presence of the Surveyor. Functions are to be checked in a coordinated operation with the peripheral equipment.

Test procedures have to be approved by TL.
B. Communication Systems

1. Internal Communications

1.1 An internal communication system is to be provided for exchanging information between all rooms and working places.

1.2 Internal means of communication is to be available for transfer of information between all spaces where action may be necessary in case of an emergency. The power supply to the system shall be automatically switched to the emergency power source.

1.3 All types of MODUs shall be fitted with efficient means of communication between the control room, the bridge (if provided) and position or positions fitted with facilities for operation of radio equipment.

1.4 For column-stabilized units, a permanently installed means of communication, independent of the unit's main source of electrical power, shall be provided between the central ballast control station and spaces that contain ballast pumps or valves, or other spaces that may contain equipment necessary for the operation of the ballast system.

1.5 For self-elevating units, a communication system shall be provided between the central jacking control and a location at each leg.

1.6 For surface and column-stabilized units, reliable means shall be provided to communicate between locations critical to the anchoring operation.

1.7 Radiocommunication and navigation

The navigation equipment and for distress and safety radiocommunications between mobile offshore drilling units and coast stations, ships and supporting aircraft should comply with MODU Code Chapter 11.

2. Public Address System

2.1 A public address system shall be provided. The system shall be clearly audible in all spaces that are normally accessible to personnel during routine operations. It shall be possible to make announcements at the following locations (if provided):

- Emergency response centre,
- Navigation bridge,
- Engine control room,
- Ballast control station,
- Jacking control station, and
- A location near the drilling console.

The public address system is to be a loudspeaker installation enabling the broadcast of messages into all spaces where personnel are normally present and muster stations. It is to allow for the broadcast of messages from stations indicated above. It is to be installed with regard to acoustically marginal conditions and not require any action from the addressee. It is to be protected against unauthorized use.

The minimum sound pressure levels for broadcasting emergency announcements are to be:

- In interior spaces 75dB(A) and at least 20dB(A) above the speech interference level; and
- In exterior spaces 80dB(A) and at least 15dB(A) above the speech interference level.

The gas detectors shall be linked to an audible and visual alarm system, with indications on the drill floor and at the main control station. The alarm system's purpose shall clearly indicate the gas hazard's location and concentration. The combustible gas detectors shall set off an alarm at no more than 25% and no more than 60% of the lower explosive limit (LEL).

2.2 If the public address system is used to announce the general emergency alarm, the following requirements shall be fulfilled:

2.2.1 The requirements for the general emergency alarm shall be satisfied.

2.2.2 At least two amplifiers are to be provided, each of them separately supplied and fused.
2.2.3 At least two loudspeaker circuits, supplied from separate amplifiers, are to be installed in each fire zone, respectively in its subdivisions.

The loudspeaker circuits are to be so arranged that transmission at a reduced loudness is maintained in the event of a failure of an amplifier or loudspeaker circuit.

2.2.4 Where loudspeakers with built-in volume controls are used, the volume controls must be disabled by the release of the alarm signal.

2.2.5 It shall be possible to transmit the undistorted and clearly audible alarm signal at all times. Other simultaneous transmissions must be automatically interrupted.

- It shall be possible to operate all loudspeakers at the same time.
- The loudspeaker system shall be designed under observance of the minimum required sound level.
- Announcement via microphone shall be free of acoustical feedback and other disturbances.
- Audible signals in high noise areas should be supplemented with visual signals. Internal means of communication should be available for transfer of information between all spaces where action may be necessary in case of an emergency.

3. Alarm System

3.1 General Alarm System

On all units or installations an alarm system shall be provided to alert the crew or to call them to the assembly points. It shall be possible to release the alarm from the central control station and also from strategically important locations.

3.2 Each unit should be provided with a general alarm system so installed as to be clearly perceptible in all normally accessible parts of the unit, including open decks. Alarm signal devices are to be provided which will produce a distinctive and strong note.

Control stations for activating the alarm should be installed to the satisfaction of TL.

The signals used should be limited to:

- General emergency,
- Toxic gas (hydrogen sulphide),
- Combustible gas, fire alarm, and
- Abandon unit signals.

These signals should be described in the muster list and operations manual.

The signals given over the general alarm system should be supplemented by instructions over the public address system.

3.3 The elements of the alarm system have to be designed independently, but shall be connected by a bus system. The use of a common control panel is permitted.

The emergency alarm system shall at least consists of:

- Manual alarm devices
- Lines from detector and shutdown systems
- Central alarm unit receiving and evaluating input signals and creating output signals to alarm sounding devices
- Alarm sounding devices such as bells, flashing lights and/or loudspeakers
- Power supply.

The alarm system may be combined with the public address system, provided that:

- Alarms automatically override any other input (emergency announcements are allowed to mute the alarm)
Volume controls are automatically set for alarm sounding

All parts of the public address system (e.g. amplifiers, signal cables and loudspeakers) are made redundant

Redundant parts are located and routed separately

All branches are individually protected against short circuits.

Means for announcement shall be provided in a sufficient number to ensure that all persons inside the installation/unit and on deck are alerted. In noisy rooms, additional visual means of alarm may be necessary.

Note:
Regarding the required sound pressure level the IMO LSA Code (Resolution MSC.48/66), as amended, shall be observed.

Once released, the alarm shall sound continuously until it is switched off manually or is temporarily interrupted for an announcement through the public address system.

Entertainment systems shall be automatically turned off if the general emergency alarm is announced.

Cables for general emergency alarm installations and for loudspeaker systems shall be fireresistant.

The required internal communication and alarm systems shall be powered from the main power system and from a monitored uninterruptible power supply (UPS) for continuous operation on loss of main power. The UPS shall be powered from the emergency power system for a period of at least 18 hours and have a capacity as a stand-by power sufficient to operate the system for at least 30 minutes.

At least in the following spaces general alarm is to be capable of being operated:

(a) Main control station;
(b) Drilling console;
(c) Navigating bridge (if any); and
(d) Fire control station (if any).
(e) Mud processing area
(f) Well test area

3.9 Mud system level alarms

A suitable audible and visual alarm to indicate significant increase or decrease in the level of the contents of the mud pit is to be provided at the control station for drilling operations and at the mud pit. Equivalent means to indicate possible abnormal conditions in the drilling system may be considered by TL.

3.10 Ventilation system alarm

Refer to Ch. 64, Sec 13, E 1.9 “Ventilation Alarms”.

C. Safety Systems

1. Overall Safety and Monitoring System

1.1 An integration of the safety systems of a unit/installation described in the following shall be established by an overall safety and monitoring system.

1.2 The integration of the safety systems shall be designed in co-ordination with TL. The different safety systems shall be connected by a bus system as data link but shall work without repercussion to each other.

1.3 For the design principles of the different safety systems and especially also the emergency shut down system (ESD) see Chapter 63, Section 16.

1.4 Power supply via UPS may be required for safety systems, e.g. ESD, fire detection, gas detection, depending on the system design.
2. Fire Detection and Fire Alarm System

2.1 Design

2.1.1 The requirements for fire detection and fire alarm systems of mobile offshore units are defined in the TL Rules, Chapter 5 – Electric, Section 9, D.3. For fixed offshore structures the requirements in the following apply.

Spaces having a fire risk, in principle, should be provided with an automatic fire detection and alarm system.

In selecting the type of detectors, their following features should be taken into account:

(a) Capability to detect fire at the incipient stage;
(b) Ability to avoid spurious alarm and trips; and
(c) Suitability to the located environment.

2.1.2 Central fire control panels and fire detectors which are used shall be approved by TL. Manual call points and automatically activated fire detectors are to be used in fire detection and alarm systems. Automatic detectors shall be activated by heat, smoke or other combustion products, flames or any combination of these factors. Detectors activated by other influences may be approved if their sensitivity is not less than that of the approved detectors. Flame detectors may only be used in addition to the prescribed detectors unless they are installed in areas where other detectors would be ineffective.

A fixed fire detection and fire alarm system should be installed in:

2.1.2.1 periodically unattended machinery spaces; and
2.1.2.2 the main propulsion and associated machinery, including the main sources of electrical power, are provided with various degrees of automatic or remote control and are under continuous manned supervision from a control room.

2.1.3 . The fire detection main indicator board is to be at a manned control station and is to be clearly to indicate where fire has been detected.

An automatic fire detection and alarm system should be provided in all accommodation and service spaces. Accommodation spaces should be fitted with smoke detectors.

2.1.4 Additional remote display panels may be necessary at safety stations and other control stations.

Sufficient manual fire alarm stations should be installed at suitable locations throughout the unit.

2.1.5 Clear information shall be displayed at the central fire control panel and at each display panel, indicating which rooms are monitored and the location of the individual sections.

2.1.6 The fire detectors are to be grouped in sections or detecting loops.

A fire alarm section monitoring a service area or an accommodation area shall not include a machinery space of category A.

2.1.7 The activation of a fire detector shall trigger a visual and audible alarm at the central fire control panel and at the additional remote display panels.

For all operating, service and accommodation areas, this alarm shall normally be passed on to the crew manually using the signalling facilities of the general alarm system. However, if the fire alarm at the central control panel is not acknowledged within 2 minutes, the fire alarm shall be automatically transmitted to all areas of the unit via the general alarm system or shall be audibly and visually signalled via another system suitable for this purpose.
Fire detectors are to be fitted in normally unattended machinery spaces.

Detection systems using only thermal detectors in machinery spaces, in general, are not to be permitted. An automatic fire detection and alarm system shall be provided in all accommodation and service spaces. Accommodation space shall be installed with smoke detectors. Thermal detectors shall be installed in galleys.

Smoke detectors are to be provided in all electrical rooms and control stations.

Flame or thermal detectors shall be installed in open drilling and/or mud processing areas. Smoke detectors may be utilized in enclosed mud processing areas.

2.1.8 The audible fire alarm signal shall be clearly distinguishable from all other signals.

2.1.9 Each detecting loop shall not include more than one fire zone or one watertight compartment and wherever possible, not more than two superimposed decks. Where there are separate facilities for flooding different machinery spaces with gaseous extinguishing agents (e.g. CO₂), separate detecting loops are also to be provided. The number of detectors grouped in each loop within a machinery space should not exceed ten.

2.1.10 Detectors should not be mounted close to ventilation outlets or in positions where the flow of air may affect their operation, or where they are liable to suffer mechanical damage.

Ceiling-mounted detectors shall normally be located at least 0,5 m from bulkheads.

The maximum distance between detectors (and the maximum area monitored) shall not exceed the following figures:

- For heat detectors: 9 m (37 m²)
- For smoke detectors: 11 m (74 m²)

The distance from bulkheads shall not exceed

- For heat detectors: 4,5 m

2.1.11 The following types of detectors may be used as automatic fire detectors:

- Ionization/smoke detectors for all enclosed operating areas, store rooms, stairways, passageways and escapes within accommodation areas

- Heat detectors, preferably in galleys, sleeping rooms and day rooms

- Differential and flame detectors for operating areas subject to high air speeds and for areas in the open

2.1.12 Sufficient manual fire alarm stations are to be installed throughout the accommodation spaces, service spaces and control stations. One manually operated call point is to be located at each exit. Manually operated call points are to be readily accessible in the corridors of each deck such that no part of the corridor is more than 20 m from a manually operated call point. Measures are to be taken to prevent inadvertent operation of the manual call alarm system.

If manual call points are not sufficiently well lit by emergency lighting close-by, they are to be provided with an indicator lamp.

2.1.13 In workshops and rooms where the activation of detectors is liable to be caused by, for example, welding work, the detectors may be rendered temporarily inoperative. After the expiry of a pre-selected time the detectors shall automatically become operative again.

2.1.14 The fire detection system in periodically unattended machinery spaces for all types of units is defined in Section 12 F.

2.2 Central fire control panel

2.2.1 The installation shall be supplied directly by separate cables from the main and the emergency power supply system. Provision is to be made in the central fire control panel for automatic switch-over to
take place should one of the supplies fail. The switchover shall be signalled visually and audibly.

Cables forming part of the fire detection system are to be so arranged as to avoid galleys, category A machinery spaces and other closed spaces with a high fire risk, except if it is necessary to transmit a fire signal from these spaces, to initiate a fire alarm in these spaces, or to make the connection to the appropriate source of electrical power.

2.2.2 A signal at the central control panel shall indicate that the system is operative.

2.2.3 Each detecting loop is to be provided with its own visual display.

2.2.4 The audible and visual signals shall be maintained until they are acknowledged at the central fire control panel. The acknowledgement shall not suppress further alarms in other detecting loops.

2.2.5 The central station shall be provided with means for testing and disconnecting of individual detectors or detecting loops. When a particular detector / detecting loop is disconnected, this shall be clearly indicated.

2.2.6 The failure or disconnection of a detecting loop shall not affect the operation of another detecting loop.

2.2.7 Detectors responding simultaneously shall not impair the operation of the equipment.

2.2.8 The fire detection system shall be so constructed that any faults which occur, e.g. a supply failure, short circuit or wire breakage in detecting loops, removal of a detector from its socket or an earth fault in detecting loops insulated on all poles, are signalled visually and audibly at the central fire control panel. Fault alarms are to be acknowledgeable and, wherever possible, distinguishable from a fire alarm.

2.2.9 Fire detection systems with a loop-wise indication shall be so designed that

- A loop cannot be damaged at more than one point by a fire - Equipment is available which ensures that a fault in the loop (e.g. wire break, short circuit, earth fault) does not cause failure of the entire loop

- All possible precautions have been taken to allow the function of the system to be restored in the event of a failure (electrical, electronic, affecting data processing)

- The first fire alarm indicated does not prevent the indication of further alarms by other fire detectors.

2.2.10 Where the detectors in the alarm mode are not all simultaneously indicated at the central fire alarm panel, the central panel shall have the means of scanning all the detectors which have responded in order to establish clearly whether other detectors are in the alarm mode besides the one indicated.

2.3 Fire detectors

2.3.1 The following types of detectors may be used depending on local conditions:

- Ionization detectors and optical smoke detectors which respond to a fire even in the initial phase

- Differential detectors which respond as soon as a given temperature rise per unit time is exceeded

- Heat detectors which respond when a predetermined limit temperature is exceeded

- Flame detectors activated, for example, by the infrared or ultraviolet radiation of naked flames

- Manual call points.

2.3.2 The sensitivity of automatic detectors, either individually or in groups, shall be adaptable to local conditions.
2.3.3 Unless the central fire control panel shows which detector has been activated, each detector shall itself be provided with a visual indicator. This signal shall be maintained pending acknowledgement at the central control panel.

2.3.4 All fire detectors shall be so constructed that, after the prescribed regular testing, they are once more serviceable without having to change components.

2.3.5 Where addressable detectors are used, each such detector shall be indicated at the central fire alarm panel, and the audible alarm according to regulations must be initiated.

3. **Fire Door Closing System**

3.1 The Construction Rules Chapter 4 - Machinery Section 10, B shall be observed.

3.2 Electrical power shall be supplied from the emergency electrical power supply.

3.3 Address units of a fire zone shall be combined to one loop, if the control and/or the display of a fire door work on an address unit of the fire alarm system. Fire resistant cables shall be used, if the display on the bridge works on this address unit.

4. **Indicator System for Fire Doors**

4.1 For all fire doors in main vertical zone bulkheads, galley boundaries and stairway enclosures an indication shall be provided at an indicator panel in a continuously manned control station whether each of the remote-released doors are closed.

4.2 Electrical power shall be supplied from the emergency electrical power supply.

5. **CO₂ Alarm Systems**

5.1 For the general design of CO₂ alarm systems, see Chapter 63, Section 10.

5.2 For machinery spaces, boiler, cargo pump rooms and similar spaces audible alarms of horn or siren sound and optical alarms are to be provided which shall be independent of the discharge of CO₂. The audible warning is to be automatically actuated a suitable time before flooding occurs and is to be clearly distinguishable from all other alarm signals.

As adequate shall be considered the period of time necessary to evacuate the space to be flooded but not less than 20 s. The system is to be designed such that flooding is not possible before this period of time has elapsed by means of a mechanical timer.

The automatic actuation of the CO₂ alarm in the protected space may be realized by e.g. opening the door of the release station.

The emission of audible and optical alarms shall continue as long as the flooding valves are open.

An automatically trip of emergency shutdown facilities by the CO₂ alarm is not permitted (see also Chapter 4 - Machinery, Section 18).

5.3 Where adjoining and interconnecting spaces (e.g. machinery space, purifier room, machinery control room) have separate flooding systems, any danger to persons shall be excluded by suitable alarms in the adjoining spaces.

5.4 Audible and optical alarms (pre-discharge alarms as defined in 5.2) are also to be provided in ro-ro cargo spaces, spaces for the transport of reefer containers and other spaces where personnel can be expected to enter and where the access is therefore facilitated by doors or manway hatches. In conventional cargo spaces and small spaces, e.g. small compressor rooms, paint stores, etc., alarms may be dispensed with on application.

5.5 CO₂ alarm systems shall be supplied from the emergency switchboard.

5.6 If the alarm is operated pneumatically, a permanent supply of compressed air for the alarm system is to be ensured.
6. **Alternative Gas Fire Extinguishing Systems**

6.1 A pressure drop in the extinguishing agent container shall be signalled visually and audibly by the alarm system. If the propellant tanks are released electrically, the release station is to be supplied from two power sources, one of which shall be the emergency power supply.

In this case the supply lines to the containers holding the extinguishing agent are to be laid in such a way that they are fireproof (e.g. in metal conduits), or fireproof cables are to be used.

The release device is to be self-monitoring and the release circuits are to be monitored for wire breakage and short circuit. Faults are to be signalled visually and audibly.

6.2 The release of each system shall be signalled visually and audibly outside the entrances to the rooms concerned as well as on the bridge or in the central fire control station.

6.3 Further requirements defined in Chapter 63, Section 10 are to be observed.

7. **Watertight Door Closing System, If Applicable**

7.1 Where watertight doors are operated by a power drive, an audible signal shall be automatically given close to each door about 5 seconds before the start of closure, and this signal shall remain clearly audible throughout the closing operation.

7.2 The electrical controls and indicators shall be so constructed and fused that no fault of any kind in the control of one of the doors can interfere with the operation of the other doors. In addition, a single fault in the control of each door shall not cause a closed door to open unintentionally.

7.3 The warning and control systems shall be supplied from the emergency power source.

8. **Watertight Door Indicator System, If Applicable**

8.1 All control stations from which the watertight doors are not visible shall be fitted with indicators showing whether the doors are open or closed. The equipment is to be connected to the emergency power supply.

8.2 The transmitters for the indicators shall have at least IP X 6 type of enclosure.

9. **Sprinkler Systems**

Where required, the automatic sprinkler systems shall be of the wet pipe type, but small exposed sections may be of the dry pipe type where, in the opinion of the TL, this is a necessary precaution. Automatic sprinkler systems shall be approved by TL.

Sprinkler systems, where used, shall comply with FSS code Ch.8.

9.1 Installations/units equipped with an automatic sprinkler system are to be additionally provided with a fire detection and alarm system with automatic smoke detectors and manual call points with displays in the control room.

9.2 Where sprinkler systems are installed in the accommodation and day rooms, the alarm devices are to conform to the following requirements:

Automatic devices shall be mounted which give an audible and visual alarm as soon as a sprinkler is activated. Activation shall be indicated in the control room. With regard to the self-monitoring function, the alarm system is to be designed similarly to a fire detection system.

10. **Gas Detection Systems**

10.1 **Design of gas detection systems**

10.1.1 For the general requirements covering gas detection systems, see also Chapter 63, Section 10, G.
10.1.2 Equipment type tested by TL should preferably be used for the central unit and the gas detectors.

10.1.3 Gas detection systems are used for the early detection of both explosion hazards due to explosive gas-air mixtures and toxic gases such as hydrogen sulphide (H₂S).

The measurement of explosive or toxic atmospheres shall be continuous.

The relevant hazard warning shall be given before the lower hazard limit is reached.

10.1.4 For the measurement of combustible hydrocarbons, the scale of measurement shall extend from 0 % to 100 % of the lower explosion limit. The alarm thresholds are normally set at 20 % and 60 % of the lower explosion limit.

10.1.5 For the measurement of toxic gases, instruments with a measuring range from 0 ppm to about 300 ppm are used. The limit values for the preliminary and main alarms, e.g. for hydrogen sulphide, are normally set at 10 ppm and about 70 ppm respectively.

10.1.6 The actual alarm limits depend on the properties of the media concerned and are to be decided by agreement with TL.

10.1.7 The actual gas detection station is to be sited in a permanently manned location, e.g. the control room. It shall be provided with easily intelligible indications showing which detectors have been activated and where these are located.

10.1.8 The appropriate arrangement of gas detectors depends on their purpose and the construction of the area being monitored. Monitoring encompasses both the hazardous areas and areas classified as „safe“, where it shall be assumed that the latter too could be endangered by an operational malfunction.

Gas detectors are therefore in principle to be arranged in such a way that

- Accidental gas leaks can be detected as soon as possible. This means that gas detectors shall be placed close to possible gas leaks in the hazardous area
- Dangers due to gas infiltrating into safe areas are detected in good time, i.e. the paths along which the gas must pass to reach the safe areas are to be monitored with gas detectors

The necessary protective measures such as the shutdown of ventilation equipment, the automatic closure of ventilation inlets and vents and, where applicable, the disconnection of non-explosion-protected facilities, etc. are initiated by the gas warning system.

10.1.9 The activation of a gas detector shall trip a visual and audible alarm at the central gas detection station. This alarm shall be passed on to all areas of the unit via the signalling equipment of the general alarm system or via a separate alarm system for the crew. The audible signal of the gas alarm shall be clearly distinguishable from all other alarms.

10.1.10 Safety functions initiated by the gas detectors and carried out automatically, e.g.

- Interventions in production processes
- Disconnection of possible sources of ignition
- Protection of unclassified (safe) areas

are to be designed in accordance with a safety logic tested and approved by TL. For further details on safety actions see Chapter 63, Section 17 – Safety Syste

10.2 Gas detection station

10.2.1 The installation shall be supplied with power via separate cables from the main power supply and an emergency power source. Should one of the power supplies fail, the central gas detection station shall switch automatically to the remaining supply. The completed switch-over shall trip an alarm.

10.2.2 The central station, which shall be located in a permanently attended space, shall be provided with a visual indicator showing that the system is operative.
10.2.3 Each gas detector shall be provided with its own evaluator.

Each evaluator should be equipped as follows:

- Two adjustable alarm limit values
- An indicator lamp for the lower limit value
- An indicator lamp for the upper limit value
- An indicator lamp for failures (e.g. wire breakage)
- A pilot light showing that the evaluator is operative
- Isolated signal outputs for actuating external alarms and safety circuits
- A reset button

Failure signals shall be acknowledgeable and, as far as possible, distinguishable from a gas alarm.

Wherever possible, evaluators with an integrated indicating device are to be used for toxic gases.

10.2.4 The measured gas concentrations are to be indicated as a percentage of the lower explosion limit (LEL) or in ppm in the case of toxic hazard. The detection system shall initiate an alarm in the control station before the gas concentration reaches dangerous limits.

At a concentration of 20 % of the LEL an audible and visual alarm shall be initiated.

At a concentration of 60 % of the LEL safety functions shall be activated before the concentration of gases reaches the explosion limit, see Chapter 63, Section 17, B.

For toxic gases like hydrogen sulphide an audible and visual alarm shall be initiated for a concentration of 10 ppm.

10.2.5 The central console shall be fitted with a selector switch for the "normal operation" and "test" modes. The indicating device shall function both in the normal operating mode and in the test mode.

10.2.6 The visual and audible signals, including the external alarms, shall be maintained pending acknowledgement at the central unit.

The visual signal at the evaluator and switching commands for safety equipment shall not be acknowledgeable until the variable concerned has dropped below the alarm limit value.

It shall be possible to identify the detector giving alarm on the control panel.

In systems for measuring toxic gases the external alarms shall be maintained until the variable concerned drops below the alarm limit value. Only then shall it be possible to acknowledge the external alarm.

10.3 Gas detectors

10.3.1 Gas detectors type tested by TL should be used.

The agreement of TL is required for the use of nontype-tested measuring heads.

Note

The agreement of TL for non-type-tested gas detectors is necessary because various measuring techniques may be used, including some which offer only limited practical operation experience.

10.3.2 Only gas detectors with a type of protection suitable for the particular explosive atmosphere may be used.

10.3.3 Gas detectors mounted in the open shall be provided with sufficient protection against water spray and jets.

Where necessary it should also be possible to retrofit them with a wind shield.
10.4 Calibration and testing

10.4.1 Provision shall be made to enable the fixed system to be tested without disruption of the normal routine.

10.4.2 Means shall be provided whereby operational personnel may readily check on the accuracy of gas percentage readings and the response of fire detectors. In the test mode it shall be possible to test the operation of the individual measuring channels and the calibration of the gas detectors without transmitting control instructions to external equipment.

10.4.3 To introduce test gases to not easily accessible gas detectors, it shall be possible to retrofit gas detectors with a test attachment enabling the test gases to be piped to the measuring head through a measuring line.

A fixed test attachment shall not impair the measurements made in normal operation.

10.5 Flammable gas detection and alarm system

10.5.1 A fixed automatic gas detection and alarm system should be provided to the satisfaction of the Administration so arranged as to monitor continuously all enclosed areas of the unit in which an accumulation of flammable gas may be expected to occur and capable of indicating at the main control point by aural and visual means the presence and location of an accumulation.

10.5.2 At least two portable gas monitoring devices should be provided, each capable of accurately measuring a concentration of flammable gas.

10.6 Hydrogen sulphide detection and alarm system

10.6.1 A fixed automatic hydrogen sulphide gas detection and alarm system should be provided to the satisfaction of the Administration so arranged as to monitor continuously the drilling area, mud processing area and well fluid test area of the unit and capable of giving audible and visual alarm at the main control points. If the alarm at the main control point is unanswered within 2 min, the toxic gas (hydrogen sulphide) alarm and the helideck status light should be automatically activated.

10.6.2 At least two portable hydrogen sulphide gas monitoring devices should be provided on the unit.

11. Lift Alarm

11.1 Lifts with internal controls shall be equipped with an audible emergency calling device which can be actuated from the lift cage. The alarm is to be transmitted to a permanently manned position.

11.2 The lift cage lighting and the emergency calling system are to be supplied from the emergency power source.

11.3 The relevant national regulations are to be observed.

11.4 A telephone (sound powered, battery operated or electrically powered), or equivalent means of communication, shall be permanently installed in lift cabins with internal controls and connected to a permanently manned location.

11.5 The emergency calling system and the telephone shall be supplied from the emergency source of electrical power and shall be independent of the power and control system.

12. Engine Safety Systems

12.1 Safety devices

12.1.1 The design of safety devices shall be as simple as possible, reliable and inevitable in operation. Proven safety devices which are not depending on a power source are to be preferred.

12.1.2 The suitability and function of safety devices has to be demonstrated in the given application.

12.1.3 Safety devices shall be designed so that potential faults such as, for example, loss of voltage or a broken wire shall not create a hazard to human life, unit/installation or machinery.
These faults and also the tripping of safety devices shall be signalled by an alarm.

12.1.4 For preference, safety devices shall be designed in conventional technology (hard wired). Alternative technical solutions shall be agreed with TL.

12.1.5 The adjustment facilities for safety devices shall be designed so that the last setting can be detected.

12.1.6 Where auxiliary energy is needed for the function of safety devices, this has to be monitored and a failure has to be alarmed.

12.1.7 Safety devices are subject to mandatory type approval.

12.1.8 Security equipment like short circuit monitoring of generators as well as overspeed monitoring of diesel engines shall run independently from automatic power control system, to ensure that the equipment can continue operating manually in case of a breakdown.

12.2 Safety Systems

12.2.1 Safety systems shall be independent of open and closed loop control and alarm systems. Faults in one system shall not affect other systems. Deviations from this requirement may be allowed for redundant equipment with the agreement of TL where this would entail no risk to human life and where installation/unit safety would not be compromised.

12.2.2 Systems shall be assigned to systems which need protection.

12.2.3 Where systems are provided with overriding arrangements, these shall be protected against unintentional operation. The actuation of overriding arrangements shall be indicated and recorded.

12.2.4 The monitored open-circuit principle shall be used for these systems. Alternatively, the closed circuit principle shall be applied where the provisions of national regulations demand it (e.g. boiler and oil-fired systems).

Equivalent monitoring principles are permitted.

12.2.5 The systems shall be designed for preference using conventional technology (hard wired). Alternative technical solutions shall be agreed with TL.

12.2.6 The power supply shall be monitored and loss of power shall be indicated by an alarm and recorded.

12.2.7 Safety systems are subject to mandatory type approval.

12.2.9 Manual emergency stop

12.2.9.1 Manual emergency stops are to be protected against unintentional activation.

12.2.9.2 The manual emergency stop shall not be automatically cancelled.

12.2.9.3 It shall be recognizable which manual emergency stop has been activated.

12.2.9.4 Manual emergency stops shall be designed according to the monitored open-circuit principle.

12.3 Open loop control

12.3.1 Main engines and essential equipment shall be provided with effective means for the control of its operation. All controls for essential equipment shall be independent or so designed that failure of one system does not impair the performance of other systems, see also A.2.4, 12.7 to 12.9.

12.3.2 Control equipment shall have built-in protection features where incorrect operation would result in serious damage or in the loss of essential functions.

12.3.3 The consequences of control commands shall be indicated at the respective control station.

12.3.4 It shall be possible to control the essential equipment at or near to the equipment concerned.

12.3.5 Where controls are possible from several control stations, the following shall be observed:
- Competitive commands shall be prevented by suitable interlocks. The control station in operation must be recognizable as such;

- Taking over of command shall only be possible with the authorization of the user of the control station which is in operation

- Precautions shall be taken to prevent changes to desired values due to a change-over in control station

- Open loop control for speed and power of internal combustion engines (main and auxiliary engines) and electrical actuators are subject to mandatory type approval

12.4 Closed loop control

12.4.1 Closed loop control shall keep the process variables under normal conditions within the specified limits.

12.4.2 Closed loop controls shall maintain the specified reaction over the full control range. Anticipated variations of the parameters must be considered during the planning.

12.4.3 Defects in a control loop shall not impair the function of operationally essential control loops.

12.4.4 The power supply of operationally essential control loops shall be monitored and power failure must be signalled by an alarm.

12.4.5 Closed loop control for speed and power of internal combustion engines (main and auxiliary engines) and electrical actuators are subject to mandatory type testing.

12.5 Engine alarm systems

12.5.1 Engine alarm systems shall indicate unacceptable deviations from operating figures optically and audibly.

12.5.2 Engine alarm delays shall be kept within such time limits that any risk to the monitored system is prevented if the limit value is exceeded.

Engine faults shall be indicated at the control locations for engine.

12.5.3 Optical signals shall be individually indicated. The meaning of the individual indications shall be clearly identifiable by text or symbols.

If a fault is indicated, the optical signal shall remain visible until the fault has been eliminated. It shall be possible to distinguish between an optical signal which has been acknowledged and one that has not been acknowledged.

12.5.4 It shall be possible to acknowledge audible signals.

The acknowledgement of an alarm shall not inhibit an alarm which has been generated by new causes.

Alarms shall be discernible under all operating conditions. Where this cannot be achieved, for example due to the noise level, additional optical signals, e.g. flashing lights must be installed.

12.5.5 Transient faults which are self-correcting without intervention shall be memorized and indicated by optical signals which shall only disappear when the alarm has been acknowledged.

12.5.6 Engine alarm systems shall be designed according to the closed-circuit principle or the monitored open-circuit principle. Equivalent monitoring principles are permitted.

12.5.7 The power supply shall be monitored and a failure shall cause an alarm.

12.5.8 Alarm systems for periodically unattended machinery spaces for all types of units are defined in Ch. 64, Sec. 12, F.

12.6 Operational devices for auxiliary engines

Operational devices required for the engine room control position for:
- Speed
- Lubricating oil pressure
- Control air pressure
- Fuel pressure

shall be electrically independent of other systems.

12.7 Speed/output controls of diesel engines

12.7.1 General

12.7.1.1 The governor and the actuator shall be suitable for controlling the engine under the operating conditions laid down in the TL Rules for Construction and shall be also in line with the requirements specified by the engine manufacturer, see Chapter 63 – Machinery Installations, Section 3, F.

12.7.1.2 Electrical governors and the associated actuators are subject to mandatory type approval.

12.7.1.3 In the event of faults in the governor system, the operating condition of the engine shall not become dangerous.

Faults in the governor system shall cause an alarm. In the case of auxiliary engines, in the event of faults in the governor system, the fuel admission in the injection pumps shall be set to “0”.

12.7.2 Power supply to the control systems of generator sets

12.7.2.1 Each control system shall be provided with a separate supply from the main source of electrical power with battery back-up for at least 15 minutes.

12.7.2.2 If there are more than two auxiliary engines, a total number of two back-up batteries is sufficient.

12.7.2.3 If the auxiliary engines are started electrically, a combination of the back-up battery with the starter battery is permissible.

The automation battery may be used as a second backup battery to boost the input voltage.

12.7.2.4 No supply or battery back-up is required for a control system with its own power source.

12.7.2.5 No battery back-up is needed if a back-up system is provided.

12.7.2.6 Batteries shall not be discharged by the control system following an engine shutdown.

12.8 Speed/output controls of gas turbines

The requirements for the speed and output control of gas turbines have to be agreed with TL.

12.9 Integration of systems for essential equipment

12.9.1 The integration of functions of independent equipment shall not decrease the reliability of the single equipment.

12.9.2 A defect in one of the subsystems (individual module, unit or subsystem) of the integrated system shall not affect the function of other subsystems.

12.9.3 Any failure in the transfer of data of autonomous subsystems which are linked together shall not impair their independent function.

12.9.4 Essential equipment shall also be capable of being operated independently of integrated systems.

D. Computer Systems

1. General

1.1 For mobile self-propelled offshore units the TL Rules, Chapter 5, Electric, Section 10 apply directly to the propulsion part.

1.2 The requirements defined in the following are valid for the non-propulsion part of mobile offshore units and for fixed offshore installations.

1.3 The safety integrity level of a self related computer system (especially PLC based ESD Systems)
Section 9 – Control, Monitoring and Safety Systems

1.4 It has to be proven that the selected computer system fulfils the approval requirements, e.g.:
- A type approval by a recognized organisation
- A listing of measures to fulfil the requirement according to a related standard

1.5 In any case, the documentation necessary to enable TL to examine the application software of the system has to be submitted for approval. TL type approved systems should be used preferably.

1.6 Computer systems shall fulfil the requirements of the process under normal and abnormal operating conditions. The following shall be considered:
- Danger to persons
- Environmental impact
- Endangering of technical equipment
- Usability of computer systems
- Operability of all equipment and systems in the process

1.7 If process times for important functions of the system to be supervised are shorter than the reaction times of a supervisor and therefore damage cannot be prevented by manual intervention, means of automatic intervention shall be provided.

1.8 Computer systems shall be designed in such a way that they can be used without special previous knowledge. Otherwise, appropriate assistance shall be provided for the user.

2. System Configuration

2.1 General requirements

2.1.1 The computer systems shall be fast enough to perform autonomous control operations and to inform the user correctly and carry out his instructions in correct time under all operating conditions.

2.1.2 Computer systems shall monitor the program execution and the data flow automatically and cyclically e.g. by means of plausibility tests, monitoring of the program and data flow over time.

2.1.3 In the event of failure and restarting of computer systems, the process shall be protected against undefined and critical states.

2.2 Power supply

2.2.1 The power supply shall be monitored and failures shall be indicated by an alarm.

2.2.2 Redundant systems shall be separately protected against short circuits and overloads and shall be selectively fed.

2.3 Hardware

2.3.1 The design of the hardware shall be clear. Easy access to interchangeable parts for repairs and maintenance shall be provided.

2.3.2 Plug-in cards and plug-in connections shall be appropriately marked to protect against unintentional transposition or, if inserted in an incorrect position, shall not be destroyed and not cause any malfunctions which might cause a danger.

2.3.3 For integrated systems, it is recommended that sub-systems be electrically isolated from each other.

2.3.4 Computers shall preferably be designed without forced ventilation. If forced ventilation of the computers is necessary, it shall be ensured that an alarm is given in the case of an unacceptable rise of temperature.

2.4 Software

2.4.1 The manufacturer shall prove that a systematic procedure is followed during all the phases of software development.

2.4.2 After drafting the specification, the test
scheduling shall be made (listing the test cases and establishment of the software to be tested and the scope of testing). The test schedule lays down when, how and in what depth testing shall be made.

2.4.3 The quality assurance measures and tests for the production of software and the punctual preparation of the documentation and tests shall be retraceable.

2.4.4 The version of the software with the relevant date and release has to be documented and shall be recognizable of the assignment to the particular requirement class.

2.5 Data communication links

2.5.1 The reliability of data transmission shall be suitable for the particular application and the requirement class and specified accordingly.

2.5.2 The architecture and the configuration of a network shall be suitable for the particular requirement class.

2.5.3 The data communication link shall be continuously self-checking, for detection of failures on the link itself and for data communication failure on the nodes.

2.5.4 When the same data communication link is used for two or more essential functions, this link shall be redundant.

2.5.5 Switching between redundant links shall not disturb data communication or continuous operation of functions.

2.5.6 To ensure that data can be exchanged between various systems, standardised interfaces shall be used.

2.5.7 If approved systems are extended, prove of trouble-free operation of the complete system shall be provided.

2.6 Integration or interaction of systems

2.6.1 The integration of functions of independent systems shall not decrease the reliability of a single system.

2.6.2 A defect in one of the subsystems of the integrated system shall not affect the functions of other subsystems.

2.6.3 A failure of the transfer of data between connected autarkic subsystems shall not impair their independent functions.

2.7 User interface

2.7.1 The handling of a system shall be designed for ease of understanding and user-friendliness and shall follow ergonomic standards.

2.7.2 The status of the computer system shall be recognisable.

2.7.3 Failure or shutdown of sub-systems or functional units shall be indicated by an alarm and displayed at every operator station.

2.7.4 For using computer systems, a general comprehensible user guide shall be provided.

2.8 Input devices

2.8.1 The feedback of control commands shall be indicated.

2.8.2 Dedicated function keys should be provided for frequently recurring commands. If multiple functions are assigned to keys, it shall be possible to recognise which of the assigned functions are active.

2.8.3 Where equipment operations or functions may be changed via keyboards, appropriate measures shall be provided to prevent an unintentional operation of the control devices. Measures shall be taken to prevent the execution by a single action only, such as:

- use of a special keyboard lock
- use of two or more keyboards

2.8.4 Competitive control interventions shall be prevented by means of interlocks. The control station in operation shall be indicated as such.
2.8.5 Controls shall correspond with regard to their position and direction of operation to the controlled equipment.

2.9 Output devices

2.9.1 The size, colour and density of text, graphic information and alarm signals displayed on a visual display unit shall be such that it may be easily read from the normal operator position under all lighting conditions.

2.9.2 Information shall be displayed in a logical priority.

2.9.3 If alarm messages are displayed on colour monitors, the distinctions in the alarm status shall be ensured even in the event of failure of a primary colour.

2.10 Graphical user interface

2.10.1 Information shall be presented clearly and intelligibly according to its functional significance and association. Screen contents shall be logically structured and their representation shall be restricted to the data which is directly relevant for the user.

2.10.2 When general purpose graphical user interfaces are employed, only the functions necessary for the respective process shall be available.

2.10.3 Alarms shall be visually and audibly presented with priority over other information in every operating mode of the system; they shall be clearly distinguishable from other information.

3. Testing of Computer Systems

3.1 For testing of computer systems see also Section 16.

3.2 Evidence, tests and assessments of computer systems have to be carried out in accordance to their importance for the unit/installation.

3.3 By the use of demonstrably service-proven systems and components, the extent of the evidence and tests required may be adapted by agreement.

3.4 If other proofs and tests are provided by the manufacturer and are of an equivalent nature, they may be recognized.

3.5 The test schedule of system testing has to be specified and submitted before the hardware and software test will be carried out.

3.6 Modifications after completed tests which have influence on the functionality and/or the safety of the system have to be documented and retested.

3.7 Tests in the manufacturer’s work

- Function tests
- Operating conditions simulation
- Fault simulation
- Simulation of the application environment

3.8 Tests on board

- Complete system tests
- Integration tests

E. Emergency Shut-down System

Reference is also made to the requirements for the emergency shut down system in Chapter 63, Section 17.

1. General Design Requirements

1.1 The emergency shut down system initiated by the gas/oil production process, drilling process, etc. comprises, in principle, 3 levels of components

- Sensors, manual initiators
- A safety related data processing logic (hydraulic, pneumatic or electric)
- Actuators (process equipment)
1.2 Where necessary, operating equipment is to be provided in order to limit or prevent the spread of damage or danger in case of fire, aggravated explosion hazard or other hazard situations.

1.3 An emergency shut-down may be designed to function as general or selective shut-down. It may be designed to be tripped manually or automatically. Both methods of tripping are normally provided in conjunction and fulfil equivalent functions.

1.4 Operating equipment which has to continue in service in hazard situations in order to prevent the danger from spreading shall not be included in a general emergency shut-down system. Wherever necessary, it is to be provided with a separate emergency shut-down system.

1.5 Shut-down systems shall operate on the failsafe principle wherever possible (e.g. process safety systems). Faults in the safety system shall, however, be indicated.

1.6 Installations requiring emergency remote shut-down include the following:

- Drilling system
- Processing systems oil/gas production systems
- Ventilation systems
- Non-essential equipment
- Essential electrical equipment
- Internal combustion engines for generators
- Internal combustion engines for pumps
- Battery-powered installations

1.7 Manually operated emergency remote shut-downs (e.g. push buttons) are to be mounted at important operating, control and escape stations, including:

- Control station respectively bridge
- Safety stations
- Drilling plant or processing area
- Boat landing stage
- Helicopter landing area

1.8 Automatically tripped emergency shut-downs are normally installed as a follow-up to area alarms and early-warning systems such as:

- Fire detection system
- Gas detection system

Their purpose, after the tripping of the alarm system, is to act in the danger area by disconnecting installations or by the automatic execution of suitable safety measures, as the case may be, in order either to eliminate or at least to limit the danger.

1.9 Systems such as

- Emergency shut-down systems
- Fire and gas detection systems
- Battery-powered lighting of escapes
- Battery-powered lighting of the helicopter landing deck
- Light beacon and associated sonic transmitter
- Blow-out preventer control
- Telephone connections and loudspeaker systems between important operating, control and safety stations
- General alarm system
- Battery-powered emergency radio equipment should not be disconnected by the tripping of the emergency shut-down.
1.10 The final shut-down configuration has to be agreed with TL, depending on the safety philosophy, see also Chapter 63, Section 17.

2. Shut-down in Case of Fire

2.1 Independently of the remote shut-down tripped centrally in accordance with 1.8, power-driven fans for
- Accommodation
- Service spaces
- Store rooms
- Control stations
- Material spaces, etc.

shall be capable of being disconnected by sections from outside the ventilated areas concerned. The closing mechanisms of the corresponding air intakes and outlets shall be actuated simultaneously, unless these openings are exclusively for manual closure.

2.2 A separate remote shut-down from outside the spaces in which they are mounted is to be provided for the power drives of
- Fuel pumps
- Fuel separators
- Lubricating oil separators
- Oil/gas fired equipment
- Auxiliary blowers for main engines
- Thermal oil pumps

and similar operating equipment.

3. Shut-down in Case of Explosion Hazard

3.1 Where installations with areas subject to an explosion hazard are placed on the unit/installation, an examination shall be carried out to determine whether, as a result of an operating fault, the danger of explosion can spread into the safe areas.

3.2 Further requirements are defined in Section 13, D.

4. Special Aspects for Automatic Shut-down Systems

Disconnect or shutdown of machinery and equipment required to keep the dynamic positioning system operational shall be based on a shutdown logic system designed to preserve the ability to maintain operational control over the integrity of the well and station keeping capability in the case of units using dynamic positioning systems. Shutdown of generators and related power supply equipment required for dynamic positioning system operation shall be split into independent groups to allow response to gas detection alarms while maintaining position keeping.

4.1 If the installation of a start-up by-pass is required by process conditions, this has to be clearly indicated at the main control station.

4.2 Shut-down actions as a result of a cascade effect are not acceptable. A direct trip signal has to be provided.

4.3 Shut-down systems are safety related systems in any case and shall be independent from all other systems.

One way links to other systems, e.g. to the process control system, are acceptable for status transfer, if the integrity of the shut-down system is maintained.

4.4 If overrides for input as well as output signals are provided, the solution has to be discussed with TL in detail.

4.5 For electrical systems an uninterruptible power supply has to be provided for the whole shutdown time, as a minimum for ½ hour.

4.6 The complete emergency shut-down (ESD) chain has to be designed fail-safe. If the data processing logic is a PLC based system, the requirements stated in D. have to be considered.
4.7 Services to be available after the emergency shutdown

Electrical power shall be provided, in case of emergency shutdown causing loss of both main and emergency power so that services listed below remain available during half an hour, in order to allow the personnel on board to escape safely from the installation and to maintain contact with the external emergency services:

- Emergency lighting:
  - At every muster and embarkation station on deck and over sides
  - In all service and accommodation alleyways, stairways and exits, personnel lift cars and personnel lift trunks
  - In the machinery spaces and main generating stations including their control positions
  - In all control stations, machinery control rooms, and at each main and emergency switchboard

- Navigation aids,

- Blow-out preventer control system,

- General alarm system,

- Public address system,

- Battery-supplied radiocommunication installations.

Electrical equipment required to be operable for services listed above shall be compliant with dispositions relative to installation of electrical equipment in hazardous areas detailed in Sec 13.

Operator shall be responsible for initiation of the foregoing shutdown of facilities. The initiated action may vary in accordance with the nature of the emergency. A recommended sequence of shutdowns shall be implemented in the Operating Manual.
SECTION 10

LIGHTING and SOCKET OUTLETS

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<td>Marking of the Unit or Installation Fixed on Site</td>
<td>10-5</td>
</tr>
<tr>
<td>1.</td>
<td>General</td>
<td></td>
</tr>
<tr>
<td>F.</td>
<td>Helicopter Landing Area</td>
<td>10-6</td>
</tr>
</tbody>
</table>
A. Lighting Equipment

1. General Requirements

1.1 The provisions contained in the other Sections of this Chapter also apply generally to the lighting equipment. Particular attention is to be given to the following items.

1.2 For lighting in spaces with explosion hazard, see Section 13.

1.3 For minimum degrees of protection against touching and water, see Section 1, K.

1.4 For permissible voltages, see Section 1, H. and F.1.

2. Construction and Extent of the Lighting System

The lighting system shall be in accordance with the following separation of the system:

- main lighting system supplied from the main power supply system
- emergency lighting system supplied from the emergency power supply system
- escape (transitional) lighting system supplied from a battery backup (transitional) source of electrical power.

2.1 Main lighting

The main electric lighting system shall provide illumination throughout those parts of the offshore unit normally accessible to, and used by, passengers or crew, and shall be supplied from the main source of electrical power. (Reference is made to MODU 5.3.4)

2.1.1 There shall be a main lighting system supplied by the main source of electrical power and illuminating all areas normally accessible to and used by personnel.

2.1.2 The arrangement of the main lighting system shall be such that a fire or other casualty in the space or spaces containing the main source of power, including transformers or converters, if any, will not render the emergency lighting system required by 2.2 inoperative.

2.2 Emergency lighting

2.2.1 An emergency lighting system is to be installed, the extent of which shall conform to Section 3, D.2.

Upon loss of main source of power, all required emergency lighting shall be automatically supplied from the emergency source of power. (Reference is made to MODU 5.4.6.1 and 5.4.8.2).

2.2.2 The arrangement of the emergency lighting system shall be such that a fire or other casualty in the space or spaces containing the emergency source of power, including transformers or converters, if any, will not render the main lighting system required by 2.1 inoperative.

2.2.3 Emergency lights shall be marked for easy identification.

2.3 Additional emergency lighting, if applicable

In addition to the emergency lighting, the means of escape in accommodation areas, including stairways and exits, shall be marked by lighting or photoluminescent strip indicators placed not more than 300 mm above the deck at all points of the escape route, including angles and intersections. The marking is to enable personnel to identify the routes of escape and readily identify the escape exits. If electric illumination is used, it should be supplied by the emergency source of power and it is to be so arranged that the failure of any single light or cut in a lighting strip will not result in the marking being ineffective.

Additionally, escape route signs and fire equipment location markings should be of photoluminescent material or marked by lighting. The Society is to ensure that such lighting or photoluminescent equipment has been evaluated, tested and applied in accordance with the FSS Code.
2.3.1 Additional emergency lighting may be provided on request of the Operator in addition to the emergency lighting according to 2.2. The task of the additional emergency lighting is to provide so much additional lighting that the Operator will be able to start the operation of the unit/installation from “dead ship” condition.

2.3.2 The volume of the additional emergency lighting may be in the range of 30 % of the main lighting according to 2.1.

2.3.3 The additional emergency lighting, if installed, may be used as emergency lighting as per 2.2.

2.4 Transitional emergency lighting

2.4.1 Transitional emergency lighting is understood as the emergency lighting according to 2.2 supplied by the transitional source of emergency power according to Section 3, D.2.2.3.

The escape lighting system shall be switched on automatically in the event of failure of the main and emergency power supply. (Reference is made to IEC 61892-2, sec. 11.4)

2.4.2 Where the emergency source of power is a generator not fitted with an automatic starting device and an automatic connection to the emergency switchboard, a transitional source of emergency power is to be installed.

2.4.3 Normally the transitional emergency lighting will be based on an accumulator battery with a capacity for half an hour of illumination.

2.5 Lighting in hazardous areas

2.5.1 Lighting systems in hazardous areas as defined in Chapter 63, Section 2 have to be provided with electrical equipment according to Section 13.

2.5.2 Emergency and transitional emergency lighting in non-hazardous areas, but where the danger of explosion can spread into these areas, have to be suitable for a zone 2 location. For installations in enclosed spaces see also Section 9, E.3. Protection classes and performance are defined in Section 13.

2.6 Low level escape direction system

In case of fire, escape routes in living areas have to be visible even in event of thick smoke. A low level lighting system or self reflecting escape route signs approximately 0,3 m above ground are deemed to be sufficient.

2.7 Main fire zones

Where, in accordance with the Rules, an installation or unit is divided into main fire zones, at least two circuits shall be provided for the lighting of each main fire zone, and each of these shall have its own power supply line. The supply lines shall be routed in such a way, that a fire in one main fire zone does not, if possible, interfere with the lighting of the other zones.

2.8 Machinery and service spaces

Lights in machinery and service spaces, stores, galleys and service passageways shall be provided with unbreakable covers or with additional mechanical protection if that afforded by their positioning is inadequate.

3. Siting of Lights

3.1 On self-propelled mobile units, lights on open decks which are to be in use while the unit is travelling are to be located in such a way that they do not interfere with navigation.

3.2 High-intensity lights with housings experiencing a temperature rise of more than 55 K in service are not to be sited within arm’s reach.

3.3 The use of low-pressure sodium lamps is not permitted in areas with an explosion hazard.

3.4 For light fittings or switches in bathrooms and shower rooms see C.

3.5 Where lights are fitted in corridors, the clear headroom should be at least 1,80 m.
4. **Design of Light Fittings**

Lighting fittings shall be arranged as to prevent temperature rises which could damage the cables and wiring, and to prevent surrounding material from becoming excessively hot. See Section 15, I.

5. **Power Supply to Lighting Systems**

5.1 Lighting systems are to be supplied from the main switchboard, emergency lighting from the emergency switchboard.

The navigation light controller shall be supplied by two alternative circuits, one from the main source of power and one from the emergency source of power. A changeover switch shall be arranged for the two supply circuits. Upon failure of either power supply, an alarm shall be given.

For offshore units without emergency power the navigation lighting shall have a battery backed up supply.

5.1.1 **Navigation light circuits**

A separate circuit shall be arranged for each light connected to this controller with a multipole circuit breaker, multipole fused circuit breaker or with a multipole switch and fuses in each phase.

The overload and short circuit protection for each of these circuits shall be correlated with the supply circuit to ensure discriminative action of the protection devices.

Each light circuit shall be provided with an automatic monitoring device when the light circuit is switched on, giving alarm in the event of failure of the light, and in the event of a short circuit.

A masthead light, sidelights and a sternlight installed on board an offshore unit not less than 50 m in length should be duplicated or be fitted with duplicate lamps. (Reference is made to IMO MSC.253(83))

5.2 **Final circuits**

The maximum permissible fused current of final lighting circuits is 16 A.

5.3 Switches shall act simultaneously on all the non-earthed conductors of a circuit. The single-pole disconnection of final lighting circuits in systems insulated on all poles is permitted only in the accommodation area.

5.4 Wherever possible, socket outlets are to be connected to separate circuits.

5.5 In the important rooms listed below the lighting shall be supplied by at least two separate fused circuits:

- Machinery and other important service spaces, safety stations and control rooms.
- galleys
- passageways and other escapes
- stairs and passageways leading to the lifeboats
- messes and day rooms for the personnel
- drilling floor
- helicopter landing area

Where an emergency generator set is installed, it is recommended that one of the circuits should be supplied from the emergency switchboard. However, it is not permitted to supply all the lighting circuits exclusively from the emergency switchboard.

The light fittings are to be so arranged that adequate illumination is maintained should any circuit fail.

B. **Socket-Outlets**

1. **General**

1.1 The supply for socket-outlets in the accommodation, day rooms and service rooms (250 V) are to be run from lighting distribution panels. The maximum fuse rating for a circuit is 16 A.
1.2 For sockets of distribution systems with different voltages and/or frequencies, noninterchangeable plugs and socket outlets shall be used.

1.3 Plug-in connections shall not be installed below the floor in engine rooms or boiler rooms or in enclosed fuel oil and lubricating oil separator rooms.

1.4 Socket outlets for power circuits over 16 A AC or 10 A DC shall be interlocked in such a way that the plug can be neither inserted nor withdrawn when the socket contacts are live.

Socket outlet for power circuits shall be supplied individually from distribution panels, shall be fused individually and shall be individually disconnectable.

1.5 Where sockets are mounted in different distribution systems with differing voltages and/or frequencies, non-interchangeable sockets and plugs are to be used to ensure that a consumer cannot be connected to a socket of another system.

2. Holds

Sockets in holds shall be installed only in locations with sufficient protection against mechanical damage.

3. Container Connections

Several socket outlets may be grouped together for common supply via one power cable, provided that the individual connections are protected at site against overcurrent and short circuit, and the supply cable is rated for the total power demand. For details, see Section 11, C.

C. Electrical Installations in Shower Rooms and Bathing Rooms

1. In locations containing a bath or shower the electrical equipment shall be installed in accordance with IEC publication 60364-7-701.

2. The minimum degree of protection against foreign bodies and water shall be appropriate to Table 10.1.

D. Navigation Lights

The navigation lights shall be connected to a dedicated navigation light controller placed on the bridge or in the chart room or space. This navigation light controller shall not be used for other purposes, except that signal lights required by canal authorities can be supplied.

For navigation lights of units in transfer respectively during self-propelled travel see Section 12, K.

E. Marking of the Unit or Installation Fixed on Site

1. General

Offshore units and installations fixed at the operation site are to be equipped with nautical facilities conforming to the IALA Recommendations for the Marking of Offshore Structures and the requirements for safety of navigation of the coastal state in whose waters the site is located. These include signal lights and sound signalling devices for fog.

2. Signal lights and sound signalling devices for fog which transmit a coded signal for the identification of the offshore structure are to be provided with their own emergency battery. The capacity of this battery, assuming simultaneous operation of all consumers, is to be rated to provide a supply for at least 4 days, unless some other period is specified by national regulations.

3. The coding and range of the visual and sound signalling equipment are governed by the national regulations relating to the site.

Table 10.1 Minimum degree of protection against foreign bodies and water

<table>
<thead>
<tr>
<th>Zone</th>
<th>Degree of protection of the installed electrical equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>IP x7</td>
</tr>
<tr>
<td>1</td>
<td>IP 55</td>
</tr>
<tr>
<td>2</td>
<td>IP 34</td>
</tr>
</tbody>
</table>
4. The switchboard for the signalling equipment is to be sited in a permanently manned room, e.g. the control station.

5. Each signalling device is to be supplied from the switchboard by its own feeder which is to be protected by a fuse or automatic circuit breaker.

6. The failure of a signalling device is to be indicated visually and audibly.

7. The switchboard is to be supplied from the emergency switchboard and the emergency battery mentioned in Section 3, D.2. In the event of a mains failure, the supply shall switch automatically to the emergency battery.

8. A charger is to be assigned exclusively to meet the needs of the battery. Failure of the charger and switch-over to the battery shall be indicated at the switchboard.

9. Where the signalling devices are switched on and off automatically, e.g. by photo-electric switches and visibility meters, the switchboard is to be provided with a manual/automatic selector switch. The operating mode at any time shall be indicated.

F. Helicopter Landing Area

See Section 14, B.
SECTION 11
CABLE NETWORK

A. Choice of Cables and Wires
   2. Rated Voltage
   3. Temperatures
   4. Ambient Conditions
   5. Mechanical Protection
   6. Movable Connections
   7. Application of Cables and Wires

B. Determination of Conductor Cross Sections
   1. Rating Method on the Basis of Maximum Current-carrying Capacity
   2. Rating on the Basis of Voltage Drop
   3. Consideration of Current Peaks
   4. Minimum Cross-sectional Areas and Their Current-carrying Capacities

C. Current-carrying Capacity, Protection and Installation of Circuits
   1. Individual Consumers and Current-carrying Capacity of Final Subcircuit
cnts
   2. Consideration of the Diversity Factor to be Applied to Group Supply Cables
   3. Cables Overload Protection
   4. Separation of Circuits
   5. Cable Laying for Circuits

D. Installation
   1. Routing of Cables
   2. Fastening of Cables and Wires
   3. Stress Relief
   4. Protection Against Mechanical Damage
   5. Installation of Cables and Wires in Metallic Pipes, Conduits or Closed Metal Ducts
   6. Installation in Non-metallic Pipes and Ducts
   8. Bulkhead and Deck Penetrations
  10. Magnetic Compass Zone for Mobile Offshore Units
  11. Cable Installation in Refrigeration Spaces
  12. Earthing of Braided Screens of Cable Network and Accessories
  13. Cable Joints and Branches
  14. Measures to Limit the Propagation of Fire Along Cable and Wire Bundles
  15. Application of Fire-resistant Cables

E. Requirements for Busbar Trunking Systems Intended for the Electrical Supply of Distribution Panels and Single Consumers
   1. Scope
   2. Components of the Busbar Trunking System
   3. Requirements
   4. Tests
A. Choice of Cables and Wires


Cables and wires shall generally conform to the provisions of Section 15.

2. Rated Voltage

The rated voltage of cables shall be not less than the rated operating voltage of the relevant circuit.

In insulated distribution systems, the voltage between two phases shall be deemed to be the rated voltage of the cable between a conductor and the hull/structure.

3. Temperatures

At places where higher ambient temperatures are expected, only those cables shall be used whose permissible temperature is at least 10 K above the maximum anticipated ambient temperature.

A correction factor shall be applied to the permissible current rating in accordance with Table 11.1.

Cables on locations, where there is danger of excessive heating or even jet fire, shall be so routed that they are protected against inadmissible external heating stress, or cables are to be used which are approved for the maximum arising ambient temperature.

4. Ambient Conditions

In accordance with the characteristics specified in Section 15, only those cables may be used whose sheaths are resistant to the ambient conditions at the work site.

5. Mechanical Protection

Cables shall be fitted that they are not likely to suffer mechanical damage. If necessary, they shall be protected by providing the cable runs with covers of plates, profiles or grids, or by carrying the cables in pipes.

Below the floor in engine and boiler rooms and similar spaces, cables that may be subjected to mechanical damage during maintenance work in the space, shall be protected according to above requirement.

All cables that may be subjected to mechanical damage, shall be protected by covers of steel plates, steel grids or profiles, or by being carried in steel pipes such as on weather decks in cargo hold areas, and through cargo holds.

The selection of the cables shall take account of the mechanical loads at the work site concerned (see also D. – Installation).

6. Movable Connections

6.1 Machines or equipment mounted on (rubber or spring) vibration absorbers are to be connected via cables or wires with sufficient flexibility and compensation loops.

6.2 Mobile equipment shall, in every case, be supplied via flexible cables, e.g. of type HO7RN-F, CENELEC HD 22 or equivalent.

For rated voltages above 50 V, the movable connecting cables or wires for equipment without double insulation shall also include an earthing conductor.

The earth conductor shall have continuous green/yellow coloured marking.

6.3 For mobile parts of installations supplied via scissor-type cable supports, suspended loops, festoon systems, etc., the use of suitable, flexible cables is required.

7. Application of Cables and Wires

Cables and wires shall be used according to the application defined in Table 11.2.

B. Determination of Conductor Cross Sections

1. Rating Method on the Basis of Maximum Current-carrying Capacity

Conductor cross-sections are to be determined on the basis of load with due regard for C.1. - C.3. The
calculated current shall be equal to, or smaller than, the permissible current for the chosen conductor cross-section.

The permissible current-carrying capacities of cables listed in Tables 11.6 and 11.7 apply to an ambient temperature of 45 °C and to the stated permissible operating temperature of the cables or wires.

1.1 The current-carrying capacities listed in Tables 11.6 and 11.7 apply to flat cable configurations containing not more than 6 cables laid side by side, or to groupings of not more than 3 cables or insulated wires, as follows:

Flat arrangement:

Groupings of not more than 3 cables:

The triple groups shall be laid in each direction with a spacing corresponding to at least one outer diameter of the largest cable or largest insulated wire.

Table 11.1 Corrective factors for rating capacity of conductor cross-sectional areas

<table>
<thead>
<tr>
<th>Permissible operating temperature [°C]</th>
<th>Ambient temperature [°C] 35</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>55</th>
<th>60</th>
<th>65</th>
<th>70</th>
<th>75</th>
<th>80</th>
<th>85</th>
</tr>
</thead>
<tbody>
<tr>
<td>[°C]</td>
<td>Table</td>
<td>11.6</td>
<td>11.6</td>
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<tr>
<td>Ambient temperature [°C]</td>
<td>35</td>
<td>0.82</td>
<td>0.91</td>
<td>0.93</td>
<td>0.94</td>
<td>0.95</td>
<td>0.94</td>
<td>0.95</td>
<td>0.96</td>
<td>0.97</td>
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<td></td>
<td>40</td>
<td>0.82</td>
<td>0.82</td>
<td>0.85</td>
<td>0.87</td>
<td>0.88</td>
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<td>0.82</td>
<td>0.71</td>
<td>0.76</td>
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<td>0.84</td>
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<td>0.82</td>
<td>0.84</td>
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<td></td>
<td>50</td>
<td>0.58</td>
<td>0.58</td>
<td>0.65</td>
<td>0.71</td>
<td>0.74</td>
<td>0.77</td>
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</tbody>
</table>

Table 11.2 Application for power, control and communication cables

<table>
<thead>
<tr>
<th>Application</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within the installation/unit in all areas and on open deck</td>
<td>Cables with shielding and outer sheath</td>
</tr>
<tr>
<td>Within the installation/unit in all areas, except where EMC requirements exist and not in hazardous areas</td>
<td>Cables without shielding</td>
</tr>
<tr>
<td>Only in crew accommodation / day rooms, for final supply circuits of lighting, sockets and space heating</td>
<td>Cables without shielding, with single wire (solid) conductors up to 4 mm²</td>
</tr>
<tr>
<td>At diesel engines, turbines, boilers and other devices with higher temperatures</td>
<td>Heat-resistance cables (wires)</td>
</tr>
<tr>
<td>Other application areas, not specified above</td>
<td>See type test Certificate</td>
</tr>
</tbody>
</table>
1.2 If the specified configurations cannot be adhered to, or the passage of cooling air is not assured, the current-carrying capacity shall be reduced to 85 % of the values given in the tables, and the overcurrent protection shall be modified accordingly.

Exceptions are made for bundles of cables and insulated wires which are not part of the same circuit and/or which will not be loaded with their rated currents simultaneously.

1.3 For the laying of single-core cables and wires in single-phase and three-phase alternating current systems, see D.7.

1.4 Cables whose maximum permissible conductor temperatures differ from each other by more than 5 K, may be bundled together only, if the permissible current-carrying capacity of the lowest capacity type is taken as the rating-basis for all cables.

1.5 Parallel cables are permitted only with conductor cross-sections of 10 mm² (AWG 7) and over.

Only cables of the same length and having the same conductor cross-section may be installed as parallel cables. Equal current-distribution shall be ensured.

Parallel cables may be loaded to the sum of their individual current-carrying capacities, and shall be common fused.

2. Rating on the Basis of Voltage Drop

2.1 Under normal service conditions, the voltage drop between the busbars (main/emergency switchboard) and the consumers shall not exceed 6 %, or 10 % in the case of battery-supplied Networks of 50 V or less. Navigation lights are subject to the requirements of Section 12, K.

Specific requirements for transient voltages on consumer terminals during start or stop are not given. However, the system shall be designed so that all consumers function satisfactorily.

2.2 Where short-term peak loads are possible, for instance due to starting processes, it is to ensure that the voltage drop in the cable does not cause malfunctions.

3. Consideration of Current Peaks

The cross-section shall be so chosen that the conductor temperatures do not exceed the maximum limits specified below neither under short circuit nor start-up conditions:

- for EPR (EPM or EPDM) (85 °C) 200 °C
- for XLPE (VPE) (85 °C) 250 °C
- for silicone (95 °C) according to specification

The figures in brackets are the permissible operating temperatures at the conductor in continuous operation.

4. Minimum Cross-sectional Areas and Their Current-carrying Capacity

4.1 The conductor cross-sections indicated in Table 11.3 are the minimum cross-sections for external cabling respective for internal wiring, e.g. of switchgear and consoles.

4.2 The maximum current-carrying capacity of conductor cross-sections for external cabling is indicated in Tables 11.6 and 11.7. For cables and wires in telecommunications systems the values listed in Table 11.4 are to applied.

A maximum permissible current of 1.0 A is applicable to the 0.2 mm² (AWG 24) conductor cross-section regardless of the number of cores.

4.3 In accommodation and day rooms, flexible cables with a conductor cross-section of not less than 0.75 mm² (AWG 18) may also be used for the connection of movable equipment with a current consumption of up to 6 A.

4.4 For hull / main structure return, see Section 1, G.3. and Section 4, H.1.2.
### Table 11.3  Minimum cross-sectional areas

<table>
<thead>
<tr>
<th>Nominal cross section</th>
<th>External wiring</th>
<th>Internal wiring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>International</td>
<td>International</td>
</tr>
<tr>
<td>Power, heating and lighting systems</td>
<td>1,0 mm²</td>
<td>17</td>
</tr>
<tr>
<td>Control circuits for power plants</td>
<td>1,0 mm²</td>
<td>17</td>
</tr>
<tr>
<td>Control circuits in general, safety system in accordance with Section 9</td>
<td>0,75 mm²</td>
<td>18</td>
</tr>
<tr>
<td>Telecommunications equipment in general, automation equipment</td>
<td>0,5 mm²</td>
<td>20</td>
</tr>
<tr>
<td>Telephone and bell equipment, not required for the safety of the installation/unit or crew call installations</td>
<td>0,2 mm²</td>
<td>24</td>
</tr>
<tr>
<td>Data bus and data cables</td>
<td>0,2 mm²</td>
<td>24</td>
</tr>
</tbody>
</table>

(1) *AWG = American wire gauge*

### Table 11.4  Rating of telecommunication and control cables

<table>
<thead>
<tr>
<th>Number of core pairs (2 cores each)</th>
<th>Number of cores</th>
<th>Nominal cross section 0,5 mm² (AWG 20)</th>
<th>Nominal cross section 0,75 mm² (AWG 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Permissible load A Maks.</td>
<td>Rated fuse Current A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1x2</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2x2</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>4x2</td>
<td>8</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>7x2</td>
<td>14</td>
<td>3,5</td>
<td>4</td>
</tr>
<tr>
<td>10x2</td>
<td>20</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14x2</td>
<td>28</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>19x2</td>
<td>38</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>24x2</td>
<td>48</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>48x2</td>
<td>96</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

The values in the Table relate to an ambient temperature of 45 °C and a conductor temperature of 85 °C.
4.5 For earthing conductors, see Section 1, K.

4.6 Neutral conductors in three-phase distribution systems shall be in cross-section equal to at least half the cross-section of the outer conductors. If the outer conductor cross-section is 16 mm² (AWG 5) or less, the cross-section of the neutral conductor must be the same as that of the outer conductors.

4.7 Exciter equalizer cables for three-phase generators in parallel operation shall be rated for half the nominal exciter current of the largest generator.

C. Current-carrying Capacity, Protection and Installation of Circuits

1. Individual Consumers and Current-carrying Capacity of Final Subcircuits

1.1 Cables shall be rated according to the expected operating load based on the connected load and mode of operation of the consumers. The values given on the consumer’s name plate are valid.

1.2 In calculating the expected load for 250 V AC lighting circuits and socket outlet circuits, the current corresponding to a 60 W lamp is to be counted for each lamp socket and 120 W for each socket outlet.

2. Consideration of the Diversity Factor to be Applied to Group Supply Cables

2.1 If the connected consumers in a part of the system are not in operation simultaneously, a diversity factor may be used for determining the cross section of the group supply cable.

A diversity factor is the ratio of the highest operating load expected under normal operating conditions to the sum of rated loads of all connected consumers.

2.2 The load determined by the application of a diversity factor shall be deemed to be the continuous load for the determination of the cross-section.

2.3 The diversity factors shown in Table 11.5 may be applied to the rating of cables used to supply groups of winches.

The values given in the Table 11.5 shall be related to the rated motor current, or, in the case of motors with several different outputs, to the current corresponding to the highest output.

2.4 Group supply feeders for hydraulic winches shall be rated for the installed power without the application of a diversity factor.

2.5 The cross-section of group supply feeders for cranes shall be determined in the same way as for cargo winches.

2.6 For cranes with one drive motor, the supply cable shall be rated according to the current rating of the maximum load capacity.

2.7 Where cranes have more than one motor, the feeder cable to an individual crane can be rated as follows:

The value of the current used for cross-section determination shall be equal to 100% of the output of the lifting motors plus 50% of the output of all the other motors. With this calculated current the cross-section of the cable shall be selected for continuous operation.

2.8 If current diagrams for the various operating conditions of cranes or groups of winches have been ascertained, the average current based on the diagram may be used instead of application of a diversity factor.

3. Cables Overload Protection

3.1 Cables shall be protected against short circuit and overcurrent.

3.2 Rating and setting of the protection devices shall be in compliance with the requirements in Section 4.

3.3 Cables protected against overcurrent at the consumers side require only short-circuit protection at the supply side.

3.4 Exciter cables for DC motors and DC generators operating in parallel shall not be fused.
Exciter cables for individually connected DC generators and synchronous three-phase alternators shall be fused only if there are special reasons for it, e.g. where the cables are passing through various compartments of the installation/unit.

4. **Separation of Circuits**

4.1 A separate cable is normally to be provided for each circuit having its own over-current and short circuit protection. Deviating from this requirement the following functions may be combined in one cable:

- a main circuit and its control circuits which branch off behind the main circuit protection and can be disconnected by a common switch
- various control circuits all laid separately from the main circuits
- various main circuits and their control circuits belonging to a common system, e.g. for several drives of an air-conditioning system, if all the cores of the cable can be centrally disconnected from the supply

4.2 Separate cables shall be provided for safety (extra-low) voltage circuits.

4.3 Separate cables shall be provided for intrinsically safe circuits. For cables in areas with explosion hazard, see Section 13, F.

5. **Cable Laying for Circuits**

5.1 For single-phase and three-phase AC systems, multi-core cables are to be used wherever possible.

5.2 Should it be necessary to lay single-core cables for the carriage of more than 10 A in single-phase or three-phase AC circuits, the special requirements of D.7. shall be fulfilled.

5.3 **Main structure / hull return**

Main structure / hull return is allowed only exceptionally compare Section 1, G.3. If allowed, the following requirements have to be applied:

5.3.1 In three-phase systems without hull / main structure return, three-core cables shall be used for three-phase connections; four-core cables are required for circuits with loaded neutral point.

---

**Table 11.5 Diversity factor during operation with winches**

<table>
<thead>
<tr>
<th>Number of winches</th>
<th>The following values shall be used for determining the cable cross-section</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Winches with DC motors</td>
</tr>
<tr>
<td>2</td>
<td>100 % of the largest motor + 30 % of the second motor, or, with identical motor, 65 % of their combined full current</td>
</tr>
<tr>
<td>3</td>
<td>100 % of the largest motor + 25 % of the remaining motors, or, with identical motors 50 % of their combined full current</td>
</tr>
<tr>
<td>4</td>
<td>100 % of the largest motor + 20 % of the remaining motors, or, with identical motors 40 % of their combined full current</td>
</tr>
<tr>
<td>5</td>
<td>100 % of the largest motor + 20 % of the remaining motors, or, with identical motors 36 % of their combined full current</td>
</tr>
<tr>
<td>6 or more</td>
<td>33 % of the combined full load current</td>
</tr>
</tbody>
</table>
5.3.2 In three-phase systems with hull/main structure return the asymmetry of the currents in the three conductors of three-core cables shall not exceed 20 A (see Section 4, H.).

5.3.3 In DC systems without hull/main structure return multi-core cables shall be provided in all cases of smaller cross-sections.

Where single-core cables are used for large cross-sections, the outgoing and return cables shall be laid as close as possible to each other over their entire length to avoid magnetic stray fields.

5.4 The generator cables, all cables run from the main or emergency switchboard or an auxiliary switchboard, and all interconnecting cables for essential equipment, shall be laid as far as possible uninterrupted in length to the distribution panels or to the equipment.

5.5 The cables of intrinsically safe circuits shall be laid at a distance of at least 50 mm separated from the cables of non-intrinsically safe circuits. The laying of intrinsically safe circuits together with nonintrinsically safe circuits in a pipe is not permitted. Cables of intrinsically safe circuits shall be marked, preferably with light blue colour.

D. Installation

1. Routing of Cables

1.1 The routing of cables shall be such that cables are laid as straight as possible and are not exposed to mechanical damage.

Cable lines shall be located far enough away from significant heat sources such as boilers, hot oil tanks, steam, exhaust, or other heated pipes, unless the insulation type and current rating are adapted to the actual temperatures in such places.

1.2 For bends, the minimum bending radius permitted by the manufacturer shall be observed. The radius shall be not smaller than 6 times of the outer diameters of the cables.

1.3 Where it is necessary to split an offshore unit into fire zones, cable runs shall be arranged so that fire in one fire zone shall not interfere with essential services in another.

Cables for duplicated steering gear motors shall be isolated as widely as possible along their entire length. This also applies to control circuits for the steering gears motor starters, and to cables for remote control of the rudder from the bridge.

Cables and wiring serving essential, important or emergency equipment shall not be run along fire zone divisions, so that heating through the division due to fire, jeopardise the function of the cables. Special consideration shall be given to the protection and routing of main cable runs for essential equipment, for example, between machinery spaces and the navigation bridge area, taking into account the fire risk present in accommodation areas.

1.4 The tensile stress of the cables at long cable runs caused by thermal expansion and/or movement of the structure shall not damage the cables, cable runs or cable penetration systems.

At long and straight cable runs like in passage ways or void spaces, etc. or at positions where unacceptable tensile stresses are liable to occur at the cables and cable trays, precautions shall be taken to distribute the expansion movement uniformly over a cable loop provided for such purpose, so that there is no damaging of the cables, cable runs or cable penetration systems.

The diameter of the cable loop shall be at least 12 times the diameter of the thickest cable. In each division should be provided at least one cable loop.

1.5 Cables shall not to be installed within room isolations.

Exceptions are permitted for lighting, socket outlets and control circuits in accommodation and refrigeration rooms, provided that the maximum loading of the cables does not exceed 70 % of their currentcarrying capacity.

1.6 Where, for safety reasons, a system has duplicated supply and/or control cables, the cable routes are to be placed as far apart as possible.
1.7 Supply cables for emergency consumers shall not be run through fire zones containing the main source of electrical power and associated facilities. Exceptions are made for cables supplying emergency consumers located within such areas.

1.8 The electrical cables to the emergency fire pump shall not pass through the machinery spaces containing the main fire pumps and their sources of power and prime movers. They shall be of a fire resistant type, in accordance with IEC 60331. Other cables may be routed across high fire risk areas in unusual cases, but must have additional fire protection, such as cable tested in line with IEC 60331.

1.9 Cables for supply of essential equipment and emergency consumers, e.g. lighting and important communications and signalling systems shall, wherever possible, by-pass galleys, laundries, category A engine rooms and their casings and areas with a high fire risk. On installations/units whose construction or small size precludes fulfilment of these requirements, measures shall be taken to ensure the effective protection of these cables where they have to be run through the rooms mentioned above, e.g. by the use of fire-resistant cables or by flame-retardant coating, such an installation has to be approved by TL.

1.10 Cables for high voltage installations shall be run at a distance of at least 50 mm from low-voltage cables.

2. Fastening of Cables and Wires

2.1 Cable trays and cableways shall be made preferably of metallic materials which are protected against corrosion.

All cables shall be fastened on each side of an expansion loop, such that all relative movement between structure and cable is taken up at this point, and not in the rest of the cable run.

Cables and wires shall be fastened with corrosion resistant, flameproof clips or bindings. Exceptions are made for cables which are laid in pipes or cable ducts. Cables and wiring shall be installed and supported in such a manner as to avoid chafing or other damage.

This also applies for the installation of cables and wires in connection boxes of electrical equipment and switchboards.

2.2 Suitable materials shall be placed together when cables are fastened to aluminium walls. Clips for mineral-insulated cables with copper sheaths have to be made of copper alloy if they are in electrical contact with the latter.

2.3 Single-core cables are to be fastened in such a manner that they are able to withstand the electrodynamic forces occurring in the event of short circuits.

2.4 The distances between the supports for cable racks and the fastenings used shall be selected with due regard to the cable type, cross-section and number of cables concerned.

2.5 Where cables suspended are fastened by the use of plastic clips or straps, metallic cable fixing devices, spaced not more than 2 m apart shall be used additionally in the following areas:
- generally in escape routes and emergency exits, on the open deck, in refrigeration rooms and in boiler rooms
- machinery rooms, control rooms and service rooms, where bunched cables are fastened on riser cable trays or under the cable trays

2.6 Cable trays made from plastics shall be tightened in such a way that they do not obstruct together with the cables the escape routes in case of fire, see 6.2.

The suitability of cable trays shall be proved. Such cable trays are subject to TL-approval. For installation, see also 2.5.

2.7 It is recommended, that cables and cable bunches shall not be painted.

If they still would be painted the following shall be observed:
- the paint shall be compatible with the material of the cables, and
- the flame-retardant property respectively fire resistance of the cables and cable bunches shall be maintained

3. Stress Relief

Cables shall be so installed that any tensile stresses which may occur remain within the permitted limits. This shall be particularly observed for cables on vertical runs or in vertical conduits.

4. Protection Against Mechanical Damage

4.1 Cables in storage holds, on open decks and at positions where they are exposed to a particularly high risk of mechanical damage shall be protected by pipes, covers or closed cable ducts.

4.2 Cables passing through decks shall be protected against damage by pipe sockets or casings extending to a height of about 200 mm over deck.

5. Installation of Cables and Wires in Metallic Pipes, Conduits or Closed Metal Ducts

5.1 If cables are installed in pipes or ducts, attention shall be paid that the heat from the cables can be dissipated into the environment.

5.2 The inside of the pipes or ducts shall be smooth, and their ends shaped in such a way as to avoid damage to the cable sheath. They shall be effectively protected inside against corrosion. The accumulation of condensation water shall be avoided.

5.3 The clear width and any bends shall be such that the cables can be drawn through without difficulty. The bending radius of the pipe must be equivalent to at least 9 times of the outer cable diameter.

5.4 Where pipes or ducts passing through areas where panting is expected, suitable means of compensation shall be provided.

5.5 Not more than 40 % of the clear crosssection of pipes and ducts shall be filled with cables. The total cross-section of the cables is deemed to be the sum of their individual cross-sections based on their outside diameters.

5.6 Pipes and ducts shall be earthed.

5.7 Single-core cables of single- and three phase AC systems shall be provided with plastic outer sheaths if they are installed in metallic pipes or ducts.

5.8 Long cable ducts and pipes shall be provided with a sufficient number of inspection and pull boxes.

6. Installation in Non-metallic Pipes and Ducts

6.1 Cable trays / protective casings made of plastic materials are to be type tested in accordance with TL- R E 16.

Note:
“Plastics” means both thermoplastic and thermosetting plastic materials with or without reinforcement, such as polyvinyl chloride (PVC) and fibre reinforced plastics (FRP).

“Protective casing” means a closed cover in the form of a pipe or other closed ducts of non-circular shape.

Applicable for pipes with a diameter of more than 80 mm.

6.2 Non-metallic pipes or cable ducts shall be made of flame-retardant material.

6.3 Cable trays/protective casings made of plastic materials are to be supplemented by metallic fixing and straps such that in the event of a fire they, and the cables affixed, spaced not more than 1 m apart are prevented from falling and causing an injury to personnel and/or an obstruction to any escape route.

Note: When plastic cable trays/protective casings are used on open deck, they are additionally to be protected against UV light.

6.4 The load on the cable trays / protective casings is to be within the Safe Working Load (SWL). The support
spacing is not to be greater than the Manufacturer's recommendation nor in excess of spacing at the SWL test. In general the spacing is not to exceed 1 meters.

**Note:**
The selection and spacing of cable tray / protective casing supports are to take into account:

- Cable trays / protective casings’ dimensions
- Mechanical and physical properties of their material
- Mass of 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

6.5 The sum of the cables’ total cross-sectional area, based on the cables’ external diameter, is not to exceed 40% of the protective casing’s internal cross-sectional area. This does not apply to a single cable in a protective casing.


In cases where use of multi-core cables is not possible, single-core cables and wires may be permitted for installation, if the following provisions are made and the requirements of IEC publication 60092-352 are observed:

7.1 The cables shall not be armoured or shrouded with magnetic material.

7.2 All conductors belonging to one circuit shall be run together in the same pipe or duct, or clamped by common clamps, unless the clamps are made of non-magnetic materials.

7.3 The cables forming a circuit shall be laid immediately beside of each other and preferably in triangular configuration. If spacing cannot be avoided, the spacing shall not exceed one cable diameter.

7.4 No magnetic material shall be placed between single-core cables passing through steel walls. No magnetic materials shall be between the cables of deck and bulkhead penetrations. Care shall be taken to ensure that the distance between the cables and the steel wall is at least 75 mm, unless the cables belonging to the same AC circuit are installed in trefoil formation, see 7.3.

For the installation of single-core parallel cables between the cable groups these measures are not necessary, if the cable groups are arranged in trefoil formation.

7.5 Single-core parallel cables shall be of the same length and cross-section. Furthermore, to avoid unequal division of the current, the cables of one phase are to be laid, as far as is practicable, alternatively with the cables of the other phases, e.g. in the case of two cables for each phase:

L1, L2, L3, L3, L2, L1  or  L1, L2, L3
L3, L2, L1
or  L3, L1, L2  or L2, L3, L1
L2, L1, L3   L1, L3, L2

7.6 To balance the impedance of the circuit in single-core cables more than 30 m long and with a cable cross-section of more than 150 mm², the phases are to be alternated at intervals of not more than 15 m.

7.7 For single-core cables, metallic sheaths are to be insulated from each other and from the structure over their entire length. They shall be earthed at one end only, except earthing is required at both ends for technical reasons (e.g. for high voltage cables). In such cases the cables shall be laid over their entire length in triangular configuration.
8. **Bulkhead and Deck Penetrations**

8.1 Cable penetrations shall conform to the partition categories laid down by SOLAS, and shall not impair the mechanical strength or watertightness of the bulkhead.

Penetrations shall meet the fire and watertight integrity of the bulkhead or deck.

The penetrations shall be performed either with a separate gland for each cable, cable transits, or with boxes or pipes filled with a suitable flame retardant packing or moulded material when those are put between zones or areas with different fire or water integrities.

The installation shall be based on the manufacturers’ installation instructions.

Fire rated penetrations shall be documented as required by TL approval.

Penetrations of watertight bulkheads should be located as high as practicable.

If cables are passing through watertight bulkheads and/or decks, it should be confirmed that the penetrations are able to withstand the pressure it may be subjected to.

The installation specification made by manufacturer shall be followed.

8.2 For testing of bulkhead and deck penetrations reference is made to the Fire Test Procedure (FTP) Code according to IMO resolution MSC.61(67).

8.3 The cables shall not occupy more than 40 % of the cross-section of a penetration.

8.4 Vertical cable ducts shall be so constructed that a fire on one deck cannot spread through the duct to the next higher or lower deck (see also 14.2.2).

9. **Cables in the Vicinity of Radio-communication and Navigation Equipment**

9.1 Except where laid in metallic pipes or ducts, cables and wires with metal sheaths or metal braiding are to be used above the uppermost metallic deck and in positions where the cables and wires are not separated by metallic bulkheads or decks from aerials, aerial downleads, the radio room, direction finder or other radio navigation or receiving equipment. The metallic sheaths and shields are to be earthed.

9.2 Only cables required in the radio room shall be laid there. If cables without a braid shielding have to be run through a radio room, they shall be installed in a continuous metallic pipe or duct which is earthed at the entrance to and exit from the room.

9.3 Single-core cables are not permitted in the radio room.

9.4 If the radio equipment is installed on the bridge, the requirements stated above are to be complied with as and where applicable.

10. **Magnetic Compass Zone for Mobile Offshore Units**

On mobile offshore units all electrical cables, wires, machines and apparatuses shall be laid, installed or magnetically shielded in order to avoid inadmissible interference (deviation < 0.5 degree) with the magnetic compass.

11. **Cable Installation in Refrigeration Spaces**

11.1 Only cables with outer sheaths, resistant to corrosion and to low temperatures shall be laid in refrigeration rooms.

11.2 Where cables are led through the thermal insulation, 1.5 shall be observed.

11.3 Only cables without hull / main structure return are permitted in refrigerated rooms and in the associated air cooler spaces. The earthing conductors shall be run together with the other cables from the relevant distribution panel.

12. **Earthing of Braided Screens of Cable Network and Accessories**

12.1 Metallic cable sheaths, armouring and shields in power installations shall be electrically connected at each end to the installation’s/unit’s main structure; single-core cables shall be earthed at one end only. For cables and
wires for electronic equipment, the manufacturer’s recommendation shall be observed, earthing at one end only is recommended. This applies also to intrinsically safe circuits.

12.2 Electrical continuity of all metallic cable covers shall also be maintained inside cable junction and terminal boxes.

12.3 Metallic cable sheaths, armouring and shields shall be earthed, preferably using standardized cable gland fittings designed for that purpose or suitable equivalent clips or earth clamps.

12.4 If the cable armouring is used as earthing conductor the cross-section has to be equivalent to that of a separate earthing conductor.

13. Cable Joints and Branches

13.1 Cables may be extended only with special approval of TL. The used material has to be approved by TL and shall maintain the flame-retardant – and where required - the fire-resistant properties of the cables. (Compare also Section 16, E.2.)

13.2 Junction and distribution boxes must be accessible and marked for identification.

13.3 Cables for safety low voltage shall not pass a junction or distribution box together with cables for higher voltage systems.

13.4 Terminals for systems of different types of systems, especially such of differently operating voltages, shall be separated.

14. Measures to Limit the Propagation of Fire Along Cable and Wire Bundles

All cables shall be installed so that the original flame-retardant properties of the individual cables are not impaired. This requirement may be achieved by:

14.1 Method 1;

Cables which have been tested in accordance with IEC 60332-3-22:2018 Category A or a test procedure for cables installed in bunches equivalent thereto.

14.2 Method 2 (See Figures 11.1-11.4);

14.2.1 Fire stops having at least B-0 penetrations fitted as follows:

14.2.1.1 cable entries at the main and emergency switchboard,

14.2.1.2 where cables enter engine control rooms,

14.2.1.3 cable entries at centralized control panels for propulsion machinery and essential auxiliaries,

14.2.1.4 at each end of totally enclosed cable trunks; and

14.2.2 In enclosed and semi-enclosed spaces, cable runs are to comply with the following:

14.2.2.1 To have fire protection coating applied:

- To at least 1 meter in every 14 meters
- To entire length of vertical runs, or

14.2.2.2 Fitted with fire stops having at least B-0 penetrations every second deck or approximately 6 meters for vertical runs and at every 14 meters for horizontal runs.

The cable penetrations are to be installed in steel plates of at least 3 mm thickness extending all around to twice the largest dimension of the cable run for vertical runs and once for horizontal runs, but need not extend through ceilings, decks, bulkheads or solid sides of trunk. In cargo area, fire stops need only be fitted at the boundaries of the spaces.

14.3 Exceptions

Fire stops in accordance with 14.2.1.1 and 14.2.1.3 can be omitted if the switchboards or consoles are installed in separate rooms and measures have already been taken at the cable entrances to these rooms, in cargo holds and in under-deck service passageways in the cargo zone. Fire stops shall be provided only for the boundaries of these rooms.
14.4 Version of fire stops

The flame propagation of cables passing through fire stops shall fulfil the SOLAS requirements for B-0 partitions.

Fire stops may, for example, be formed by existing partitions or by a steel plate (min. 3 mm in thickness) together with a B-0 penetration.

The steel plate shall be so formed that it extends around the cables as specified below:

- twice the maximum dimension of the cable run with vertically laid cables
- the maximum dimension of the cable run with horizontally laid cables

The steel plates, however, need not to be extended through upper covers, decks, bulkheads or trunk walls.

14.5 Application of flame-proof coatings

Instead of the fire stops specified in 14.4, installed cable bundles may be provided with (TL type-approved) flameproof coatings as follows:

- for horizontal cable runs for every 14 metres, a length of 1 m
- on vertical cable runs over the entire length

Other distances for the coatings may be approved after special testing.

14.6 Alternative methods

Other methods which have been proved to be equivalent to the measures stated in 14.4 and 14.5 may be accepted.

14.7 Explanatory sketches

Explanatory notes to the installation provisions described above are given in Figs. 11.1 – 11.4.
interpretations for tables 9.3, 9.4, 9.5, 9.6, 9.7 and 9.8 given in MSC/Circ.1120 as amended by MSC.1/Circ.1436 and MSC.1/Circ.1510)

-Spaces containing fuel treatment equipment and other highly flammable substances

-Galley and Pantries containing cooking appliances

-Laundry containing drying equipment - Spaces as defined in paragraphs (8), (12) and (14) of Regulation 9.2.2.3.2.2 of SOLAS Chapter II-2 for ships carrying more than 36 passengers.

b) Fire resistant type cables shall be easily distinguishable.

c) For special cables, requirement in the following standards may be used:

IEC 60331-23:1999: Procedures and requirements- Electric data cables

IEC 60331-25:1999: Procedures and requirements- Optical fibre cables

15.1.3 Emergency services required to be operable under fire conditions include:

- fire and general emergency alarm system
- fire extinguishing systems and fire extinguishing medium alarms
- fire and gas detection systems
- control and power systems to power operated fire doors and status indication for all fire doors
- control and power systems to power operated watertight doors and their status indication
- emergency lighting
- emergency fire pump
- public address system
- low level lighting
- remote emergency stop/shutdown arrangements for systems which may support the propagation of fire and or explosion
- emergency fire pump

15.2 Installation

For installation of fire-resistant cables the following shall be observed:

- The cables shall be arranged in such a way as to minimise the loss of operational availability as a result of a limited fire in any area.
- The cables shall be installed as straight as possible and with strict observance of special installation requirements, e.g. permitted bending radii.

E. Requirements for Busbar Trunking Systems Intended for the Electrical Supply of Distribution Panels and Single Consumers

For test and installation of busbar trunking systems see TL- G 67.

1. Scope

The following listed additional requirements are valid for the design and the installation of busbar trunking systems, which are installed outside of switchboards and are intended for the supply of distribution boards or single consumers.

Busbar trunking systems shall not be installed in explosion endangered areas and on the open deck.
Fig. 11.1 Fire stops, all plates at least 3 mm thick

Fig. 11.2 Partly-enclosed ducts - vertical
Fig. 11.3 Party-enclosed ducts – horizontal

Fig. 11.4 Open cable runs
2. Components of the Busbar Trunking System

A busbar trunking system consists of the following components:

- electrical conductors including neutral and protective conductors, their insulation and the encasement of the busbar trunking system
- connecting elements
- separation units
- insulators and fixing elements
- arc barriers
- tap-off units
- bulkhead and deck penetrations
- protection devices

3. Requirements

3.1 Basic requirements

The safety standard and availability of mains designed to include busbar trunking systems shall be at least equivalent to those of conventionally cables mains, even in case of failure.

Busbar trunking systems shall comply with the requirements of IEC publication 61439-1 and IEC publication 61439-6.

3.2 Requirements for components

3.2.1 Degree of protection

The design of the busbar trunking system shall comply with the following minimum degrees of protection:

- dry spaces, e.g. accommodation: IP 54
- wet spaces, e.g. engine rooms: IP 56

The operational readiness of the busbar trunking system shall be not impaired by condensed moisture.

Where required, means for automatic draining shall be provided.

Busbar trunking systems shall be protected against mechanical damage.

3.2.2 Bulkhead and deck penetrations, fire protection

The materials used shall be halogen-free and shall be flame-retardant according to IEC publication 60695-2.

The whole busbar trunking system shall meet with regard to the flame-spread the test requirements of IEC publication 60332-3-21.

Bulkhead and deck penetrations for busbar trunking systems shall conform to categories laid down by SOLAS and shall not impair the mechanical strength and the watertightness of bulkheads and decks.

The propagation of smoke via the busbar trunking system shall be effectively prevented.

3.3 System requirements

3.3.1 System configuration

The design of busbar trunking systems shall be such that in case of a single failure the supply to redundant essential equipment continues. Redundant essential equipment shall be supplied via separate busbar trunking systems. Common busbar systems for main and emergency supply are not permitted.

Where a busbar trunking system is arranged below the uppermost continuous deck, a unit’s manoeuvrability and the operation of all installations necessary for the main purpose of the unit as well as the safety of the crew shall not be impaired in the event of one or more watertight compartments outside the engine room being flooded.
Where busbar trunking systems are led through several watertight sections, means for separation at the supply-side of the transitions shall be provided. The units for separation shall be approachable, marked for identification and secured against unauthorized uncovering.

3.3.2 Protection devices

Busbar trunking systems shall be protected against overload and short circuit.

Switchgear of the busbar trunking system shall be arranged with regard to selectivity.

The propagation of electric areas along the busbar trunking system shall be prevented by arc barriers or other means. If current limiting circuit breakers are used, those means are not required.

4. Tests

4.1 Aboard tests

On the basis of approved documentation an aboard test of the completed installation shall be made. This includes the functional testing of the busbar trunking system and the check of settings for protection devices.

4.2 Busbar trunking systems are subject to TL approval.

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Fig. 11.5 Installation of fire resistant cables through high fire risk areas
Table 11.6  Current-carrying capacity of cable, maximum permissible conductor operating temperature of 60 °C and 75 °C

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<th>75°C</th>
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AWG : American Wire Gauge  
MCM : Mille Circular Mil
### Current-carrying capacity of cable, maximum permissible conductor operating temperature of 80 °C and 85 °C

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AWG: American Wire Gauge
MCM: Mille Circular Mil
### Table 11.8  
Current-carrying capacity of cables, conductor operating temperature of 85 °C (JIS)

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#### 3- or 4-core cables

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JIS : Japan Industry Standards
Table 11.9  Current-carrying capacity of cable, maximum permissible conductor operating temperature of 90 °C and 95 °C

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AWG: American Wire Gauge  
MCM: Millie Circular Mil
## SECTION 12

### ADDITIONAL REQUIREMENTS for MOBILE OFFSHORE UNITS

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A. General

1. Scope

The additional requirements defined in this Section apply, wherever relevant, to following types of mobile offshore units:

- Self-propelled units capable to undertake sea voyages under their own power without external assistance
- Units with auxiliary propeller drives for dynamic positioning and/or manoeuvring aids when travelling in tow
- Mobile units without propeller drives

2. Main Propulsion System

2.1 Definition

As main propulsion system of a mobile offshore unit shall be understood from electrical point of view:

- Power generation by generators driven by an internal combustion engine, gas turbine or steam turbine
- Driving source for main propellers in form of an electric motor
- Power transmission
- Drive controls
- Control of variable pitch propellers
- Measuring, indicating and monitoring equipment
- Engine telegraph system
- Electric drive of steering gear
- Rudder control and monitoring system

2.2 References

As the elements of the system described in 2.1 are identical to the systems used on seagoing merchant ships the requirements for their Classification or Certification are not fully defined in these Rules, but are also referred to the TL Rules, Chapter 5. The following references can be given:

- Generators, see Section 3
- Electric motors according to Section 15, A. and TL Rules, Chapter 5, Section 13
- Power transmission, see Sections 4 to 6
- Drive controls, see Section 7
- Engine telegraph system according to TL Rules, Chapter 5, Section 9, C.
- Control of variable pitch propellers according to TL Rules, Chapter 5, Section 7, C.
- Measuring, indicating and monitoring equipment according to TL Rules, Chapter 5, Section 13, H.
- Steering gear according to TL Rules, Chapter 5, Section 7, A.
- Rudder control and monitoring system according to TL Rules, Chapter 5, Section 7, A. and TL Rules, Chapter 5, Section 9, C.4.
- Testing according to TL Rules, Chapter 5, Section 21

3. Ship Control Systems

3.1 The requirements for control systems of self-propelled offshore units are defined in the TL Rules, Chapter 5, Electric, Section 9, C.

3.2 Where the remote control of the main engines from the bridge is envisaged, the requirements according to the TL Rules, Chapter 4-1, Automation shall be observed.
3.3 The Voyage Data Recorder, if required for mobile offshore units by the relevant Authorities, shall be supplied from the main and emergency switchboard. Data or alarms for the recorder have to be free of reactive effects on unit operation.

3.4 Main and auxiliary machinery essential for the propulsion of the unit should be provided with effective means for its operation and control. All control systems essential for the propulsion, control and safety of the unit should be independent or designed such that failure of one system does not degrade the performance of another system. A pitch indicator should be provided on the navigating bridge for controllable-pitch propellers.

Machinery essential for the safety of the unit should be provided with effective means for its operation and control.

Automatic starting, operational and control systems for machinery essential for the safety of the unit should, in general, include provisions for manually overriding the automatic controls. Failure of any part of the automatic and remote control system should not prevent the use of the manual override. Visual indication should be provided to show whether or not the override has been actuated.

3.5 Where remote control of propulsion machinery from the navigating bridge is provided and the machinery spaces are intended to be manned, the following should apply:

3.5.1 the speed, direction of thrust and, if applicable, the pitch of the propeller should be fully controllable from the navigating bridge under all sailing conditions, including manoeuvring;

3.5.2 the remote control should be performed, for each independent propeller, by a control device so designed and constructed that its operation does not require particular attention to the operational details of the machinery. Where more than one propeller is designed to operate simultaneously, these propellers may be controlled by one control device;

3.5.3 the main propulsion machinery should be provided with an emergency stopping device on the navigating bridge and independent from the bridge control system;

3.5.4 propulsion machinery orders from the navigating bridge should be indicated in the main machinery control station or at the manoeuvring platform as appropriate;

3.5.5 remote control of the propulsion machinery should be possible from only one station at a time; at one control station interconnected control units are permitted. There should be at each station an indicator showing which station is in control of the propulsion machinery. The transfer of control between navigating bridge and machinery spaces should be possible only in the machinery space or machinery control room;

3.5.6 it should be possible to control the propulsion machinery locally, even in the case of failure in any part of the remote control system;

3.5.7 the design of the remote control system should be such that in case of its failure an alarm will be given and the preset speed and direction of thrust be maintained until local control is in operation, unless the Administration considers it impracticable;

3.5.8 indicators should be fitted on the navigating bridge for:

3.5.8.1 propeller speed and direction in case of fixed-pitch propellers;

3.5.8.2 propeller speed and pitch position in case of controllable-pitch propellers;

3.5.9 an alarm should be provided at the navigating bridge and in the machinery space to indicate low starting air pressure set at a level which still permits main engine starting operations. If the remote control system of the propulsion machinery is designed for automatic starting, the number of automatic consecutive attempts which fail to produce a start should be limited to safeguard sufficient starting air pressure for starting locally; and

3.5.10 automation systems should be designed in a manner which ensures a threshold warning of impending or imminent slowdown or shutdown of the propulsion system is given to the officer in charge of the navigational watch in time to assess navigational circumstances in an emergency. In particular, the systems should control, monitor, report, alert and take safety action to slow down or stop propulsion while providing the officer in charge of
the navigational watch an opportunity to manually intervene, except for those cases where manual intervention will result in total failure of the engine and/or propulsion equipment within a short time, for example in the case of overspeed.

3.6 Where the main propulsion and associated machinery including sources of main electrical supply are provided with various degrees of automatic or remote control and are under continuous manned supervision from a control room, this control room should be designed, equipped and installed so that the machinery operation will be as safe and effective as if it were under direct supervision. Particular consideration should be given to protection against fire and flooding.

B. **Steering Gear and Rudder Propellers**

The arrangement and mechanical part of rudder propellers is defined in Chapter 63, Section 6, B.

1. **Drives and general requirements**

1.1 The electric drives for the different rudder propellers are to be individually supplied from the main switchboard.

1.2 Except where a non-conventional rudder is installed, or where a unit is steered by means other than a rudder, units should be provided with a main steering gear and an auxiliary steering gear to the satisfaction of the TL. The main steering gear and the auxiliary steering gear should be so arranged that a single failure in one of them so far as is reasonable and practicable will not render the other one inoperative.

1.3 The main steering gear power unit or units should be arranged to start automatically when power is restored after a power failure.

1.4 The auxiliary steering gear should be of adequate strength and sufficient to steer the unit at navigable speed and capable of being brought speedily into action in an emergency.

1.5 Where the main steering gear comprises two or more identical power units an auxiliary steering gear need not be fitted if the main steering gear is capable of operating the rudder over from 35° on one side to 35° on the other side with the unit running ahead at maximum service speed while operating with all power units. As far as is reasonable and practicable the main steering gear should be so arranged that a single failure in its piping or in one of the power units will not impair the integrity of the remaining part of the steering gear.

1.6 Control of the main steering gear should be provided both on the navigating bridge and in the steering gear compartment. If the steering gear control system which provides for control from the navigating bridge is electric, it should be supplied from the steering gear power circuit from a point within the steering gear compartment.

1.7 When the main steering gear is arranged such as the main steering gear comprises two or more identical power units, two independent control systems shall be provided, each of which can be operated from the navigating bridge. Where the control system comprises a hydraulic telemeter, TL may waive the provisions for a second independent control system.

1.8 Where the auxiliary steering gear is power operated, it should be provided with a control system operated from the navigating bridge and this should be independent of the control system for the main steering gear.

1.9 Means should be provided in the steering gear compartment to disconnect the steering gear control system from the power circuit.

1.10 A means of communication should be provided between the navigating bridge and:

1.10.1 the steering gear compartment; and

1.10.2 the emergency steering position, if provided.

1.11 The exact angular position of the rudder, if power operated, should be indicated on the navigating bridge. The rudder angle indication should be independent of the steering gear control system.

1.12 The angular position of the rudder should be recognizable in the steering gear compartment.
1.13 An alternative power supply, sufficient at least to supply a steering gear power unit which the auxiliary steering gear should be capable of putting the rudder over from 15° on one side to 15° on the other side in not more than 60 s with the unit at its deepest seagoing draught while running at one half of its maximum speed ahead or seven knots, whichever is the greater and also its associated control system and the rudder angle indicator, should be provided, automatically, within 45 s, either from the emergency source of electrical power or from another independent source of power located in the steering gear compartment. This independent source of power should be used only for this purpose and should have a capacity sufficient for 10 min of continuous operation.

1.14 Where a non-conventional rudder is installed, or where a unit is steered by means other than a rudder, TL, shall give special consideration to the steering system so as to ensure that an acceptable degree of reliability and effectiveness, which is based on item 1.2, is provided.

1.15 Electric and electrohydraulic steering gear

1.15.1 Indicators for running indication of the motors of electric and electrohydraulic steering gear should be installed on the navigating bridge and at a suitable machinery control position.

1.15.2 Each electric or electrohydraulic steering gear comprising one or more power units should be served by at least two circuits fed from the main switchboard. One of the circuits may pass through the emergency switchboard. An auxiliary electric or electrohydraulic steering gear associated with a main electric or electrohydraulic steering gear may be connected to one of the circuits supplying this main steering gear. The circuits supplying an electric or electrohydraulic steering gear should have adequate rating for supplying all motors which can be simultaneously connected to it and have to operate simultaneously.

1.15.3 Short-circuit protection and an overload alarm should be provided for these circuits and motors. Protection against excess current, if provided, should be for not less than twice the full load current of the motor or circuit so protected, and should be arranged to permit the passage of the appropriate starting currents. Where a three-phase supply is used, an alarm should be provided that will indicate failure of any one of the supply phases. The alarms required in the subparagraph should be both audible and visual and be situated in a position on the navigating bridge where they can be readily observed.

2. Control of the Direction of Thrust

2.1 The requirements for rudder control systems are to be applied as and where relevant. Two mutually independent control systems shall be provided. This requirement is deemed to be satisfied if two mutually independent rudder propeller drives are installed and each plant has its own complete control system.

2.2 Thrust direction indicators are to be fitted. The requirements stated in the TL Rules, Chapter 5 – Electric, Section 9, C.4. relating to rudder angle indicators are to be observed as and where applicable.

3. Propeller Speed Control

The propeller speed control shall be independent of the control of direction of thrust.

4. Monitoring and Displays

4.1 Signals

The following signals are to be mounted on the bridge and/or in the steering station for monitoring the equipment:

4.1.1 Indicator light showing which propeller unit is in operation at any time.

4.1.2 Indicator light signalling failure of the propeller units.

4.1.3 Indicator light signalling overloading of the electric motor and the loss of a phase in the feeder line to three-phase a. c. equipment,

4.1.4 Indicator light signalling failure of the control system in service at any time. This individual indication may be dispensed with, if the failure of the power supply to the control system is also covered by the monitoring facility specified in 4.1.2 above, e.g. if the control system is permanently assigned to the relevant drive unit.
4.1.5 The faults mentioned in 4.1.2 to 4.1.4 are also to be audibly signalled. Cancellation shall be possible for the audible alarm. The cancellation of an audible alarm shall not prevent the signalling of a fault in the other rudder propeller drive units in operation.

4.2 Suppression of alarms

Display and alarm suppression may be provided on the bridge of the propeller unit not in operation.

4.3 Alarms

For monitoring the equipment, the engine room or engine control room shall be provided with visual and audible alarms for:

4.3.1 The signals/fault indications mentioned in 4.1.1 to 4.1.4 as a combined alarm.

4.3.2 Low level in any of the hydraulic oil tanks.

4.3.3 The alarms mentioned in 4.3.1 and 4.3.2 shall be acknowledgeable in the engine room/engine control room and may be integrated into the general engine alarm system.

4.4 Protective equipment

A short circuit and overload protection has to be provided.

For further details see C.3.

5. Testing

5.1 For the testing of electrical machinery, see Section 16.

5.2 Switchgear and control systems for rudder propellers shall in every case be tested and certified in the manufacturer’s works in the presence of a TL Surveyor.

Exceptions are possible where the switchgear and control system has undergone a full type test.

The works test normally comprises:

- examination for conformity with the drawings approved by TL
- inspection of the components used, construction and wiring
- functional testing, wherever possible also with the voltage and frequency variations to be expected on board in accordance with Section 1, F.
- insulation measurement and voltage test in accordance with the requirements for switchboards, see Section 5

5.2 Type tests

For devices subject to mandatory type approval see Section 16, E.

C. Lateral Thrust Units

The arrangement and mechanical part of lateral thrust units is defined in Chapter 63, Section 6, C.

1. Power Supply

The power supply shall be provided directly from the main switchboard.

2. Rating

The equipment is to be designed in accordance with the operating conditions of the unit. It is normally to be rated for continuous duty.

3. Protective Equipment

3.1 The equipment shall be protected in such a way that in the event of an overcurrent, an audible and visual warning is first given on the bridge, followed by an automatic power reduction or disconnection of the system if the overload persists. The audible warning shall be acknowledgeable on the bridge. For plants with automatic current limitation the warning is not required.
3.2 If fuses are used for short-circuit protection, a phase-failure supervision is required to prevent the system to be started if one phase fails.

3.3 It shall be ensured that, if a lateral thrust propeller stalls, the main power supply to the drive is disconnected quickly enough to avoid endangering the selectivity of the system with regard to the generator switchgear.

3.4 Motors for short-term duty shall be monitored for critical winding temperature. An exceeding of temperature limits shall be alarmed. If the maximum permissible temperature is reached, the output shall be automatically reduced or the motor shall be switched off.

4. Controls, Monitors and Indicators

4.1 For lateral thrusters, the main steering station on the bridge shall be provided with the following indicators:
- an indicating light showing that the system is ready for operation
- an indicating light signalling an overload (for systems without power control)
- depending on the type of equipment, indicators showing the power steps and the desired direction of motion of the unit

4.2 Indications and alarms required in the engine room or engine control room:
- Faults which cause failure or endanger the drive shall be signalled optically and audibly as collective alarms.
- An ammeter for the drive motor shall be provided at the main switchboard.

4.3 The direction of movement of the controls of lateral thrust units shall correspond to the desired direction of motion of the unit. Power for the electrical control system shall be taken from the main power supply of the drive.

4.4 There shall be an emergency stop at every control station, which affects the feeder breaker in the main switchboard.

D. Podded Drives

Arrangement and mechanical part of podded drives are described in Chapter 63, Section 6, D.

1. Remote Controls

1.1 The design of remote control systems for propeller drives is subject to the TL Rules, Chapter 5, Electric, Section 13.

For sensor and control systems, including excess temperatures, oil levels, leakage indications, etc. see TL Rules, Chapter 4-1, Automation.

The following additional requirements are to be observed.

1.2 In all cases each propeller drive shall be capable of being individually controlled. An additional joystick control may be approved.

1.3 Subordinate and auxiliary control stands additional to the bridge control stand shall be capable of being disconnected to ensure faultless operation of the bridge control stand in case of failures. It shall be possible to make this disconnection from the bridge control stand.

1.4 Controls and displays shall be illuminated. Provision shall be made for dimming the illumination to the extent that the display remains legible but the personnel on the bridge is not dazzled.

2. Speed/direction of Rotation Indicator and Pitch Indicator

The power supply to indicators showing the speed and direction of rotation of propeller shafts, as well as the propeller pitch in the case of variable pitch propellers, shall be independent of the main power supply (e.g. tacho-generators, battery back-up).
E. Dynamic Positioning

The basic principles and the general requirements for dynamic positioning systems are defined in Chapter 63, Section 6, E and Refer to Guidance for dynamic position system (DP) operator training (MSC.1/Circ.738/Rev.1).

Dynamic positioning systems used as a sole means of position keeping should provide a level of safety equivalent to that provided for anchoring arrangements. Refer to the Guidelines for vessels with dynamic positioning systems (MSC/Circ.645).

1. Power System

1.1 The power system shall have an adequate response time to power demand changes.

1.2 For Class Notation DK 1 the power system need not be redundant.

1.3 For Class Notation DK 2, the power system shall be divisible into two or more systems such that in the event of failure of one system at least one other system will remain in operation. The power system may be run as one system during operation, but shall be arranged by bus-tie breakers to separate automatically upon failures which could be transferred from one system to another, including overloading and short circuits.

1.4 For Class Notation DK 3, the power system shall be divisible into two or more systems such that in the event of failure of one system, at least one other system will remain in operation. The divided power system shall be located in different spaces separated by A-60 class divisions.

1.5 For Class Notations DK 2 and DK 3, the power available for position keeping shall be sufficient to maintain the vessel in position after a single fault according to Chapter 63, Section 6, E.

1.6 If a power management system is installed, adequate redundancy or reliability shall be demonstrated.

2. Thruster System

The thruster system shall provide adequate thrust in longitudinal and lateral directions and yawing moment for heading control.

The thruster configuration may consist of both fixed and rotating thrusters. Variable pitch and variable speed may control thrust output. The thruster configuration shall be assessed on the basis of the mooring system.

3. Control System

3.1 General

Centralized thrust control system shall be arranged with individual manual lever for each thruster and joystick system.

3.1.1 In general, the control system shall be arranged in a DP control station from where the Operator has a good view of the unit's exterior limits and the surrounding areas.

A mode selector shall be arranged in the thruster control position to enable switching between manual and automatic thruster control.

3.1.2 The DP control station shall display information from the power system, thruster system, and control system. Information necessary to operate the DP system safely shall be always visible. Other information shall be available upon Operator request.

When the power demand for use of thrusters exceeds available power, the control system shall use the available power in an optimal manner and introduce thrust limitations to avoid overloads and blackout situations. The method of thrust limitation shall be quick enough to avoid blackout due to a sudden overload caused by stop of one or more generators.

3.1.3 For Class Notations DK 2 and DK 3, Operator controls shall be designed so that no single inadvertent action on the Operator's panel may lead to a critical condition.
3.2 Computer systems

3.2.1 For Class Notation DK 1, the control system need not be redundant.

3.2.2 For Class Notation DK 2, the control system shall consist of at least two independent computer systems. Common facilities, such as self-checking routines, data transfer arrangements and interfaces, shall not cause the failure of all systems.

3.2.3 For Class Notation DK 3, the control system shall consist of at least two independent computer systems with self-checking and alignment facilities. Common facilities, such as self-checking routines, data transfer arrangements and interfaces, shall not cause failure of all systems. In addition, one back-up control system shall be arranged. An alarm shall be initiated, if any computer fails or is not ready for operation.

3.2.4 An uninterruptable power supply (UPS) shall be provided for each DP computer system to ensure that any power failure will not affect more than one computer. UPS battery capacity shall provide a minimum of 30 minutes operation following a mains supply failure.

3.3 Position reference systems

3.3.1 Position reference systems shall be selected with due consideration to operational requirements, both with regard to the restrictions caused by the manner of deployment and expected performance for the operating conditions.

3.3.2 For Class Notations DK 2 and DK 3, at least three position reference systems shall be installed and simultaneously available to the DP control system during operation.

3.4 Sensor systems

3.4.1 Unit’s sensors shall at least measure unit’s heading, unit’s motions, and wind speed and direction.

3.4.2 If, for a Class Notation DK 2 or DK 3, the control system is fully dependent on correct signals from unit’s sensors, these signals shall be based on three systems serving the same purpose (i.e. this will result in at least three gyro compasses being installed).

4. Cable Systems

For Class Notation DK 3, cables for redundant equipment or systems shall not be routed together through the same compartments. Where this is not practicable, such cables may run together in cable ducts of A-60 class including duct ends, which are effectively protected from all fire hazards, except those originating from the cables themselves. Cable connection boxes are not allowed in such ducts.

5. Requirements for Essential Non-DP Systems

For Class Notations DK 2 and DK 3, systems not directly part of the DP system but which in the event of failure could cause failure of the DP system (e.g. common fire suppression systems, engine ventilation systems, shut-down systems, etc.), shall also comply with the relevant requirements of these Rules.

6. Further Details

Further details concerning dynamic positioning are defined in the TL Rules, Chapter 22 – Dynamic Positioning Systems.

F. Units with Unattended Engine Rooms

1. General

1.1 The extent and design of automated equipment are generally required to conform to TL Rules, Chapter 4-1, Automation.

1.2 The arrangements shall ensure that the safety of the unit in the marine mode, including manoeuvring, and in machinery spaces of category A during drilling operations, where applicable, is equivalent to that of a unit having manned machinery spaces

Where propulsion machinery spaces are normally unattended during transit, the control and monitoring systems are to be constructed and installed in accordance with the applicable requirements of the TL Rules and as specified herein.
1.3 The provisions of items 4 to 10 apply to units which are designed to undertake self-propelled passages without external assistance.

Units other than those designed for unassisted passages, having periodically unattended spaces in which machinery associated with the marine mode is located, shall comply with the applicable parts of items 4, 5, 8, 9 and 10.

Where in any unit machinery spaces of category A for drilling purposes are intended to be periodically unattended the application of items 4 and 10 to machinery spaces of category A should be considered by the Administration, due consideration being given to the characteristics of the machinery concerned and to the supervision envisaged to ensure safety.

2. Generator Standby Systems

2.1 On units with facilities for unattended engine rooms, the electrical plant is also required to comply with the requirements set out in Chapter 63 on the restoration of the power supply following a mains failure.

The automatic connection of a generator and of essential consumers following a blackout shall occur as quickly as possible and in any event within 30 seconds. Where necessary, the load may be connected in steps so that the prime mover is able to deliver the corresponding output.

In the event of continuous drop in frequency of more than 10%, the non-essential consumer shall be tripped automatically within 5 to 10 s. If this does not restore normal operating conditions, the supply generators shall disconnect themselves from the network so that the standby set can cut in.

2.2 Where provision is made for the automatic load-related connection and disconnection of generators, connection shall be initiated when any generator attains 80% of its rated current. The connection of a further generator shall also be possible in the event of a persistent drop in frequency of up to 10%.

2.3 Following a failure of the main power supply system, the restoration of the power supply shall be possible without recourse to the emergency power supply.

3. Consumer Standby Circuit

3.1 Standby circuits are to ensure the alternating service of units of the same type. A changeover to another unit due to a fault is to be signalled visually and audibly.

3.2 The systems of automatically controlled consumer groups are to be so designed that a fault in one of the systems does not disable the other systems.

3.3 Air compressors providing the starting air for diesel engines shall start and stop automatically in order to maintain the stored starting air.

4. Fire Protection

4.1 Fire Prevention

4.1.1 Where necessary, oil fuel and lubricating oil pipes is to be screened or otherwise suitably protected to avoid, as far as practicable, oil spray or oil leakages on to hot surfaces or into machinery air intakes. The number of joints in such piping systems is to be kept to a minimum and, where practicable, leakages from high-pressure oil fuel pipes should be collected and arrangements provided for an alarm to be given.

4.1.2 Where daily service oil fuel tanks are filled automatically, or by remote control, means should be provided to prevent overflow spillages. Other equipment which treats flammable liquids automatically, e.g., oil fuel purifiers, which, whenever practicable, should be installed in a special space reserved for purifiers and their heaters, shall have arrangements to prevent overflow spillages.

4.1.3 Where daily service oil fuel tanks or settling tanks are fitted with heating arrangements, a high-temperature alarm is to be provided if the flashpoint of the oil fuel can be exceeded.

4.2 Fire Detection

4.2.1 An approved fire detection system based on the
self-monitoring principle and including facilities for periodical testing is to be installed in periodically unattended machinery spaces.

4.2.2 The fire detection system should comply with the following.

- This fire detection system is to be so designed and the detectors so positioned as to detect rapidly the onset of fire in any part of those spaces and under any normal conditions of operation of the machinery and variations of ventilation as required by the possible range of ambient temperatures. Except in spaces of restricted height and where their use is specially appropriate, detection systems using only thermal detectors should not be permitted. The detection system shall initiate audible and visual alarms distinct in both respects from the alarms of any other system not indicating fire, in sufficient places to ensure that the alarms are heard and observed at the locations determined in accordance with paragraph 8.1.

- After installation the system is to be tested under varying conditions of engine operation and ventilation.

- The fire detection system, where electrically supplied, is to be fed automatically from an emergency source of power by a separate feeder if the main source of power fails.

4.2.3 Means is to be provided in case of fire:

- in boiler air supply casings and exhausts (uptakes); and

- in scavenging air belts of propulsion machinery, to detect fires and give alarms at an early stage, unless the Administration considers this to be unnecessary in a particular case.

4.2.4 Internal combustion engines of 2,250 kW and above or having cylinders of more than 300 mm bore shall be provided with crankcase oil mist detectors or engine bearing temperature monitors or equivalent devices.

4.3 Fire Fighting

4.3.1 An approved fixed fire-extinguishing system is to be provided in units that are not required to have this provision by Chapter 63, Sec. 10, I.

4.3.2 Provision is to be made for immediate water delivery from the fire main system at a suitable pressure, due regard being paid to the possibility of freezing, either:

- by remote starting arrangements for one of the main fire pumps. The starting positions shall be provided at strategic locations including the navigating bridge, if any, and a normally manned control station; or

- by permanent pressurization of the fire main system, either

  - by one of the main fire pumps; or

  - by a dedicated pump for the purpose with automatic starting of one of the main fire pumps on reduction of the pressure.

4.3.4 Special consideration is to be given for maintaining the fire integrity of the machinery spaces, to the location and centralization of the fire-extinguishing system controls and to the required shutdown arrangements (e.g., ventilation, fuel pumps, etc.); it may require additional fire-extinguishing appliances and other fire-fighting equipment and breathing apparatus.

5. Protection against flooding

5.1 Bilge-water level detection

High bilge-water level in periodically unattended machinery spaces below the assigned load line should activate an audible and visual alarm at the locations determined in accordance with paragraph 4.7.1.

5.2 Bilge wells should be provided, where practicable, in periodically unattended machinery spaces and should be large enough to accommodate easily the normal drainage during unattended periods. They should be located and monitored in such a way that the accumulation of liquids is detected at pre-set levels, at normal angles of inclination.
5.3 Where the bilge pumps are capable of being started automatically, means should be provided to indicate at the locations determined in accordance with paragraph 8.7.1 when the influx of liquid is greater than the pump capacity or when the pump is operating more frequently than would normally be expected. In these cases, smaller bilge wells to cover a reasonable period of time may be permitted. Where automatically controlled bilge pumps are provided, special attention should be given to oil pollution prevention requirements.

6. Bridge control of propulsion machinery

6.1 In the marine mode, including manoeuvring, the speed, direction of thrust and, if applicable, the pitch of the propeller should be fully controllable from the navigating bridge.

6.2 Such remote control should be performed by a single control device for each independent propeller, with automatic performance of all associated services, including, where necessary, means of preventing overload of the propulsion machinery. However, where more than one propeller is designed to operate simultaneously, these propellers may be controlled by a single control device.

6.3 The main propulsion machinery should be provided with an emergency stopping device on the navigating bridge which should be independent of the navigating bridge control system referred to in paragraph 6.2.

6.4 Propulsion machinery orders from the navigating bridge should be indicated in the main machinery control station or at the propulsion machinery control position, as appropriate.

6.5 Remote control of the propulsion machinery should be possible only from one location at a time; at such locations interconnected control positions are permitted. At each location there should be an indicator showing which location is in control of the propulsion machinery. The transfer of control between the navigating bridge and machinery spaces should be possible only in the main machinery space or in the main machinery control station. The system should include means to prevent the propelling thrust from altering significantly when transferring control from one location to another.

6.6 It should be possible for all machinery essential for propulsion and manoeuvring to be controlled from a local position, even in the case of failure in any part of the automatic or remote control systems.

6.7 The design of the remote automatic control system should be such that in case of its failure an alarm will be given on the navigating bridge and at the main machinery control station. Unless the Administration considers it impracticable, the pre-set speed and direction of thrust of the propeller should be maintained until local control is in operation.

6.8 Indicators should be fitted on the navigating bridge for:

6.8.1 propeller speed and direction of rotation in the case of fixed-pitch propellers; or

6.8.2 propeller speed and pitch position in the case of controllable-pitch propellers.

6.9 The number of consecutive automatic attempts which fail to produce a start should be limited to safeguard sufficient starting air pressure. An alarm should be provided to indicate low starting air pressure, set at a level which still permits starting operations of the propulsion machinery.

7. Communication

A reliable means of vocal communication should be provided between the main machinery control station or the propulsion machinery control position as appropriate, the navigating bridge, the engineer officers’ accommodation and, on column-stabilized units, the central ballast control station.

8. Machinery Alarm Systems

8.1 Alarms shall also be given on the bridge, in the living quarters and accommodation area of the technical officers and/or the personnel responsible for the machinery plant, if the engine room is unattended. The watch station of the technical officer or responsible crew
member shall be individually selectable and indicated on the bridge. It should also:

8.1.1 activate an audible and visual alarm at another normally manned control station;

8.1.2 activate the engineers’ alarm provided in accordance with G 1.4, or an equivalent alarm acceptable to TL, if an alarm function has not received attention locally within a limited time;

8.1.3 as far as is practicable be designed on the fail-to-safety principle; and

8.1.4 when in the marine mode, activate an audible and visual alarm on the navigating bridge for any situation which requires action by the officer on watch or which should be brought to the attention of the officer on watch.

8.2 Depending on the degree of urgency involved, the visual failure signals on the bridge may be arranged in three groups to act as collective alarm signals:

- **Group 1:**
  
  Alarms due to failures requiring the immediate shut-down of the main engine (red lights).

- **Group 2:**
  
  Alarms due to failures requiring a reduction in power of the main engine (red light).

- **Group 3:**
  
  Alarms due to failures which do not require measures as described in groups 1 and 2 (yellow light).

Simultaneously with a collective alarm signal, an acknowledgeable audible alarm is to be given on the navigating bridge. After acknowledgement, this alarm shall at once be available for actuation in the event of another collective alarm signal.

Acknowledgement of the alarm signal in the engine control room is to be indicated on the navigating bridge. A group 3 visual collective alarm signal may then be cancelled. However, group 1 and group 2 visual indications shall remain until the fault has been corrected.

8.3 The audible alarm in the engine room may be switched off for the period of unattended operation, provided that special measures are taken to ensure that the audible signalling device is operative during the remaining time, e.g. by coupling it to a duty-time selector switch.

8.4 The extent of the monitoring points is to be determined in accordance with Chapter 63, Section 17.

8.5 The alarm system should be continuously powered and should have an automatic change-over to a stand-by power supply in case of loss of normal power supply. (see Section 4)

8.6 Failure of the normal power supply of the alarm system should be alarmed.

8.7 The alarm system should be able to indicate at the same time more than one fault and the acceptance of any alarm should not inhibit another alarm.

8.8 Acceptance at the position mentioned in paragraph 8.1 of any alarm condition should be indicated at the positions where it has been shown. Alarms should be maintained until they are accepted and the visual indications should remain until the fault has been corrected, when the alarm system should automatically reset to the normal operating condition.

9. Special provisions for machinery, boiler and electrical installations

9.1 The special provisions for the machinery, boiler and electrical installations shall be to the satisfaction of the Administration and should include at least the requirements of this section.

9.2 Change-over function

Where stand-by machines are required for other auxiliary machinery essential to propulsion, automatic change-over devices are to be provided. An alarm should be given on automatic change-over.
9.3 Automatic control and alarm systems

9.3.1 The control systems are to be such that the services needed for the operation of the main propulsion machinery and its auxiliaries are ensured through the necessary automatic arrangements.

9.3.2 Means are to be provided to keep the starting air pressure at the required level where internal combustion engines are used for main propulsion.

9.3.3 An alarm system complying with item is to be provided for all important pressures, temperatures and fluid levels and other essential parameters.

10. Safety Systems

A safety system is to be provided to ensure that serious malfunction in machinery or boiler operations, which presents an immediate danger, should initiate the automatic shutdown of that part of the plant and that an alarm is to be given at the locations determined in accordance with item 8.1. Shutdown of the propulsion system should not be automatically activated except in cases which could lead to serious damage, complete breakdown, or explosion. Where arrangements for overriding the shutdown of the main propelling machinery are fitted, these shall be such as to preclude inadvertent operation. Visual means shall be provided to indicate when the override has been activated.

G. Communication Systems

The general internal communications and the public address/alarm systems are defined in Section 9, B.

1. Engineer Calling System "Engine Room - Accommodation Area"

1.1 Provision shall be made for alerting the technical officers or the crew members responsible for the machinery installation in their accommodation area from the engine room or engine control room. The calling devices may be located individually in the respective cabins and the mess room within the technical officers’ accommodation area.

1.2 With a decentralized arrangement of the calling devices it shall be possible to call the responsible personnel both individually and together.

1.3 The engineer calling system is to be powered from the emergency switchboard or from another permanently available power source.

1.4 Engineers’ alarm

An engineers’ alarm should be provided to be operated from the engine control room or at the manoeuvring platform, as appropriate, and clearly audible in the engineers’ accommodation.

2. Important Intercom Systems

2.1 The important intercom systems specified in the following are to be designed to ensure fully satisfactory vocal intercommunication under all operating conditions.

Where several service telephones are located in one room, the called telephone must be indicated visually.

Intercom links are to be provided between the following stations:

2.2 Engine room - bridge and engine control room - bridge

2.2.1 An intercom link is to be provided between the bridge, the engine room and all control positions from which the main propulsion plant can be operated.

A noise-absorbent hood should be used in engine rooms with high noise levels.

The calling devices in the engine room are to be so designed that they clearly attract attention from any position in the engine room even when the plant is running at full load. Additional visual means may be used to meet this requirement.

2.2.2 Units should be provided with at least two independent means for communicating orders from the navigating bridge to the position in the machinery space or control room from which the engines are normally controlled, one of which should provide visual indication.
of the orders and responses both in the engine-room and on the navigating bridge. Consideration should be given to providing a means of communication to any other positions from which the engines may be controlled.

2.3 Bridge - radio room

An intercom link is to be provided between the bridge and the Operator’s position in the radio room. This intercom link is not required if communication can be made without technical aid.

2.4 Bridge - steering gear compartment

Provision shall be made for fully satisfactory transmission of commands between the bridge and the steering gear control stand (if any) in the steering gear compartment.

2.5 Other intercom links

Intercom links shall also be provided between all other locations at which activities may need to be performed in an emergency.

2.6 Power supply to intercom systems and special instructions

The intercommunication systems specified in 2.2 and 2.3 must be independent of the main power supply system and any other power source. Wherever possible, they are to be designed as one-to-one links. A one-to-one link between the bridge and engine room or between the bridge and radio room may be dispensed with, if the system consists of not more than 6 sets and steps are taken to ensure that intercommunication between the two points can be established at all times (e.g. by cutting into an engaged line).

2.7 In the event of a failure of the main power supply, the intercom links specified in 1., 2.4 and 2.5 have to be uninterruptibly supplied by a battery whose installation meets the requirements for an emergency battery.

3. Voice Communications in an Emergency

3.1 An intercommunication system shall be provided which enables commands to be transmitted between strategically important locations, the assembly points, the emergency control stations, the muster stations and launching stations of lifesaving equipment.

3.2 This system may comprise portable or permanently installed equipment, and must also be operable in the event of a failure of the main power supply.

H. Deck Machinery

1. General

1.1 Deck machinery is to be designed in accordance with the requirements for mooring equipment in Chapter 60, Section 8, for windlasses and winches in Chapter 63, Section 8 and for cranes in Chapter 62, Section 8.

1.2 Enclosures

The degree of protection for motors and switchgear shall be selected in accordance with Section 1, Table 1.13.

1.3 Emergency stop

Hoisting gear shall be equipped with an emergency switch which allows the motor to be stopped immediately in case of a control device failure.

1.4 Control devices

When released, the levers and hand wheels controlling hoisting gear shall automatically return to the zero position. Exceptions to this requirement may be allowed for special drives.

2. Windlasses and Mooring Winches

2.1 Motor rating

Motor design and construction are to conform to Section 15, A. Windlasses and mooring winches are to be rated in accordance with the proposed application and shall be capable of delivering twice the rated torque for 2 minutes without dangerous overheating.
2.2 Overload protection

An electrical overload protective device is to be provided to prevent excessive overloading of the motors and, as far as possible, of the windlasses and winches.

2.3 Power supply

Windlass and winch motors and their control systems shall be supplied directly from the switchboard of the main electrical power source.

2.4 Brakes

The electromagnetic operating elements of brakes shall conform to Section 15.

If the power supply to windlasses and winches fails, the brakes shall engage automatically and be capable of holding against 50% of the total static braking capacity of the windlass.

Their holding power is to be rated in accordance with Chapter 63, Section 8.

2.5 Winch controls

2.5.1 From the winch control stands it shall be possible to observe the operation of each winch, including fairleads, cables and anchor handling vessels.

2.5.2 Individual control shall be provided for each winch. Any failure in the control systems of one winch shall not affect the operation of the controls of other winches.

2.5.3 The respective control stand shall be equipped with at least the following facilities for each winch in addition to the emergency OFF switch mentioned in 1.3:

- wattmeter or ammeter
- device for monitoring and indicating the pull on the anchor chain or cable
- devices showing the length of paid-out chain or cable

The power supply to the above mentioned devices shall be independent of the power supply to the winch control system. The operative state of the system is to be indicated.

2.5.4 In a permanently manned control station the following data are to be indicated:

- the pull on the chain or cable, and
- the strength and direction of the wind

2.5.5 Local and remote means shall be provided to enable the anchors to be emergency released from the unit after loss of main power.

2.5.6 Circuits shall be arranged for automatic transfer in the event of failure of the normal control power supply, but need not be exclusive to the supply of the anchor operation control power.

Operation of transfer arrangements shall not cause a power supply failure mode to be initiated.

2.5.7 A permanently installed communication system shall be provided to establish communication between all stations from which an anchoring operation can be controlled and supervised.

I. Electrical Systems for Self-elevating Units

1. General

1.1 References

The basic requirements for self elevating units, where the jacking systems are part of, are already defined in Chapter 60, Section 2.

The general design principles and the machinery installations of jacking systems as well as the documents for approval are defined in Chapter 63, Section 9.

All electrical and electronic requirements for jacking systems are defined in this Section.
1.2 Design principles

1.2.1 The electrical installations and controls of the jacking system are to be designed and constructed with sufficient redundancy so that upon failure of any one component, the system shall be capable of continuing to jack or holding in place.

1.2.2 The system shall be designed so that overloading of the electrical components is avoided during all kinds of operation.

1.2.2.1 The electrical items to be considered for rack and pinion jacking systems in this respect include the following:

- motor controller, if applicable
- drive of central or local hydraulic power stations, if applicable
- characteristic of electric motors
- brake torque
- interlock between electric motors and blocking system (if any)

1.2.2.2 The electrical items to be considered for ram and pin jacking systems are:

- drive of central or local hydraulic power stations
- actuators for pins
- control of operation of the hydraulic rams

1.2.2.3 The electrical items to be considered for rubber block friction systems are:

- drive of the compressor
- drive of the hydraulic power station, if applicable
- control of operation of the pneumatic holding and ram system

2. Electrical Jacking Motors

2.1 Capacity

2.1.1 The capacity of the electrical jacking motors shall be sufficient for lifting requirements such as the following:

- requirements as defined in Chapter 63, Section 9
- lifting the platform with uneven load (but within approved tolerances) for a specific duration
- lifting in preload, if specified, with a specific duration

The friction between legs and guides, as well as the efficiency of the gear transmissions are to be considered.

2.1.2 At least two motors shall be provided for each transmission or drive unit.

2.1.3 In determining the motor ratings an allowance is to be made for reserve capacity. This is to be determined in such a way that, if individual motors fail, the residual capacity is sufficient for the safe conclusion of the lifting or lowering operation.

2.1.4 The torque characteristics of the electric motors shall be such that the motor is not able to damage any part of the transmission or pinion rack in the case of a mechanically blocked lifting system.

2.2 Design and construction

Design and construction of the motors shall conform to Section 15, A.

2.3 Power supply

2.3.1 The jacking motors may be arranged in drive groups for each platform leg.

2.3.2 Each drive group shall be supplied directly from the main switchboard via a circuit breaker.
2.4 Generating of electric power

When lowering a unit with an electric rack and pinion system, the weight of the unit will tend to overspeed the electric motors causing them to actually generate electric power. This electric power shall be absorbed to avoid damage to the electric power generation and control equipment.

3. Protective Devices

3.1 Each drive group at a leg is to be protected against short circuit and overload.

The short-circuit protective device is to be set to a threshold value corresponding to not more than 10 times the rated current of all the motors in a group.

3.2 The overcurrent protective device shall release a visual/audible alarm at the control console.

3.3 Automatic disconnection of the drive in case of overload is to be provided only where excessive load torque can cause damage to the transmission system, the platform leg and the platform structure. Each drive motor is to be fitted with an overload indicator at the control console so that, for instance, in case of a brake failure selective remedial measures can immediately be taken.

4. Brakes

Electro-magnetically operated brakes shall conform to Section 15, A.

Brakes shall engage automatically, should the power supply fail.

5. Control

5.1 The elevating system should be operable from a central jacking control station.

An individual control system is to be provided for each leg drive group.

The control circuits of the individual drive groups shall work independently of each other.

5.2 Means shall be provided for the simultaneous collective control of all the drive groups at the legs. An emergency push button shall enable the drive groups of all the legs to be shut off simultaneously. If not an automatic collective load control is used, the group torque at the electric motors shall be checked and adjusted for the purpose of load equalization between the drive groups, if necessary. This shall be done after the lifting of the platform and after being subject to weather conditions which may have altered the distribution.

5.3 Control of the blocking system is to be provided, if any.

5.4 The jacking control station should have the following:

5.4.1 audible and visual alarms for jacking system overload and out-of-level. Units whose jacking systems are subject to rack phase differential should also have audible and visual alarms for rack phase differential; and

5.4.2 instrumentation to indicate:

5.4.2.1 the inclination of the unit on two horizontal perpendicular axes;

5.4.2.2 power consumption or other indicators for lifting or lowering the legs, as applicable; and

5.4.2.3 brake release status.

6. Monitoring

6.1 For each leg the following control and monitoring elements are to be provided at least:

- ON/OFF control main switch
- UP/STOP/DOWN control switch
- "Ready" indicator lights
- "Overload" indicator lights
- Wattmeter and/or ammeter for electrical power of all current motors running together
- position of the blocking system, if any

6.1 At the jacking control station the following control and monitoring elements are to be provided at least:

- control system for a collective jacking operation, if any

- an emergency stop push button for all drives simultaneously

- the available generator capacity is to be indicated

- displays for monitoring the inclination angle of the platform structure

- with more than 3 legs, a continuous overload monitor with an alarm system for signalling excessive differences between the leg loads

7. Communications

A communication system should be provided between the central jacking control and a location at each leg.

A permanently installed communication system is to be provided between the central jacking control station and the local leg drive stand of the individual platform legs. This may form part of the telephone network or of the loud-speaker intercom system.

8. Testing

8.1 Tests at manufacturer’s works

Shop tests of system elements are to be provided as appropriate. For major components the presence of a TL-Surveyor at the testing is required.

8.2 Dock trials

8.2.1 The electrical installations shall be function tested for at least one complete cycle of all specified conditions and with preload. During these tests all alarms, brake or valve functions and interlocks, if any, shall be checked. The different elements of the trial program are defined in Chapter 63, Section 9, E.2.

8.2.2 For rack and pinion jacking systems, electric motor input torque and speed shall be checked for all loading conditions.

After the lifting test, the brake torques shall be checked and adjusted, if necessary.

J. Ballast Systems for Column-Stabilized Units

1. General

1.1 References

Besides the application at all mobile offshore units, the ballast system has special importance for column-stabilized units. The basic requirements for column-stabilized units are already defined in Chapter 60, Section 3.

The general design principles and the machinery installations of ballast systems as well as the documents for approval are defined in Chapter 63, Section 13e, I.

All electrical and electronic requirements for ballast systems are defined in this Section.

1.2 Design principles

1.2.1 Units shall be provided with an efficient piping system capable of ballasting and deballasting any ballast tank under normal operation and transit conditions.

1.2.2 The ballast system shall still be capable of operation when the unit is:

- under the inclination expected in the operational condition as stated in Section 1, Table 1.3

- powered from the emergency switchboard, with the unit in the damaged condition specified by TL or the appropriate Authority

1.2.3 The power supplies and the control equipment for the ballast systems are to be so designed that at least
restricted operability is maintained should any system component fail.

1.2.4 Enclosures housing electrical components of the ballast system, the failure of which may cause unsafe operation of the ballast system upon liquid entry into the enclosure, shall have a minimum degree of protection IP 56.

2. Electric Motors

2.1 Ballast pump motors

Each pump motor shall be directly supplied both from the appropriate switchboard of the main power supply system and from the emergency power source. The device for switching over to the standby supply shall be located in the vicinity of the pump motor and outside the ballast control station.

2.2 Electric drives for ballast valves

2.2.1 Depending on the design of the ballast system, the power supply to individual valve drives can be arranged in groups. Each group shall be supplied directly from the appropriate switchboard of the main power supply and from the emergency power source.

2.2.2 The device for switching over to the standby supply shall be located at the group distribution panel. Each valve drive shall as a minimum requirement be protected against short circuit at the group distribution panel.

2.2.3 Each power-operated ballast valve shall fail to the closed position upon loss of control power. Upon the reactivation of control power, each such valve shall remain closed until the ballast control operator assumes control of the reactivated system. TL may accept ballast valve arrangements that do not fail to the closed position upon loss of power, provided TL is satisfied that the safety of the unit is not impaired.

3. Controls

3.1 Central control

3.1.1 A central ballast control station shall be provided. It shall be located above the worst damage waterline and adequately protected from weather. From this station the individual remote control of ballast pumps and of ballast valves shall be possible.

3.1.2 In addition to the individual controls, approval may be given for the collective control of functional units, e.g. a combination of certain ballast valve controls which have to be operated simultaneously. In the event of a fault, however, the operability of the individual controls shall be maintained.

3.1.3 The use of computer based ballast control systems is permissible but shall be agreed with TL. Computer based systems are in addition to be provided with

- a manual OFF push button, independent of the computer, with which all the controls of the ballast system can be shut down

- a safety system hard-wired and computer-independent, for detecting inadmissible limit values, tripping the associated alarms and, where applicable, initiating safety measures

3.1.4 If the voltage fails, control circuits shall assume the OFF condition, and

- ballast valves shall close automatically

Restoration of the voltage shall not automatically reanimate the systems. Reinstate shall require intervention by the operating personnel.

3.1.5 Provision shall be made at the central ballast control station for the all-pole disconnection of the power supply of the controls of ballast pumps and ballast valves.

3.1.6 The control and display systems shall work independently of each other. A failure in one system shall not affect the operability of the other systems.

3.1.7 The control and display systems shall be provided with a second power supply from an emergency power source.
3.2 Local controls

3.2.1 It shall be possible to control pump motors and valve drives locally and independently of the central control station.

The controls for both systems shall be located in the same room and in the vicinity of the ballast valves and ballast pumps.

3.2.2 It shall be possible to check the position of the ballast valves from the local control stand. The indicators shall rely on movement of the valve spindle.

3.2.3 The availability of the main and emergency power supplies for valve drives and pump motors shall be indicated.

3.2.4 The power for local controls shall be supplied from the appropriate group distribution panel in the case of valve drives and from the associated motor switchgear in the case of ballast pumps. Faults in the remote controls shall not affect the local controls.

4. Monitoring

4.1 At the central ballast control station the following displays shall be provided in so far as they are required by the operating principle of the ballast system and for assessing its current state:

- availability of the main and emergency power supply
- hydraulic/pneumatic pressure in the ballast system, if applicable
- operational status of the ballast pumps
- position (open/closed) of the ballast valves
- liquid level in all ballast tanks and all other tanks liable to affect the stability of the unit
- draught of the unit either at each corner of the unit or at a representative position as required for assessing the draught of the underwater areas concerned
- unit’s heeling angle and trim
- type of control (remote/local/automatic) and operative status

4.2 The control and monitoring systems defined in 4.1 shall function independently of one another, or have sufficient redundancy, such that a failure does not jeopardize the operation of any of the other systems.

4.3 Recording level gauges are not to be mounted in the pipes of the ballast system.

4.4 The failure of a control or indicating system shall release a visual and audible alarm.

5. Communications

A permanent installed intercom link, independent of the unit’s main source of electrical power, is to be provided between the central ballast control station, any additional safety station, where installed, and the local control stands.

6. Testing

6.1 Shop tests of system elements are to be provided as appropriate.

6.2 The complete ballast system and its electrical installations shall be function tested for all relevant ballast situations under TL’s supervision. During these tests all alarms and interlocks, if any, shall be checked.

K. Navigation Lights and Sound Signalling Equipment

1. General

1.1 When a unit is not stationary, attention is drawn to the IMO Regulation „Convention on the International Regulations for Preventing Collisions at Sea” (COLREG). Attention is drawn in relation to the provision of primary and alternative lanterns for each of the navigation lights.

All units shall be provided with “steaming lights”, which comprise masthead, side, stern, anchor, not under
command and, if applicable, special purpose lights, etc.

The distribution board for navigation lights shall be placed in an accessible location on the bridge or at the central control position.

1.2 When the unit is fixed at the operation site the requirements of Section 10, D. have to be applied.

2. Lamps

The construction and installation of navigation lights shall be to the satisfaction of the appropriate Administration.

The lamps, which are to be individually protected by a fuse or mini-circuit-breaker, are each to be supplied by a separate cable from the navigation lights panel.

Main and standby lamps of identical type may be supplied via a single cable with separated conductors provided that it is guaranteed that the lamps can be switched on/off individually.

3. Lights Panel

3.1 The navigation lights panel may be extended to provide connections for signal lamps specified in the current "International Regulations for Preventing Collisions at Sea".

Other consumers shall not be connected to this panel.

3.2 For every lamp the panel is to be fitted with a device which indicates or signals the extinction of a lamp.

RKS Where the indicating device is connected in series with the lamp, it must be ensured that a failure of the device does not cause the navigation light to be extinguished.

If an acoustic device is used alone for indicating, it shall be connected to an independent source of supply, for example a battery, and provision shall be made for testing this supply.

Navigation and signal lights have to be fed from the main and emergency power source.

4. Lamp Supply

4.1 Where navigation lights are supplied from the main power source, the voltages at the lamp holder shall not be permanently more than 5% above or below the rated voltages.

If, in case of a mains failure, the navigation lights are supplied from the emergency power source, the voltage at the lamp holder may be temporarily up to 10% above or below the rated voltage.

4.2 So far as practicable, the arrangements should be such that a fire, a fault or mechanical damage at any one point will not render both systems inoperative.

It is, however, accepted that the systems must come together at some point where the changeover can be effected. This should, preferably, be at or near the light panel.

5. Foghorn

The sound signalling system shall be supplied from the emergency power source if it is only electrically operated or controlled.
SECTION 13

EXPLOSION PROTECTION in HAZARDOUS AREAS

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   5. Semi-enclosed Location

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Section 13 – Explosion Protection in Hazardous Areas

A. General

The requirements in this section are in accordance with the standards in the IEC 60079-series, IEC 61892 part 7 “Mobile and fixed offshore units; Hazardous areas”, IEC 60092 502 “Special features-tankers”, and IMO MODU Code, for equipment selection and installation requirements.

1. The requirements of this Section apply additionally to offshore units and installations with spaces subject to an explosion hazard due to flammable gas-air mixtures.

2. Where certified equipment has to be used, the Test Certificate has to be issued by an internationally recognized institution accepted by TL.

3. The explosion protection and the testing of the electrical equipment shall conform to a recognized national or international standard, e.g. IEC Publication 60079.

The following requirements shall apply for the selection of electrical equipment that shall be fitted in hazardous areas, such as:

- Electrical equipment fitted in a hazardous area shall be certified safe. The Ex protection type shall be according to any requirements for the area or zone in question, or as found in any applicable additional class notation.

- Electrical equipment and wiring shall not be fitted in hazardous areas unless essential for operational purposes and when permitted by the applicable technical standards.

- Unless defined in additional class notations, the hazardous area shall be categorized into hazardous zones in accordance with a relevant IEC standard, and the equipment shall be acceptable for installation in the hazardous zone category.

- Gas group and temperature class of electrical equipment shall be according to the requirements applicable for the gas or vapor that can be existing.

4. Enclosed space

An enclosed space is considered to be a space bounded by bulkheads and decks which may have doors, windows, or other similar openings.

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 so arranged that the dispersion of gas may not occur.

B. Hazardous Areas

1. Hazardous areas are all those areas where, due to the possible presence of a flammable atmosphere arising from the drilling operations, the use without proper consideration of machinery or electrical equipment may lead to fire hazard or explosion. For the purpose of machinery and electrical installations, hazardous areas are classified as in this section item C. Hazardous areas not covered (such as, but not limited to, well test equipment areas, helicopter fuel storage areas, acetylene cylinder storage areas, battery rooms, paint lockers, flammable gas or vapour vents and diverter line outlets) in item C are to be classified as in 2.

2. Hazardous areas are divided into zones as follows:
   Zone 0: in which ignitable concentrations of flammable gases or vapours are continuously present or present for long periods.
   Zone 1: in which ignitable concentrations of flammable gases or vapours are likely to occur in normal operation.
   Zone 2: in which ignitable concentrations of flammable gases or vapours are not likely to occur, or in which such a mixture, if it does occur, will only exist for a short time.

3. For the purpose of machinery and electrical installations, hazardous areas are classified as in 5-7. Hazardous areas not covered (such as, but not limited to, well test equipment areas, helicopter fuel storage areas, acetylene cylinder storage areas, battery rooms, paint lockers, flammable gas or vapour vents and diverter line outlets) in item C are to be classified as in 2.
outlets) in this section should be classified in accordance with 2.

4. Areas such as paint stores or battery rooms, which are not covered by a zone classification, and spaces in which tanks, pipes and machines for media with a flash point below 60 °C are operated, are also considered to be dangerous spaces assigned to Zone 1.

These areas have also to be considered as Zone 1, if liquids with a flashpoint above 60 °C are heated to a temperature higher than 10 °C below their flashpoint. The explosion protection of the electrical equipment is to be so specified that it at least meets the requirements for the atmosphere which may be formed in the aforementioned spaces, or which may infiltrate into these spaces from the drilling or processing area, e.g. in case of faulty conditions.

Electrical installations in hazardous areas shall be documented to comply with this standard.

5. Hazardous areas Zone 0

5.1 The internal spaces of closed tanks and piping for containing active non-degassed drilling mud, oil that has a closed-cup flashpoint below 60°C or flammable gas and vapour, as well as produced oil and gas in which an oil/gas/air mixture is continuously present or present for long periods.

6. Hazardous areas Zone 1:

6.1 Enclosed spaces containing any part of the mud circulating system that has an opening into the spaces and is between the well and the final degassing discharge.

6.2 Enclosed spaces or semi-enclosed locations that are below the drill floor and contain a possible source of release such as the top of a drilling nipple.

6.3 Outdoor locations below the drill floor and within a radius of 1.5 m from a possible source of release such as the top of a drilling nipple.

6.4 Enclosed spaces that are on the drill floor and which are not separated by a solid floor from the spaces in paragraph 6.2.

6.5 In outdoor or semi-enclosed locations, except as provided for in paragraph 6.2, the area within 1.5 m from the boundaries of any openings to equipment which is part of the mud system as specified in paragraph 6.1, any ventilation outlets of zone 1 spaces, or any access to zone 1 spaces.

6.6 Pits, ducts or similar structures in locations which would otherwise be zone 2 but which are so arranged that dispersion of gas may not occur.

7. Hazardous areas Zone 2

7.1 Enclosed spaces which contain open sections of the mud circulating system from the final degassing discharge to the mud pump suction connection at the mud pit.

7.2 Outdoor locations within the boundaries of the drilling derrick up to a height of 3 m above the drill floor.

7.3 Semi-enclosed locations below and contiguous to the drill floor and to the boundaries of the derrick or to the extent of any enclosure which is liable to trap gases.

7.4 In outdoor locations below the drill floor, within a radius of 1.5 m area beyond the zone 1 area as specified in paragraph 6.3.

7.5 The areas 1.5 m beyond the zone 1 areas specified in paragraph 6.5 and beyond the semi-enclosed locations specified in paragraph 6.2.

7.6 Outdoor areas within 1.5 m of the boundaries of any ventilation outlet from or access to a zone 2 space.

7.7 Semi-enclosed derricks to the extent of their enclosure above the drill floor or to a height of 3 m above the drill floor, whichever is greater.

7.8 Air locks between a zone 1 and a non-hazardous area.
8. Openings, access and ventilation conditions affecting the extent of hazardous zones

Except for operational reasons, access doors or other openings should not be provided between a non-
hazardous space and a hazardous area or 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 paragraph 6. 3 or 6.4 and
having a direct access to any zone 1 location or zone 2 location becomes the same zone as the location except
that:

8.1 an enclosed space with direct access to any zone 1 location can be considered as zone 2 if:
8.1.1 the access is fitted with a self-closing gastight door opening into the zone 2 space,
8.1.2 ventilation is such that the air flow with the door open is from the zone 2 space into the zone 1 location, and
8.1.3 loss of ventilation is alarmed at a manned station;
8.2 an enclosed space with direct access to any zone 2 location is not considered hazardous if:
8.2.1 the access is fitted with a self-closing gastight door that opens into the non-hazardous location,
8.2.2 ventilation is such that the air flow with the door open is from the non-hazardous space into the zone 2 location, and
8.2.3 loss of ventilation is alarmed at a manned station;
8.3 an enclosed space with direct access to any zone 1 location is not considered hazardous if:
8.3.1 the access is fitted with two self-closing gastight doors forming an airlock,
8.3.2 the space has ventilation overpressure in relation to the hazardous space, and
8.3.3 loss of ventilation overpressure is alarmed at a manned station.

Where ventilation arrangements of the intended safe space are considered sufficient by TL to prevent any
ingress of gas from the zone 1 location, the two self-closing doors forming an airlock may be replaced by a
single self-closing gastight door which opens into the non-hazardous location and has no hold-back device.

8.4 Piping systems should be designed to preclude direct communication between hazardous areas of
different classifications and between hazardous and non-
hazardous areas.

8.5 Hold-back devices should not be used on self-
closing gastight doors forming hazardous area boundaries.

C. Electrical Equipment in Zones 0, 1 and 2

1. Electrical equipment and wiring installed in hazardous areas shall be limited to that necessary for
operational purposes. Only the cables and types of equipment described in this Section shall be installed.

Selection and installation of equipment and cables in hazardous areas should be in accordance with
international standards. Refer to the following recommendations published by the International
Electrotechnical Commission:

IEC 61892-1:2001 Mobile and fixed offshore units − Electrical installations − Part 1: General requirements
and conditions.


IEC 61892-4:2007 Mobile and fixed offshore units − Electrical installations − Part 4: Cables

IEC 61892-5:2000 Mobile and fixed offshore units − Electrical Installations − Part 5: Mobile units

IEC 61892-7:2007 Mobile and fixed offshore units – Electrical installations – Part 7: Hazardous areas

2. In selection of electrical apparatus for use in hazardous areas, consideration should be given to:

2.1 the zone in which the apparatus will be used;

2.2 the sensitivity to ignition of the gases or vapours likely to be present, expressed as a gas group; and

2.3 the sensitivity of the gases or vapours likely to be present to ignition by hot surfaces, expressed as a temperature classification.

3. Electrical apparatus used in hazardous areas should be manufactured, tested, marked and installed in accordance with international standards (IEC 60079 series) and certified by an independent testing laboratory recognized by the Administration. Equipment classified in accordance with the following protection classes may be used:

Table 13.1 Electrical protection type

<table>
<thead>
<tr>
<th>Type</th>
<th>Protection method</th>
</tr>
</thead>
<tbody>
<tr>
<td>ia and ib</td>
<td>Intrinsic safety</td>
</tr>
<tr>
<td>d</td>
<td>Flameproof enclosures</td>
</tr>
<tr>
<td>e</td>
<td>Increased safety</td>
</tr>
<tr>
<td>m</td>
<td>Encapsulation</td>
</tr>
<tr>
<td>n</td>
<td>Non incendive</td>
</tr>
<tr>
<td>o</td>
<td>Oil immersion</td>
</tr>
<tr>
<td>p</td>
<td>Pressurized enclosures</td>
</tr>
<tr>
<td>q</td>
<td>Powder filling</td>
</tr>
<tr>
<td>s</td>
<td>Special *</td>
</tr>
</tbody>
</table>

* Equipment specially approved for use in this zone by an organization recognized by the Administration.

4. Types of electrical equipment permitted should be determined according to the electrical hazardous area classification of the location in which the equipment is to be installed. Permissible equipment is shown by an “x” in table 13.2. The use of type “o” (oil immersion) should be limited. For transportable apparatus, protection type “o” should not be used.

Table 13.2 Type of electrical apparatus used in hazardous zones

<table>
<thead>
<tr>
<th>Protection type</th>
<th>ia</th>
<th>ib</th>
<th>d</th>
<th>e</th>
<th>m</th>
<th>n</th>
<th>o</th>
<th>p</th>
<th>q</th>
<th>s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 0</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zone 1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Zone 2</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

5. Group selection for electrical equipment should be as follows:

5.1 Group II should be selected for types “e”, “m”, “n”, “o”, “p”, “q” and “s” apparatus.

5.2 Group II A, II B or II C should be selected for types “i”, “d”, and certain types of “n” apparatus according to table 13.3.

Table 13.3 Relationship between gas/vapour group and permitted equipment group

<table>
<thead>
<tr>
<th>Gas/vapour group</th>
<th>Electrical equipment group</th>
</tr>
</thead>
<tbody>
<tr>
<td>II C</td>
<td>II C</td>
</tr>
<tr>
<td>II B</td>
<td>II B or II C</td>
</tr>
<tr>
<td>II A</td>
<td>II A, II B or II C</td>
</tr>
</tbody>
</table>

6. Electrical apparatus should be so selected that its maximum surface temperature will not reach ignition temperature of any gas/vapour possibly presenting in the hazardous areas in which the electrical apparatus is located. The relationship among equipment temperature class, equipment maximum surface temperature, gas/vapour ignition temperature is shown in table 13.4.

7. Electrical apparatus located in hazardous drilling well and mud processing areas should meet at least Group IIA and temperature class T3.
Table 13.4 Relationship among temperature class, maximum surface temperature and ignition temperature

<table>
<thead>
<tr>
<th>Electrical apparatus Temperature class</th>
<th>Electrical apparatus Maximum surface temperature [°]</th>
<th>Gas/vapour ignition temperature [°]</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>450</td>
<td>&gt; 450</td>
</tr>
<tr>
<td>T2</td>
<td>300</td>
<td>&gt; 300</td>
</tr>
<tr>
<td>T3</td>
<td>200</td>
<td>&gt; 200</td>
</tr>
<tr>
<td>T4</td>
<td>135</td>
<td>&gt; 135</td>
</tr>
<tr>
<td>T5</td>
<td>100</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>T6</td>
<td>85</td>
<td>&gt; 85</td>
</tr>
</tbody>
</table>

8. Electrical cables should meet the following:

8.1 Only cables associated with type "ia" equipment should be permitted in zone 0 areas.

8.2 Thermoplastic sheathed cables, thermosetting sheathed cables or elastomeric sheathed cables should be used for fixed wiring in zone 2 areas.

8.3 Flexible and portable cables, where necessary, used in zone 1 and zone 2 areas should be to the satisfaction of TL.

8.4 Permanently installed, fixed cable passing through zone 1 hazardous areas should be fitted with conductive covering, braiding or sheathed for earth detection

Notes
- Remarks of the test Certificates of the certified equipment, e.g. tE time for Ex e components have to be considered. For intrinsically safe circuits a calculation of the circuits has to be carried out and has to be submitted to TL. Reference is made to IEC 60079-14.

9. For fixed offshore installations the national requirements valid at site have to be met in addition.

10. Repairs, maintenance and overhaul of hazardous area certified equipment should be performed by suitably qualified personnel in accordance with appropriate international standards. (e.g. IEC 60079-29-2, IEC 60079-30-1, and IEC 60079-30-2).

There should be maintained a register of electrical equipment installed in the designated hazardous areas, including a description of the equipment, applicable degree of protection and ratings. These requirements are applicable to mobile offshore units with a construction date of 1 January 2020 or later.

D. Emergency Conditions due to Drilling Operations

1. Scope of Shutdown

In view of exceptional conditions in which the explosion hazard may extend outside the above mentioned zones, special arrangements shall be provided to facilitate the selective disconnection or shutdown of:

- Ventilation systems, except fans necessary for supplying combustion air to prime movers for the production of electrical power

- Main generator prime movers, including the ventilation systems for these

- Emergency generator prime movers

2. In the case of units using dynamic positioning systems disconnection or shutdown of machinery and equipment necessary for maintaining the operability of the dynamic positioning system should be based on a shutdown logic system designed to preserve the
capability to maintain operational control over the integrity of the well and station keeping capability. Shutdown of generators and related power supply equipment needed for the operation of the dynamic positioning system should be divided into independent groups to allow response to gas detection alarms while maintaining position keeping. These requirements are applicable to MODUs with a construction date of 1 January 2020 or later.

3. **Locations for Shutdown**

Disconnection or shutdown shall be possible from at least two strategic locations, one of which shall be outside hazardous areas.

4. **Shutdown Systems**

Shut-down systems that are provided to comply with 1. shall be so designed that the risk of unintentional stoppages caused by malfunction in a shutdown system and risk of inadvertent operation of a shutdown are minimized.

5. **Facilities Operable After Shutdown**

5.1 Equipment which is located in spaces other than enclosed spaces and which is capable of operation after shutdown as given in 1. shall be suitable for installation in zone 2 locations. Such equipment which is located in enclosed spaces shall be suitable for its intended application to the satisfaction of TL.

5.2 At least the following facilities shall be operable after an emergency shutdown:

- emergency lighting according to Section 3, D.2. for half an hour
- blow-out preventer control system
- fire and gas detection systems
- general alarm system
- public address system
- battery-supplied radio communication installations

6. **Requirements for Emergency Shutdown Systems**

Where emergency shutdown (ESD) systems are arranged with multiple levels of ESD, the requirement in paragraph 5.1 and 5.2, that equipment located in spaces other than enclosed spaces and which is capable of operation after shutdown as given in paragraph 1. should be suitable for installation in zone 2 locations, shall apply for any ESD level related to gas release. Exceptions may be accepted for equipment that are expected to be out of operation during drilling operations (such as shore power panel, towing winches, windlass, jacking motors etc.).

E. **Other Hazardous Spaces**

1. **Scope**

1.1 Other hazardous spaces to be considered are:

- paint stores
- battery rooms
- welding gas storage rooms
- Helicopter Refueling Facilities
- Oxygen-acetylene Storage Rooms

1.2 The following electrical appliances with approved explosion-protected enclosure may be installed:

- lighting fixtures and the associated switches
- fan motors and the associated switches.

Where fan motors are installed in the exhaust air flow of the ventilation system, the cables located in the air flow shall be mechanically protected, e.g. by conduits extending to the terminal box.
1.3 The following explosion groups and temperature classes are applicable:

- for battery rooms: IIC, T1
- for paint and oil lamp rooms: II B, T3
- for storerooms containing welding gas bottles: IIC, T2

1.4 Paint Stores

1.4.1 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.

1.4.2 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.

1.5. Battery Rooms

1.5.1 Hazardous Areas Zone 1:

- The interior of the battery room;
- Outdoor or semi-enclosed locations within 0.5 m from the boundaries of the natural ventilation outlet;
- Enclosed space containing components of the refueling pump/equipment;

1.5.2 Hazardous Areas Zone 2:

- Outdoor or semi-enclosed locations within 0.5 m from the boundaries of the power ventilation outlet.
- Outdoor or semi-enclosed locations within 1.5 m beyond the Zone 1 area from the power ventilation outlet.
- Outdoor or semi-enclosed locations within 0.5 m from the boundaries of the tank vent outlet;
- Outdoor or semi-enclosed locations within 1.5 m from the boundaries of the refueling pump/equipment.

1.5.3 Hazardous Areas Zone 2:

- Outdoor or semi-enclosed locations within 1.5 m beyond the Zone 1 area from the tank vent outlet;
- Outdoor or semi-enclosed locations within 1.5 m beyond the Zone 1 area from the refueling pump/equipment.
- Outdoor or semi-enclosed locations within 1.5 m 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 beyond the Zone 1 area from the tank vent outlet;
- Outdoor or semi-enclosed locations within 1.5 m beyond the Zone 1 area from the refueling pump/equipment.

1.5.4 For Lithium batteries requirements refer to Additional Rules for the Certification, Installation and Testing of Lithium Batteries.

1.6 Helicopter Refueling Facilities

1.6.1 Hazardous Areas Zone 1:

- Enclosed space containing components of the refueling pump/equipment;
Section 13 – Explosion Protection in Hazardous Areas

1.6.2 Hazardous Areas Zone 2:
- Outdoor or semi-enclosed locations within 1.5 m 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 beyond the Zone 1 area from the tank vent outlet;
- Outdoor or semi-enclosed locations within 1.5 m beyond the Zone 1 area from the refueling pump/equipment.

1.7 Oxygen-acetylene Storage Rooms

1.7.1 Hazardous Areas Zone 1:
- The interior of the storage room;
- Outdoor or semi-enclosed locations within 0.5 m from the boundaries of natural ventilation outlet;
- Outdoor and semi-enclosed locations within 1.5 m from the boundaries of power ventilation outlet.

1.7.2 Hazardous Areas Zone 2:
- Outdoor or semi-enclosed locations within 0.5 m beyond the Zone 1 area from the natural ventilation outlet;

1.8 For ventilation of hazardous areas see Ch. 63, Sec. 2, C.

1.9 Ventilation Alarms

Enclosed space with direct access to any Zone 1 location and enclosed space with direct access to any Zone 2 location Loss of ventilation is to be alarmed at a normally manned station. The alarms to indicate failure of the mechanical ventilation 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.

Enclosed space with access to any zone 1 location air lock and single door loss of ventilation overpressure is to be alarmed at a normally manned station.

The alarms to indicate loss of ventilation overpressure 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 gastight 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.

2. Pipe Tunnels

In pipe tunnels with fuel lines or with adjacent fuel tanks, all equipment and apparatus shall be fixed installed regardless of the flash point of the fuels.

Where pipe tunnels are arranged immediately adjacent to tanks containing combustible liquids with a flash point below 60°, or where these tunnels contain pipes carrying liquids with a flash point below 60 °C, all equipment and apparatus shall have explosion-protected enclosures in accordance with Zone 1 requirements.
3. **Areas with Ignitable Dust Atmosphere**

Only lighting fixtures having at least IP 65 type protection may be used in spaces in which ignitable dusts may be present.

The surface temperature of horizontal surfaces and surfaces inclined at up to 60° off horizontal shall in continuous service be at least 75 K lower than the glow temperature of a 5 mm thick layer of the dust. Other electrical installations are to be agreed with TL.

4. **Helicopter Landing Decks**

See Section 14.

**F. Selection and Routing of Cables**

1. Cables for equipment installed in Zone 0 shall be armoured or screened or run inside metal tubes.

Cables for equipment installed in Zone 1 shall be armoured or screened or run inside metal tubes, and cables for echo-sounders and cathodic protection systems, installed in thick-walled steel pipes with gastight joints up to above the main deck.

2. 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 from other electric cables and are not to occupy an enclosure (such as a junction box or terminal cabinet) with non-intrinsically-safe circuits.

For separation distances of different (separate) intrinsically safe circuits in terminal boxes, the requirements in IEC 60079-14, and IEC 60079-11, Clause 6.21, are to be complied with.

The segregation between the intrinsically safe wiring terminals and between bare conducting parts of connection facilities are to comply with IEC 60079.

Intrinsically-safe cables and wires shall be marked. If the marking is done by colour, the colour has to be light blue.

3. Flexible lines for connecting portable electric appliances may not be run in spaces with an explosion hazard, except for the lines of intrinsically-safe circuits.

4. 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 nonflexible cables), the joints are to be made in approved junction boxes.

5. Portable electrical equipment, important for aboard operation and used in hazardous areas or stipulated for such use by regulations shall be of a certified safe type.

6. Electrical equipment shall not be installed in hazardous areas Zones 0, 1 and 2, unless it is necessary for ships operation or safety. All electrical equipment, necessary to install in hazardous areas Zone 0 and 1 shall be either manufactured according to a recognized standard such as IEC 60079 and certified by an authority recognized by TL or of a simple type belonging to an intrinsically safe circuit. Certificates for electrical equipment installed in zone 2 may be requested TL. Special conditions, mentioned in the certificates or in their instruction manuals have to be observed.

**G. Aerials in Hazardous Spaces**

1. Aerials and their riggings shall be placed outside hazardous areas.

2. If aerials shall be placed in hazardous areas owing important reasons of ship construction or radio technology, the level of radiated power or field strength shall be limited to safe values acceptable to the appropriate authority.

**H. Earthing/Equipotential Bonding**

1. All electrical equipment in hazardous areas shall be earthed regardless of the operating voltage.
2. To avoid static charges, tanks, processing plant, piping systems, etc. shall be permanently linked by electrical conductors and/or earthed to the structure, unless they are electrically connected to the structure by welds or bolts.

Where bonding straps are required, they should be:

- Clearly visible so that any shortcomings can be clearly detected,

- Designed and sited so that they are protected against mechanical damage and that they are not affected by high resistivity contamination e.g. corrosive products or paint,

- Easy to install and replace.

These connections shall be accessible for inspection and protected against mechanical damage and corrosion.

3. For helicopter earthing see Section 14.
SECTION 14
HELICOPTER FACILITIES

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2. Perimeter lighting
3. Floodlighting of the landing area
4. Obstruction lights
5. Visual warning system
6. Feeding and control

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A. General

Helicopter facilities are to be in accordance with a recognised code acceptable to TL. Recognised codes accepted by TL are:

- MODU CODE Chapter 13
- CAA CAP 437 “Civil Aviation Authority; Offshore Helicopter Landing Areas - Guidance on Standards”

Reference is also made to the definition of helicopter facilities in Chapter 62, Section 9.

B. Lighting

1. General

The lighting arrangements for landing areas are to be so designed that they also comply with current national regulations. The following facilities are normally to be provided:

- perimeter lighting of the landing area
- floodlighting of the landing area
- obstruction lights for marking elevated superstructures
- visual warning system

2. Perimeter lighting

2.1 The perimeter lighting depends on the current national regulations, compare Chapter 62, Section 9, A.2.

2.2 Normally shall the helicopter deck be fitted with omni-directional lights in order to enable the landing area to be easily identified at night. The colour of the lights shall meet the requirement of the relevant Authority. These lights shall be uniformly positioned along the perimeter of the helicopter deck and not more than 3 m apart.

An intensity of at least 25 candelas is recommended.

2.3 The lights shall not project more than 25 cm above the plane of the landing area. Use of flush fitting lights or electro-luminescent panels in the obstruction free approach sector perimeter would provide adequate illumination whilst affording minimum obstruction to personnel and equipment movement.

3. Floodlighting of the landing area

3.1 The landing area shall also be floodlit, if intended for night use. The arrangements and aiming of floodlights shall be such that the markings are illuminated and the shadows are kept to a minimum. They shall be arranged so as not to dazzle the pilot and, if elevated and located off the landing area, the system shall not present a hazard to helicopters landing or taking off. Such floodlights shall be capable of being switched on and off at the pilot's request.

3.2 It may be necessary to enhance the lighting to improve depth perception, possibly by using discrete floodlighting to the main structure or legs of self-elevating units.

3.3 The wind direction indicator is to be illuminated.

3.4 Undirected and therefore unnecessary light from other parts of the installation/unit shall be avoided at the helicopter deck area. Adequate shielding of helicopter deck “polluting” light sources shall already be considered in the early design stage or shall also be minimised on existing installations/units. Temporary working lights which pollute the helicopter deck lighting environment should be switched off for helicopter operations.

It is also important to confine the helicopter deck lighting to the landing area, since any light overspill may cause reflections from the sea.

4. Obstruction lights

4.1 For the guidance of helicopter pilots, obstructions such as elevated superstructures, drilling towers, processing plant, crane booms, tops of legs, etc. are to be marked with red obstruction lights.
Objects which are more than 15 m higher than the landing area shall be fitted with intermediate red lights of the same intensity spaced at 10 metre intervals down to the level of the landing area (except such lights would be obscured by other objects).

4.2 Lights are to be used which conform to the recommendations of the International Civil Aviation Organization (ICAO).

4.3 The lights are to be assigned to more than one circuit so that not all the lights are simultaneously extinguished in the event of a fault.

5. Visual warning system

5.1 If a condition can exist on an installation/unit which may be hazardous for the helicopter or its occupants, a visual warning system should be installed according to national regulations. This system (status lights) may be a flashing red light which is visible to the pilot from any direction of approach and on any landing heading.

5.2 The system shall be automatically initiated at the appropriate hazard level, e.g. gas alarm, crane travel, etc., as well as being capable of manual activation.

6. Feeding and control

6.1 The lighting systems according to 2. to 5. are to be supplied from a common lighting switchboard. Each circuit shall be protected against short circuit and overload. Supplies to the switchboard are to be run from the main switchboard and the emergency switchboard of the installation/unit and are to be fed from an Uninterrupted Power Supply (UPS) system.

6.2 The control of the lighting shall be possible from a central position overlooking the complete helicopter operations. It shall be executed by the officer responsible for flight operations on the installation/unit, who shall be able to report any failures or outages immediately to the helicopter pilot.

C. Protection

1. All lighting components and fitments shall meet with the requirements defined in CAA CAP 437.

2. Electrical equipment, including the aviation fuel handling system according to Chapter 62, Section 9, E., shall be explosion protected conforming to temperature class T3 and an explosion group II A suitable for installation in explosion Zone 1 as a minimum requirement.

3. All equipment used in refuelling operations shall have earthing to the installation/unit.

4. During the whole refuelling procedure, helicopters shall have earthing to the installation/unit. This is to be done by a flexible cable with a minimum cross-section of 6 mm². The cable shall be connected to an electrically conductive and earthed part of the helicopter deck. The free end of the cable shall be fitted with a suitable device permitting easy and reliable connection to the helicopter.
SECTION 15

ELECTRICAL EQUIPMENT

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A. Electrical Machinery

1. Generators and Motors

The design and function of rotating machines shall generally comply with the requirements of IEC 60092-301.

Electrical machines shall conform to IEC publication 60034 or an equivalent standard.

Electrical machines, including any excitation system, shall be designed for continuous duty unless otherwise clearly stated. All windings for machines shall be treated to resist moisture, sea air, and oil vapours.

For high-voltage machines, see also Section 6.

Each machine shall be fitted with nameplate of durable material, giving the following information:
- make, type, serial no.
- performance standard
- IP rating
- for AC machines: the winding connection
- rated values for: output apparent power, voltage(s), frequency, current(s), power factor, speed
- duty type, if other than S1
- thermal classification of insulation
- maximum permissible cooling medium temperature
- technical data necessary for the application of the machine
- total mass.

1.1 Materials

Materials for the construction of electrical machines shall conform to the requirements set out in Section 1, J.

For shaft materials, see 1.4.

1.2 Degree of protection

Protection against electric shock, accidental contacts and the entry of foreign bodies and water shall conform to Section 1, K. The degree of required protection shall be assured when the equipment is installed and in operation.

1.3 Ventilation and cooling

1.3.1 The construction of machines with coolants other than air shall be agreed with TL considering the operating conditions.

1.3.2 Draught ventilation

The supply air to draught-ventilated machines shall be as far as practicable free of moisture, oil vapours and dust. If required, filters shall be provided.

1.3.3 Enclosed air cooling circuit

Where heat-exchangers are used in the air circuit, they shall be designed and mounted in such a way that condensation or leakage water from the exchanger system is kept away from the machine windings.

Leakage monitoring is required. The water supply lines and recirculating lines of each heat-exchanger shall be fitted with shut-off valves. The air ducts shall be provided with inspection holes for visual observation of the heat-exchanger.

A failure of cooling (air filters, fan flaps, forced ventilation, recooling) shall be alarmed, e.g. by monitoring of the cooling air temperature.

Machines for electric propulsion plants shall be equipped with monitoring devices in accordance with Section 12.

Machines fitted with brushes shall be ventilated in such direction that fines from the brushes does not enter the inside of the machine.
1.3.4 Surface cooling

Surface-cooled machines on the open deck shall have external fans only if they are fully protected against icing.

1.4 Construction of shafts

The materials for the shafts of

- motors of electric propulsion plants
- main generators supplying the motors of electric propulsion plants
- shaft generators or supplementary electrical drives, if their shafts form part of the unit's main shafting

shall conform to TL Rules, Chapter 2, Material, Section 2 and 4.

Shaft material for other machines is to be in accordance with recognized international or national standard.

Welds on shafts and rotors shall comply with TL Rules Chapter 3, Welding.

1.5 Bearings and bearing lubrication

1.5.1 Plain bearings

Bearing shells shall be easily replaceable. Provision shall be made for checking the bearing lubrication. Adequate lubrication shall be assured even in inclined positions in accordance with Section 1, Tables 1.2 - 1.4. No oil shall flow out and penetrate into the machine.

In the case of bearings with forced lubrication, failure of the oil supply and the attainment of excessive bearing temperatures shall cause an alarm.

Two-part bearings shall be fitted with thermometers indicating, wherever possible, the temperature of the lower bearing shell.

Turbogenerators and propulsion motors shall be equipped with devices which, in the event of a failure of the normal lubricating oil supply, provide adequate lubrication until the machine has come to standstill.

1.5.2 Prevention of bearing currents

To avoid damage to bearings, it is essential to ensure that no harmful currents can flow between bearing and shaft.

1.6 Standstill heating system

Generators and main propulsion motors with an output ≥ 500 kW and all transverse-thruster motors shall be equipped with an electric heating designed to maintain the temperature inside the machine at about 3 K above ambient temperature.

An indicator shall show when the standstill heating system is in operation.

1.7 Accessibility for inspection, repairs and maintenance

Components like commutators, sliprings, carbon brushes and regulators for example shall be accessible for inspection, repairs and maintenance.

For larger machines with plain bearings, provision shall be made for the direct or indirect measurement of the air gap.

1.8 Windings

In interaction with the specified protection devices, machines shall be able to withstand the dynamic and thermal stresses likely to result from a short circuit.

Machines shall be designed and rated in such a way that the permissible temperature rises listed in Table 15.3 are not exceeded.

All windings shall be effectively protected against the effects of oil vapours and air laden with moisture or salt.

1.9 Air gaps

Machines with only one internal bearing shall have a minimum air gap of 1,5 mm.
1.10 Brush rocker

The operation position of the brush rocker shall be clearly marked.

1.11 Terminal boxes

Terminal boxes shall be located in accessible positions. Separate terminal boxes are required for terminals with service voltages above 1000 V AC or 1500 V DC.

Terminals shall be clearly marked. The degree of protection of terminal boxes shall correspond to that of the machine, but shall in no case be less than IP 44, see Section 1, K.

1.12 Voltage regulators

Regulators shall withstand the loads expected at the place of installation, see Section 1.

The installation of regulators in terminal boxes is only permitted if the regulator units are mechanically separated so that they cannot be damaged during the mounting of the main cables.

Set point adjusters shall be so designed that shifting of themselves is impossible, and they shall be adjustable from outside by use of a tool only.

1.13 Operation in network with semiconductor converters

Electric machines operating in networks containing semiconductor converters shall be designed for the expected harmonics of the system. A sufficient reserve shall be considered for the temperature rise, compared with a sinusoidal load.

1.14 Rating plate

Machines shall be fitted with durable corrosion-resistant rating plates.

2. Magnetic Brakes

The requirements stated in 1. shall be applied correspondingly.

The temperature rise of the windings shall not exceed the permitted values shown in Table 15.3.

Where windings are located in the immediate vicinity of the brake linings, the heat generated during braking shall be considered.

3. Magnetic Clutches

The requirements stated in 1. shall be applied correspondingly.

When engaged, the clutch shall take over the drive smoothly and reliably. The clutch shall exert no axial thrust.

4. Testing of Electrical Machinery

4.1 General

All electric machines shall be tested at the manufacturer's works.

A works test report shall be prepared covering the tests performed.

The tests shall be performed in accordance with IEC 60092-301:1980/AMD2:1995 and 60034-1:2017. TL reserve the right to stipulate additional tests in the case of new types of machines or where it is required for another particular reason.

4.2 Tests in the presence of a Surveyor

The machines listed below are subject to testing in the manufacturer's works in the presence of a TL Surveyor:

Note: An alternative survey scheme may be agreed by the TL with the manufacturer whereby attendance of the Surveyor will not be required as required below.

4.2.1 Generators and motors for essential equipment with outputs of 50 kW or kVA and over.

4.2.2 Material test for shafts of:
- motors of electric propulsion plants
Section 15 – Electrical Equipment

- main generators supplying the motors of electric propulsion plants

4.3 Works test reports

On request, works test reports shall be presented for machines not tested in the presence of a TL -Surveyor.

4.4 Extent of tests

Type tests are to be carried out on a prototype machine or on the first of a batch of machines, and routine tests carried out on subsequent machines in accordance with Table 15.1

Note:
Test requirements may differ for shaft generators, special purpose machines and machines of novel construction.

4.3.1 Examination of the technical documentation

Technical documentation of machines rated at 100kW and over is to be available for examination by the Surveyor.

4.3.2 Visual inspection

A visual examination is to be made of the machine to ensure, as far as is practicable, that it complies with technical documentation.

4.4.2 Measurement of winding resistance

The resistances of the machine windings are to be measured and recorded using an appropriate bridge method or voltage and current method.

4.4.3 No load test

Machines are to be operated at no load and rated speed whilst being supplied at rated voltage and frequency as a motor or if a generator it is to be driven by a suitable means and excited to give rated terminal voltage.

During the running test, the vibration of the machine and operation of the bearing lubrication system, if appropriate, are to be checked.

4.4.4 Temperature rise test

The temperature rises are to be measured at the rated output, voltage, frequency and the duty for which the machine is rated and marked in accordance with the testing methods specified in IEC 60034-1:2017, or by means of a combination of other tests.

The limits of temperature rise are those specified in the relevant table of IEC 60034-1:2017 adjusted as necessary for the ambient reference temperatures specified in TL- R M40.

- A heat test shall be performed until the steady-state temperature corresponding to the required mode of operation is reached. The steady-state temperature pass for reached when the temperature rises by not more than 2 K per hour.

Machines with separate cooling fans, air filters and heat exchangers shall be tested together with this equipment.

The heat run shall be completed with the determination of the temperature rise. The maximum permissible values shown in Table 20.3 shall not be exceeded.

- An extrapolation of the measured values to the disconnection time (t = 0) is not necessary if the reading takes place within the periods listed in Table 15.2.

- Heat tests on machines of identical construction made not more than 3 years previously can be recognized.

The referenced temperature rise shall be at least 10 % lower than that listed in Table 15.3.

The following tests shall be carried out at approximately normal operating temperatures.

4.4.5 Load characteristics

For generators the voltage, and for motors the speed shall be checked as a function of the load.
Table 15.1    Summary of test to be carried out

<table>
<thead>
<tr>
<th>No</th>
<th>Tests</th>
<th>A.C. Generators</th>
<th>Motors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Type test (1)</td>
<td>Routine test (2)</td>
</tr>
<tr>
<td>1.</td>
<td>Examination of the technical documentation, as appropriate and visual inspection</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>2.</td>
<td>Insulation resistance measurement</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>3.</td>
<td>Winding resistance measurement</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>4.</td>
<td>Verification of the voltage regulation system</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>5.</td>
<td>Rated load test and temperature rise measurements</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>6.</td>
<td>Overload/overcurrent test</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>7.</td>
<td>Verification of steady short circuit conditions (5)</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>8.</td>
<td>Overspeed test</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>9.</td>
<td>Dielectric strength test</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>10.</td>
<td>No-load test</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>11.</td>
<td>Verification of degree of protection</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>12.</td>
<td>Verification of bearings</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

(1) Type tests on prototype machine or tests on at least the first batch of machines.
(2) The report of machines routine tested is to contain the manufacturer's serial number of the machine which has been type tested and the test result.
(3) Only functional test of voltage regulator system.
(4) Only applicable for machine of essential services rated above 100kW.
(5) Verification of steady short circuit condition applies to synchronous generators only.
(6) Not applicable for squirrel cage motors.

Table 15.2    Time limits for data acquisition

<table>
<thead>
<tr>
<th>Rated power [kW/kVA]</th>
<th>Time elapsed after disconnection [s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 50</td>
<td>30</td>
</tr>
<tr>
<td>over 50 up to 200</td>
<td>90</td>
</tr>
<tr>
<td>over 200 up to 5000</td>
<td>120</td>
</tr>
<tr>
<td>over 5000</td>
<td>by agreement</td>
</tr>
</tbody>
</table>

4.4.6    Overload, overcurrent test

Overload test is to be carried out as a type test for generators as a proof of overload capability of generators and excitation system, for motors as a proof of momentary excess torque as required in IEC 60034-1:2017. The overload test can be replaced at routine test by the overcurrent test. The over current test shall be the proof of current capability of windings, wires, connections etc. of each machine. The overcurrent test can be done at reduced speed (motors) or at short circuit (generators).
for generators at 1,5 times the rated current for two minutes

- for motors where no particular assessments are made, at 1,6 times the rated torque for 15 seconds. During the tests the motors shall not deviate substantially from their rated speeds. Three phase motors shall not pull-out.

- for anchor windlass motors, at 1,6 times the rated torque for two minutes. Overload tests already performed on motors of identical construction may be recognized. The current of the operating stage corresponding to twice the rated torque shall be measured and indicated on the rating plate.

4.4.7 Short-circuit test

It is to be verified that under steady-state short-circuit conditions, the generator with its voltage regulating system is capable of maintaining, without sustaining any damage, a current of at least three times the rated current for a duration of at least 2 s or, where precise data is available, for a duration of any time delay which will be fitted in the tripping device for discrimination purposes.

- In order to provide sufficient information to the party responsible for determining the discrimination settings in the distribution system where the generator is going to be used, the generator manufacturer shall provide documentation showing the transient behaviour of the short circuit current upon a sudden short-circuit occurring when excited, and running at nominal speed. The influence of the automatic voltage regulator shall be taken into account, and the setting parameters for the voltage regulator shall be noted together with the decrement curve. Such a decrement curve shall be available when the setting of the distribution system’s short-circuit protection is calculated. The decrement curve need not be based on physical testing. The manufacturer’s simulation model for the generator and the voltage regulator may be used where this has been validated through the previous type test on the same model.

On all synchronous generators, the steady short circuit current shall be determined with the exciter unit in operation.

With a three-phase short circuit between terminals, the steady short-circuit current shall not be less than three times the rated current. The generator and its exciter unit shall be capable of withstanding the steady short-circuit current for a period of two seconds without suffering damage.

- A sudden short-circuit test may be demanded to determine the reactances, if there is any concern regarding mechanical and electrical strength.

Synchronous generators which have undergone a sudden-short-circuit test shall be thoroughly examined after the test for any damage.

4.4.8 Overspeed test

As proof of mechanical strength, a two-minute overspeed test shall be carried out as follows:

- for generators with their own drive, at 1,2 times the rated speed

- for generators coupled to the main propulsion plant and not arranged in the main shafting, at 1,25 times the rated speed

- for motors with one nominal speed, at 1,2 times the no-load speed

- for variable-speed motors, at 1,2 times the maximum no-load speed

- for motors with series characteristics, at 1,2 times the maximum speed shown on the rating plate, but at least at 1,5 times the rated speed
The overspeed test may be dispensed with in the case of squirrel-cage machines.

4.4.9  **Dielectric strength test (high-voltage test)**

Machines are to withstand a dielectric test as specified in IEC 60034-1:2017. For high voltage machine an impulse test is to be carried out on the coils according to TL- R E11.

4.4.9.1  The test voltage shall be as shown in Table 15.4. It shall be applied for one minute for each single test.

The voltage test shall be carried out between the windings and the machine housing, the machine housing being connected to the windings not involved in the test. This test shall be performed only on new, fullyassembled machines fitted with all their working parts.

The test voltage shall be a practically sinusoidal AC voltage at system frequency.

The maximum anticipated no-load voltage or the maximum system voltage is to be used as reference in determining the test voltage.

4.4.9.2  Any repetition of the voltage test which may be necessary shall be performed at only 80 % of the nominal test voltage specified in Table 15.4.

4.4.9.3  Electrical machines with voltage ratings acc. to Section 6 shall be subjected to a lightning impulse withstand voltage test acc. to IEC publication 60034- 15. The test shall be carried out for the coils as a random sample test.

4.4.10  **Determination of insulation resistance**

Immediately after the high voltage tests the insulation resistances are to be measured using a direct current insulation tester between:

- All current carrying parts connected together and earth,
- All current carrying parts of different polarity or phase, where both ends of each polarity or phase are individually accessible.

The minimum values of test voltages and corresponding insulation resistances are given in Table 15.5. The insulation resistance is to be measured close to the operating temperature, or an appropriate method of calculation is to be used.

4.4.11  **Test of degree of protection**

As specified in IEC 60034-5:2000+AMD1

4.4.12  **Bearing check**

Upon completion of the above tests, machines which have sleeve bearings are to be opened upon request for examination by the TL Surveyor, to establish that the shaft is correctly seated in the bearing shells.

4.4.13  **Test of voltage regulator**

See Section 3, C.2.

**B. Power Transformers**

1.  **General**

The design of transformers shall in general comply with the requirements of IEC 60092-303 and relevant parts of IEC 60076 – “Power Transformers”.

For high-voltage transformers, see also Section 6.

1.1  **Coolant**

Preferably dry type transformers shall be used on board of ships.

For separately cooled transformers the cooling air shall be monitored and alarm on failure. Where forced cooling is used, it shall be possible to operate at reduced power on failure.
### Table 15.3 Permitted temperature rises of air cooled machines at an ambient temperature of 45 °C (difference values in K)

<table>
<thead>
<tr>
<th>No</th>
<th>Machinery component</th>
<th>Method or measurement (3)</th>
<th>Insulation class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>1</td>
<td>AC windings of machines</td>
<td>R</td>
<td>55</td>
</tr>
<tr>
<td>2</td>
<td>Commutator windings</td>
<td>R</td>
<td>55</td>
</tr>
<tr>
<td>3</td>
<td>Field windings of AC and DC machines with DC excitation, other than those specified under 4</td>
<td>R</td>
<td>55</td>
</tr>
<tr>
<td>4</td>
<td>a) Filed windings of synchronous machines with cylindrical rotors having DC excitation winding, embedded in slots except synchronous induction motors</td>
<td>R</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>b) Stationary field windings of DC machines having more than one layer</td>
<td>R</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>c) Low-resistance field windings of AC and DC machines and compensation windings of DC machines having more than one layer</td>
<td>R</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>d) Single-layer field windings of AC and DC machines with exposed bare or varnished metal surfaces and single-layer compensation windings of DC machines</td>
<td>R</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Th</td>
<td>55</td>
</tr>
<tr>
<td>5</td>
<td>Permanently short-circuited, insulated windings</td>
<td>Th</td>
<td>55</td>
</tr>
<tr>
<td>6</td>
<td>Permanently short-circuited, uninsulated windings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Iron cores and other parts not in contact with windings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Iron cores and other parts in contact with windings</td>
<td>Th</td>
<td>55</td>
</tr>
<tr>
<td>9</td>
<td>Commutators and slip rings, open or enclosed</td>
<td>Th</td>
<td>55</td>
</tr>
<tr>
<td>10</td>
<td>Plain bearings</td>
<td>measured in the lower bearing shell or in the oil sump after shutdown</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Roller bearings Rollers bearings with special grease</td>
<td>measured in the lubrication nipple bore or near the outer bearing seat</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Surface temperature</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) These values may need correction in the case of high-voltage AC windings.

(2) Higher temperature rises may be expected on electrical machines with insulation material for high temperatures. Where parts of such machinery may be accidentally touched and there is a risk of burns (> 80 °C), TL reserve the right to request means of protection such as a handrail to prevent accidental contacts.

(3) R = resistance method, Th = thermometer method
1.2 Windings

All transformers shall have separate windings for primary and secondary coils except for starting and ignition transformers, which may be of the autotransformer type. Medium voltage distribution transformers and propulsion transformers are to be provided with temperature monitoring. Medium voltage propulsion transformers shall have earthed screen windings.

2. Rating

2.1 Voltage variation during loading

Under resistive load, the voltage variation between no load and full load may not exceed 2.5%.

This requirement does not apply to short-circuit proof transformers.

2.2 Temperature rise

The limit temperature rise of windings may not exceed the values shown in Table 15.6.

Parts of casings with surface temperatures exceeding 80 °C shall be protected against unintentional contact.

2.3 Short circuit resistance

Transformers shall be constructed to withstand a primary or secondary terminal short circuit with a duration of minimum 1 s, with rated primary voltage and frequency, without damage to internal parts or enclosure.

2.4 Parallel operation

Transformers for parallel operation shall have compatible coupling groups and voltage regulation. The actual current of each transformer will not differ from its proportionate share of the total load by more than 10% of its full load current.

3. Rating Plate

Transformers shall be provided with a durable corrosion-resistant rating plate, giving the following information:

- Make, type, serial no.
- Performance standard
- Rated values for: output apparent power, voltage(s), frequency, current(s)
- Duty type, if other than S1
- Thermal classification of insulation
- IP code of enclosure and termination box
- Vector group of windings
- Maximum permissible cooling medium temperature
- Short circuit impedance value
- Liquid type (if applicable)
- Total mass.

4. Tests

4.1 Transformers shall be tested in the manufacturer’s works. Transformers rated with 100 kW and above shall be tested in the presence of a Surveyor. A works test report covering the tests carried out shall be prepared. The works test reports shall be presented on request. Tests noted as type tests shall be carried out on a prototype or the first of a batch of identical transformers. Tests noted as routine tests shall be carried out on each transformer.

Required inspection and tests for transformers are given in Table 15.7.

The following tests shall be carried out. The tests according to 4.3 – 4.6 shall be performed at approximately operating temperature.
## Table 15.4  
Test voltages for the winding test

<table>
<thead>
<tr>
<th>No</th>
<th>Machine or machinery component</th>
<th>Test voltage (rms) dependent on rated voltage U of the subject winding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Insulated windings of rotating machines of output less than 1 kW (kVA), and of rated voltages less than 100 V with the exception of those in items 4 to 8</td>
<td>$2U + 500V$</td>
</tr>
<tr>
<td>2</td>
<td>Insulated windings of rotating machines of size less than 10000 kW (kVA), with the exception of those in item 1 and items 4 to 8</td>
<td>$2U + 1000V$, with a minimum of 1500 V</td>
</tr>
<tr>
<td>3</td>
<td>Insulated windings of rotating machines of size 10000 kW (kVA) or more with the exception of those in items 4 to 8, and a rated voltage up to 11000 V</td>
<td>$2U + 1000V$</td>
</tr>
<tr>
<td>4</td>
<td>Separately excited field windings of DC machines</td>
<td>$1000V +$ twice the maximum excitation voltage but not less than 1500 V</td>
</tr>
<tr>
<td>5</td>
<td>Field windings of synchronous generators, synchronous motors and rotary phase converters</td>
<td>10 times rated field voltage with a minimum of 1500 V</td>
</tr>
<tr>
<td></td>
<td>a) rated field voltage up to 500 V</td>
<td>4000 V + twice rated field voltage</td>
</tr>
<tr>
<td></td>
<td>b) over 500 V</td>
<td>10 times the rated field voltage, minimum 1500 V, maximum 3500 V</td>
</tr>
<tr>
<td></td>
<td>When a machine is intended to be started with the field winding short-circuited or connected across a resistance of value less than ten times the resistance of the winding</td>
<td>1000 V + twice the maximum value of the rms voltage, which can occur under the specified starting conditions, between the terminals of the field winding, or in the case of a sectionalized field winding between the terminals of any section with a minimum of 1500 V</td>
</tr>
<tr>
<td></td>
<td>When the machine is intended to be started either with the field winding connected across a resistance of value equal to, or more than, ten times the resistance of the winding, or with the field windings on open-circuit with or without a field dividing switch</td>
<td>1000 V + twice the open-circuit standstill voltage as measured between slip rings or secondary terminals with rated voltage applied to the primary windings</td>
</tr>
<tr>
<td>6</td>
<td>Secondary (usually rotor) windings of induction motors or synchronous induction motors if not permanently short-circuited (e.g. if intended for rheostatic starting)</td>
<td>$1000V +$ twice the open-circuit standstill voltage as measured between slip rings or secondary terminals with rated voltage applied to the primary windings</td>
</tr>
<tr>
<td></td>
<td>a) for non-reversing motors or motors reversible from standstill only</td>
<td>1000 V + four times the open-circuit secondary voltage as defined in item 6a)</td>
</tr>
<tr>
<td></td>
<td>b) for motors to be reversed or braked by reversing the primary supply while the motor is running</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Exciters (exception below)</td>
<td>as for the windings to which they are connected</td>
</tr>
<tr>
<td></td>
<td>Exception 1: Exciters of synchronous motors (including synchronous induction motors) if connected to earth or disconnected from the field windings during starting</td>
<td>twice rated exciter voltage + 1000 V, with a minimum of 1500 V</td>
</tr>
<tr>
<td></td>
<td>Exception 2: Separately excited field windings of exciters</td>
<td>as under item 4</td>
</tr>
<tr>
<td>8</td>
<td>Assembled group of machines and apparatus</td>
<td>A repetition of the test in items 1 to 7 above should be avoided if possible, but if a test on an assembled group of several pieces of new machines, each one of which has previously passed its high-voltage test, is made, the test voltage to be applied to such assembled group shall be 80% of the lowest test voltage appropriate for any of the group. 1</td>
</tr>
</tbody>
</table>

(1) Where a number of windings belonging to one or more machines are connected together, the test voltage is dictated by the maximum voltage to earth which can occur.
### Table 15.5 Minimum values for measurement voltage and insulation resistance

<table>
<thead>
<tr>
<th>Rated voltage [V] \ (1)</th>
<th>Measurement voltage [V]</th>
<th>Insulation resistance [MΩ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U_n \leq 250$</td>
<td>2 × $U_n$</td>
<td>1</td>
</tr>
<tr>
<td>$250 &lt; U_n \leq 1000$</td>
<td>500</td>
<td>1</td>
</tr>
<tr>
<td>$1000 &lt; U_n \leq 7200$</td>
<td>1000</td>
<td>$1 + U_n/1000$</td>
</tr>
<tr>
<td>$7200 &lt; U_n \leq 15000$</td>
<td>5000</td>
<td>$1 + U_n/1000$</td>
</tr>
</tbody>
</table>

(1) The maximum anticipated no-load voltage or the maximum system voltage shall be taken for the rated voltage.

### 4.2 Heat test

The test shall be performed to determine the temperature rise, which shall not exceed the maximum permissible values in Table 15.6.

Temperature test at full load may be difficult to realise on large transformers, due to insufficient test power being available. One of these simulated tests, or equivalent may be accepted:
- Back to back method, according to IEC 60076-11.
- Simulated load method, according to IEC 60076-11.

Temperature rise tests on transformers of identical construction manufactured not more than 3 years previously may be recognized. The referenced temperature rise shall be 10% below the values shown in Table 15.6.

### Table 15.6 Permissible temperature rise of transformer and reactance coil windings at an ambient temperature of 45 °C

<table>
<thead>
<tr>
<th>Insulation class</th>
<th>A</th>
<th>E</th>
<th>B</th>
<th>F</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature rise [K]</td>
<td>55</td>
<td>70</td>
<td>75</td>
<td>95</td>
<td>120</td>
</tr>
</tbody>
</table>

### 4.3 Induced overvoltage test

The windings shall be tested at twice the rated voltage and at increased frequency to verify that the insulation between turns is satisfactory. The applied frequency shall be tested up to twice of nominal frequency (including twice of nominal frequency) for 60 seconds.

The duration of the test shall be

$$120 \cdot \text{rated frequency} / \text{test frequency}$$

but not less than 15 s.

### 4.4 Short circuit test

Where required, short circuit proof property in accordance with 2.3 shall be verified.

### 4.5 Winding test (High voltage test)

The test voltage shown in Table 15.8 shall be applied after temperature rise test (if done) between the winding parts to be tested and all other windings, which are to be connected to the core and the frame during the test.

The test voltage shall be applied for one minute.

After rewinding or other extensive repair the transformer shall be subjected to a high voltage test with a test voltage of at least 75% of that specified in Table 15.8.

### 4.6 Determination of insulation resistance

The measurement of insulation resistance shall be carried out at the end of the test sequence. Test voltage and minimum insulation resistance is given in Table 15.5. The test shall be carried out between:

- All current carrying parts, connected together, and earth
- All current carrying parts of different polarity or phase, where both ends of each polarity or phase are individually accessible.
The insulation resistance shall at least conform to the values indicated in Table 15.5.

4.7 Onboard testing

All transformers shall be subject to function tests with intended loading, after installation onboard.

C. Capacitors

1. General

The requirements of this Section apply to power capacitors with a reactive power of 0.5 kVA and over.

2. Construction

2.1 Capacitors shall have gastight steel cases. The metal cases shall have means for the connection of earthing conductors.

2.2 Internal faults shall be limited by element fuses.

2.3 Discharge resistors shall ensure the discharge of the capacitor to a terminal voltage below 50 V within one minute after disconnection.

Capacitors within a converter shall be discharged to less than 60 Volt in less than 5 s (or a residual charge of less than 50 μC) after removal of the power. If this requirement not is achievable, warning signboards shall be installed.

3. Testing

A type test report shall be submitted for each capacitor on request.

### Table 15.7 Scope of testing and inspection of transformers

<table>
<thead>
<tr>
<th>No.</th>
<th>Explanations</th>
<th>Routine Tests</th>
<th>Type Tests</th>
<th>IEC reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inspection of enclosure, terminations, instrumentation or protection</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Measuring of insulation resistance</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Measuring of voltage ratio and check of phase displacement</td>
<td>x</td>
<td>IEC 60076-11.14.2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Measuring of winding resistance</td>
<td>x</td>
<td>IEC 60076-11.14.2</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Short circuit impedance and load losses</td>
<td>x</td>
<td>IEC 60076-11.14.2</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Measuring of no-load loss and current</td>
<td>x</td>
<td>IEC 60076-11.14.2</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Applied voltage test (AV)</td>
<td>x</td>
<td>IEC 60076-11.14.2</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Induced voltage withstand test (IVW)</td>
<td>x</td>
<td>IEC 60076-11.14.2</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Temperature rise test</td>
<td></td>
<td>IEC 60076-11.14.3</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Partial discharge measurement on transformer windings with Um ≥ 3.6 kV.</td>
<td>x</td>
<td>IEC 60076-11.14.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maximum level of partial discharge shall be 10 pC.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Not applicable to liquid immersed transformers.)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The dimensional design of capacitors shall be such that, if the case is damaged, not more than 10 litres of impregnating agent can leak out.
4. Selection and Operation

4.1 The dissipation of heat by convection and radiation shall be ensured. In locations with a high ambient temperature, capacitors of a higher temperature class shall be used.

4.2 The capacitor voltage rating shall be selected in accordance with the operating voltage of the power system, with due regard to a possible voltage increase caused by the capacitor and any inductances in series.

4.3 In systems with high levels of harmonics, capacitors shall be protected against overloading by the use of series inductors and/or by selecting a higher capacitor voltage rating.

4.4 To avoid self-excitation of individually compensated motors, the compensation power shall not exceed 90 % of the no-load reactive power of the motor.

4.5 Reactive power controllers or electrical interlocks are required to avoid overcompensation of the installation’s/unit’s main.

Table 15.8 Test voltage for transformers

<table>
<thead>
<tr>
<th>Maximum operating voltage [V]</th>
<th>Alternating withstand voltage [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 1000</td>
<td>3000</td>
</tr>
<tr>
<td>≤ 3600</td>
<td>10000</td>
</tr>
<tr>
<td>≤ 7200</td>
<td>20000</td>
</tr>
<tr>
<td>≤ 12000</td>
<td>28000</td>
</tr>
<tr>
<td>&lt; 17500</td>
<td>38000</td>
</tr>
</tbody>
</table>

D. Storage Batteries, Chargers and Uninterruptible Power Supplies (UPS)

1. General

1.1 These requirements apply to stationary storage batteries and chargers.

1.2 Rating of batteries

Storage batteries shall be so rated that they can supply the consumers for the required period, in accordance with the energy balance, when charged to 80 % of their rated capacity.

At the end of the supply period, the voltage at the battery or at the consumers shall conform as a minimum requirement to the values indicated in Section 1, F. and Section 3, D.

1.3 References to other rules

See Section 2, B. and Section 3.

2. Storage Batteries

2.1 Permitted are lead-acid storage batteries with dilute sulphuric acid as electrolyte and steel batteries with nickel-cadmium cells and dilute potassium hydroxide as electrolyte.

2.2 Other types of storage batteries such as silver/zinc batteries or sealed lead-acid batteries may be permitted, if their suitability for offshore use is proven.

2.3 In case of mobile units storage batteries shall be so designed that they retain their rated capacity at inclinations of up to 22.5°, and no electrolyte leaks out at inclinations of up to 40°. Cells without covers are not allowed.

2.4 The casing shall be resistant to electrolytes, mineral oils, cleaning agents and corrosion by saline mist. Glass and readily flammable materials shall not be used for battery casings.

2.5 For storage batteries containing liquid electrolyte it must be possible to check the electrolyte level. The maximum permissible electrolyte level has to be marked.

2.6 The weight of the greatest transportable unit shall not exceed 100 kg.
2.7 The nominal operating data of storage batteries shall be indicated on rating plates.

2.8 Storage batteries shall be maintained and operated in accordance with the manufacturer’s instructions.

3. Chargers

3.1 Charging equipment shall be so rated that discharged storage batteries can be charged to 80% of their rated capacity within a period not greater than 10 hours without exceeding the maximum permissible charging currents.

Only automatic chargers shall be used with charging characteristics adapted to the type of batteries.

3.2 If consumers are simultaneously supplied during charging, the maximum charging voltage shall not exceed 120% of the rated voltage.

The power demand of the consumers shall be considered for the selection of the chargers.

3.3 Chargers with a charging power above 2 kW shall be tested in presence of a TL Surveyor.

4. Uninterruptible Power Supplies (UPS)

4.1 General

4.1.1 These requirements to UPS units, as defined in IEC 62040-3:2011, apply when providing an alternative power supply or transitional power supply to services as defined in Section 3, D. A UPS unit complying with these requirements may provide an alternative power supply as an accumulator battery in terms of being an independent power supply for services defined in Section 3, D.2.1.3 and 2.1.4.

4.1.2 Definitions

4.1.2.1 Uninterruptible power system (UPS)

Combination of converter, inverter, switches and energy storage means, for example batteries, constituting a power supply system for maintaining continuity of load power in case of input power failure (IEC 62040-3:2011).

4.1.2.2 Off-line UPS unit

A UPS unit where under normal operation the output load is powered from the input power supply (via by-pass) and only transferred to the inverter if the input power supply fails or goes outside preset limits. This transition will invariably result in a brief break in the load supply.

4.1.2.3 On-line UPS unit

A UPS unit where under normal operation the output load is powered from the inverter, and will therefore continue to operate without break in the event of the power supply input failing or going outside preset limits.

4.1.2.4 Line interactive UPS unit

An off-line UPS unit where the bypass line switch to stored energy power when the input power goes outside the preset voltage and frequency limits.

4.2 Design and construction

4.2.1 UPS units are to be constructed in accordance with IEC 62040-1:2017, IEC 62040-2:2016, IEC 62040-3:2011, IEC 62040-4:2013 and/or IEC 62040-5:2016, as applicable, or an acceptable and relevant national or international standard. Battery ventilation shall be designed in accordance with Section 2,B.

4.2.2 The operation of the UPS is not to depend upon external services.

4.2.3 The type of UPS unit employed, whether off-line or on-line, is to be appropriate to the power supply requirements of the connected load equipment.
4.2.4 A bypass or a second UPS in parallel is to be provided.

4.2.5 The UPS unit is to be monitored. An audible and visual alarm is to be given on the ship’s alarm system for
- Power supply failure (voltage and frequency) to the connected load,
- Earth fault, if applicable,
- Operation of battery protective device,
- When the battery is being discharged, and
- When the UPS is not operating under normal condition.

4.3 Location

4.3.1 The UPS unit is to be suitably located for use in an emergency.

4.3.2 UPS units utilising valve regulated sealed batteries may be located in compartments with normal electrical equipment, provided the ventilation arrangements are in accordance with the requirements of IEC 62040-1:2017, IEC 62040-2:2016, IEC 62040-3:2011, IEC 62040-4:2013 and/or IEC 62040-5-3:2016, as applicable, or an acceptable and relevant national or international standard.

4.4 Performance

4.4.1 The output power is to be maintained for the duration required for the connected equipment as stated in Section 3, D.

4.4.2 No additional circuits are to be connected to the UPS unit without verification that the UPS unit has adequate capacity. The UPS battery capacity is, at all times, to be capable of supplying the designated loads for the time specified in Section 3, D.

4.4.3 On restoration of the input power supply, the rating of the charge unit shall be sufficient to recharge the batteries while maintaining the output supply to the load equipment.

4.5 Testing and survey

4.5.1 UPS units of 50 kVA and over are to be surveyed by TL during manufacturing and testing.

4.5.2 Appropriate testing is to be carried out to demonstrate that the UPS unit is suitable for its intended environment. This is expected to include as a minimum the following tests:
- Functionality, including operation of alarms,
- Temperature rise,
- Ventilation rate,
- Battery capacity.

4.5.3 Where the supply is to be maintained without a break following a power input failure, this is to be verified after installation by practical test.

E. Switchgear and Protective Devices

1. General

1.1 Switchgear and protective devices shall conform to IEC Publications or to another standard recognized by TL.

1.2 For materials and insulation, see Section 1, J.

1.3 For equipment and components subject to mandatory type approval, see Section 5, H. and Section 16, E.

2. High-voltage Switchgear

For details of high voltage switchgear, see Section 6.
3. Low-voltage Switchgear

3.1 Circuit breakers

3.1.1 Drives

- Power-driven circuit-breakers shall be equipped with an additional emergency drive for handoperation.

- Mechanical actuating elements on circuit breakers for generators and essential circuits shall be so connected to the circuit-breakers that they cannot be lost.

- Circuit-breakers with a making capacity exceeding 10 kA shall be equipped with a drive which performs the closing operation independently of the actuating force and speed (by snap action).

- If the conditions for the closing operation are not fulfilled (e.g. undervoltage release not energized), switching-on shall not cause the contact pieces to come into contact.

3.1.2 Making and breaking capacity

The making and breaking capacity shall be tested in accordance with IEC publication 60947-2. Other standards may be recognized.

4. Protection Devices

4.1 Short-circuit protection

Short-circuit protection devices shall be independent of energy supplied from other circuits than those to be protected. In the event of a short circuit, the total breakdown of the supply voltage shall be expected.

Short-circuit protection devices for generators shall be equipped with reclosing inhibitors, and shall be delayed for selective disconnection.
4.6 Reverse power protection

The reverse power protection device shall respond to the active power regardless of the power factor, and shall operate only in the event of reverse power.

The response value and pick up time shall be adjustable. The reverse power protection device shall remain operative despite a voltage drop to 60% of the rated value.

4.7 Phase failure protection

Protection devices for detection of a single-phase failure in three-phase circuits shall operate instantaneously.

Bimetallic relays with differential release do not constitute phase failure protection devices in the opinion of these Rules.

4.8 Check synchronizers

Check synchronizers for the protection of an alternator against parallel connection at an unacceptable phase angle shall allow parallel switching only up to an angular deviation (electrical) of 45°and up to a frequency difference of 1 Hz.

The check synchronizer shall ensure that parallel switching is impossible if the supply or measuring voltage fails or in the event of failure of any component.

4.9 Insulation monitoring equipment

Devices for insulation monitoring of unit’s/installation’s mains shall continuously monitor the insulation resistance of the network, and shall release an alarm should the insulation resistance of the system fall below 50 Ohms per volt of the operating voltage.

The measuring current shall not exceed 30 mA in the event of a dead short circuit to earth.

F. Cables and Insulated Wires

1. General

1.1 Cables and wires shall be flame-retardant and self extinguishing.

1.2 If cable- and wire types have passed a bundle fire test according to IEC publication 60332-3-21 or IEEE 45.18.13.5, the installation of fire stops is dispensed with when laying in bundles (see also Section 11, D.14 and SOLAS, Chapter II-1, Part D, Rule 45.5.2).

1.3 Where fire-resistant cables shall be used, it is permitted to use cables with retention of insulating capability in accordance with IEC publication 60331 (see also Section 11, D.15).

1.4 Cables manufactured in accordance with the relevant recommendations of IEC publication 60092-350, 60092-352, 60092-353, 60092-354, 60092-360, 60092-370, 60092-376 will be accepted by TL provided that they are tested to its satisfaction.

Cables manufactured and tested to standards other than those specified like above-mentioned will be accepted provided they are in accordance with an acceptable and relevant international or national standard and are of an equivalent or higher safety level than those listed in item 1.4. However, cables such as flexible cable, fibre-optic cable, etc. used for special purposes may be accepted provided they are manufactured and tested in accordance with the relevant standards accepted by TL.

2. Conductor Material and Structure

2.1 The conductor materials of cables and wires shall comply with IEC 60228.

2.2 If the insulation consists of natural or synthetic rubber vulcanized with sulphur, the individual conductor wires shall be tinned.
2.3 The conductors of movable wires shall be fine-stranded.

The conductors of permanently laid cables and wires shall be made of stranded copper conductors (class 2) or flexible stranded copper conductors (class 5).

Solid conductors up to 4 mm² in cross-section are permitted for final subcircuits of room lighting and space heating systems in the accommodation and for special cables of TV and multimedia applications.

3. Material and Wall Thickness of Insulating Covers

The materials used for insulation shall be of standardized types for which the maximum permissible temperatures at the conductors during undisturbed operation are specified.

4. Protective Coverings, Sheaths and Braids

4.1 Single-core cables shall have a suitable separating layer of filler material or foil over the core insulation.

4.2 Multi-core cables shall have a common core covering made of filler material or shall have a wrapping and sheath.

4.3 Only materials of a standardized type may be used for non-metallic sheaths. In all cases the thermal stability of the compounds used shall correspond to that of the insulating material.

4.4 Braids shall be made of corrosion-resistant material such as copper or copper alloy or of material treated to prevent corrosion, e.g. galvanized steel.

4.5 Outer metallic wire braids shall have a coating of protective paint, which must be lead-free and flame-retardant. The paint shall be of sufficiently low viscosity when applied to enable it to penetrate readily into the wire braid. When dry, it shall not flake off when the cable is bent around a mandrel with a diameter 15 times that of the cable.

5. Identification

5.1 Each cable must be marked for type and for name of manufacturer.

5.2 The cores of multi-core cables and wires shall have a permanent marking. In multi-core cables and wires where the cores are arranged in a number of concentric layers, two adjacent cores in each layer shall be coloured differently from each other and from all other cores, unless the individual cores are otherwise unambiguously identified, e.g. by printed numbers.

5.3 Protective earth conductors shall have green/yellow colour coding.

5.4 Cables for intrinsically safe circuits shall be easily identifiable. If the colour of the cable sheath is used as identification, light blue sheath shall be used.

5.5 High-voltage cables shall have a red outer sheath.

6. Approvals

6.1 Cables and wires are subject to mandatory type approval by TL.

6.2 Proof is required by the manufacturer by issue of workshop test reports stating that the continuous production is made in conformity to relevant standards and is verified by individual and sample tests for each production length of cables. These reports shall record any deviations from the standards.

6.3 The application of cables and wires without type test is subject to an agreement with TL in every case. Individual and sample tests performed at the manufacturer's works on each lengths delivered are required for these cables, see 7.3.

7. Tests

7.1 For type tests see Section 16, E.
7.2 If not specified in the standards, the following tests shall be performed as an additional requirement:

Ozone tests on cable sheaths whose basic material consists of natural or synthetic rubber. Test conditions shall be:
- Ozone concentration: 250 - 300 ppm
- Temperature: (25 ± 2) °C
- Duration: 24 h

The test shall be carried out in accordance with IEC publication 60811-403.

Other equivalent test methods may be agreed with TL.

The test is passed satisfactory if no cracks will be discovered visible to the naked eye.

7.3 Individual tests on non-type-tested cables and wires shall be performed in the manufacturer's works in the presence of a TL-Surveyor.

The scope of the tests shall be agreed with TL in advance.

The following tests shall be carried out at least:
- conductor resistance
- dielectric strength
- insulation resistance
- dimensions and construction of samples
- mechanical strength characteristics of samples.

G. Cable Penetrations and Fire Stops

1. Bulkhead and Deck Penetrations

1.1 For sealing compounds and packing systems see Section 16, E.

1.2 The requirements for bulkhead and deck penetrations are stated in Section 11, D.8.

Penetrations of watertight bulkheads should be placed as high as practicable. No compound or packing is required for boxes or pipes on the bulkhead or deck when cables are passing between areas or spaces with same water or fire integrity.

The distance from cable penetrations to flanges of steam or hot oil pipes shall not be less than 300 mm for steam or hot oil pipes with diameter $D \leq 75$ mm, and not less than 450 mm for larger pipes.

1.3 Type tests shall be performed in the manufacturer's works or in acknowledged independent institutions according to the TL Rules, Additional Rules and Guidelines, Test Requirements for Sealing Systems of Bulkhead and Deck Penetrations.

Cable penetrations through bulkheads and decks shall be gas tight, and of a recognised type, if used as sealing between zones or between hazardous areas and non-hazardous areas.

Fire rated penetrations shall be documented as required by TL Rules.

The installation shall be in accordance with the manufacturers' installation instructions.

2. Fire Stops

2.1 The requirements for fire stops using steel plates or coatings are stated in Section 11, D.14.

2.2 The construction of fire stops using coatings shall undergo a type test in the presence of a Surveyor from TL Head Office in the manufacturer's works or in independent institutes.

The test requirements shall be agreed with TL.
H. Installation Material

1. General

1.1 The installation material shall conform to IEC Publications. Other standards may be recognized by TL.

1.2 It is necessary to ensure that terminals are suitable for the connection of stranded conductors. Exceptions are permitted for systems with solid conductors (e.g. lighting, socket-outlets and heating appliances in the accommodation area).

The method of connection shall be compatible with the terminals used.

1.3 For materials, see Section 1, J.

2. Plug-and-socket Connections

2.1 Depending on their application, the design of plug-and-socket connections shall conform to the following regulations IEC Publication 60092-306 and with the additional standards in relation to their use:

- in the accommodation area, day rooms and service rooms (up to 16 A, 250 V AC) - IEC publication 60083 or 60320-1
- power circuits (up to 250 A, 690 V AC) – IEC publication 60309-1 and 60309-2
- electronic switchgear - IEC publications, e.g. 60130 and 60603

I. Lighting Fixtures

For installation of lighting fixtures, the conductor insulation material of the installation cable shall be suitable for the fixture being installed. Preferably, the lighting fixture shall provide a shielding between the lighting tubes and the termination part for the external cable. If there is no shielding between the lighting tube and the termination part for the installation cable, the installation cable shall have an insulating material of its conductors that is UV resistant.

Emergency lighting fixtures shall be marked for easy identification.

1. General

Luminaries, floodlights and searchlights are to conform to IEC Publications 60598 and 60092-306. Other standards may be recognized by TL.

The requirements stated in H.1. shall be observed.

2. Design

2.1 The surface temperature of easily touchable parts of light fittings shall normally not exceed 60 °C.

2.2 High-power lights with higher surface temperatures are to be protected against unintentional contact by additional means.

2.3 Lighting fittings shall be so arranged as to prevent temperature rises which could damage the cables and wiring, and to prevent surrounding material from becoming excessively hot.

2.4 The terminals and spaces for the connection of cables shall not reach a higher temperature permissible for the insulation of the wires or cables used. The temperature rise in the terminal box shall not exceed 40 K.

2.5 All the metal parts of a light fitting shall be conductively connected to each other and shall be provided with a suitable terminal for earthing.

2.6 Wiring inside lighting fixtures shall have a minimum cross section of 0.75 mm². A cross section of at least 1.5 mm² is to be used for through wiring.

Heat-resistant wires are to be used for internal wiring.
2.7 Each luminaire shall be durably marked with the following details:

- maximum permitted lamp wattage
- minimum mounting distance

2.8 Supports of live parts in lamp holders shall be at least of flame retardant material for fluorescent lamps and at least of incombustible material for incandescent lamps.

2.9 Searchlights and arc lamps

2.9.1 All parts of searchlights or arc lamps to be handled for their operation or adjustment while in use shall be so arranged that there is no risk of shock to the operator.

2.9.2 Disconnection of every searchlight or arc lamp shall be by a multi-pole (all poles) disconnecting switch.

If a series resistor is used with an arc lamp, the disconnecting switch shall be so placed in the supply circuit that both the series resistor and arc lamp are disconnected when the switch is in the off position.

2.10 Portable luminaires

2.10.1 Portable luminaires shall be so constructed and arranged that there is no risk of shock to the Operator, in accordance with one of the methods given in the following:

- supply from an isolating transformer supplying one luminaire only
- supply at extra low voltage
- double or reinforced insulation
- earthing by means of an earth continuity conductor.

2.10.2 Portable luminaires intended to be used on decks, in holds, engine rooms and other similar spaces shall be provided with a hook or ring by which the luminaire can be suspended to avoid stress on the supply cable.

J. Electrical Heating Equipment

1. General

1.1 Electrical heating equipment and boilers shall conform to IEC Publications, e.g. 60335, with particular attention to IEC 60092-307. The general provisions set out in H.1. shall be observed.

1.2 The connections of power supply cables shall be so arranged that temperatures higher than permitted for terminals and supply cables do not arise.

1.3 Controls in operation such as switch knobs and handles shall not attain temperatures higher than

- 55 °C for metal parts, or
- 65 °C for parts made of porcelain, glass, moulded plastics or wood

A temperature 5 °C higher is permissible for parts operated by finger tipping only.

1.4 Only heating elements with shrouded or ceramic-embedded heating coils shall be used. Infrared radiators are permitted.

2. Design

2.1 Space heaters

Space heaters are in general to be of the convection type, and suitable for installation on bulkheads. Radiation heaters and other space heater types may be accepted after consideration in each case.

2.1.1 The casing or enclosure of each heater shall be so designed that no objects can be placed on it and air may circulate freely around the heating elements.

2.1.2 Electrical space heaters shall be so designed that, based on an ambient temperature of 20 °C, the temperature of the casing, enclosure or cover and of the air
flow from the heater does not exceed 95 °C under defined test conditions.

Space heaters are normally to be installed on a free bulkhead space, with about 1 m free air above, and so that for example doors cannot touch the heaters. If not constructed with an inclined top plate, an perforated plate of incombustible material inclined about 30º shall be mounted above each heater.

Space heaters shall not be built into casings of woodwork or other combustible material.

2.1.3 To prevent unacceptable temperature rises due to heat accumulation, each heater shall be fitted with a safety temperature limiter. Automatic reconnection is not permitted.

The safety temperature limiter may be dispensed with for watertight heaters in rooms without substantial fire hazard, e. g. in bathrooms and washing rooms.

The operating switches shall disconnect all live conductors. The switch positions shall be clearly marked at the switches.

The following additional requirements shall apply for space heaters integrated in air-conditioning cabinets:

- each cabinet shall be provided with an interlocked over temperature thermostat with manual reset, accessible only by use of tool.

- combined cabinets for ceiling installation are accepted, the ceiling shall be constructed of incombustible materials.

2.2 Passage heaters and boilers

Passage heaters and boilers are to be equipped with two mutually independent temperature protection devices; one of them shall be a permanently set safety temperature limiter, while the other may be a thermostatic controller.

Automatic reconnection of the safety temperature limiter is not permitted.

Water heaters are normally to have insulated heating elements and shall be installed as separate units. Each water heater shall be provided with a thermostat, sensing the water temperature and maintaining this at the correct level.

2.2.1 Oil heaters

Electric oil heaters shall normally be fitted as separate units. Heating by electric heating elements in the offshore unit's oil tanks is in general not permitted, but may be accepted after special design evaluation of the arrangement in each case.

The surface temperature of the heating elements shall be below the boiling point of the oil, under normal working conditions. Further limitation of the heating elements' temperature may be required.

Each oil heater shall be provided with a working thermostat, sensing the oil temperature and maintaining this at correct level under normal working conditions. In addition, each oil heater shall be provided with an interlocked over-temperature thermostat with manual reset, and with the sensing device installed in close proximity to the heating elements, so arranged that it will trip the elements, should they tend to overheat, or become dry. Other arrangements, ensuring equivalent protection, may be accepted after design assessment in each case.

2.3 Electric ranges and cooking facilities

Cooking equipment is in general to have insulated heating elements. Special equipment, such as for example high frequency ovens or electrode pots, shall be suitable for marine use, and fitted according to the manufacturer's instructions.

2.3.1 Only enclosed-type hot plates shall be used. It shall not be possible for liquids to penetrate into the electrical equipment.

2.3.2 The switches for the individual plates and heating elements shall disconnect all live conductors. The switch steps shall be clearly marked.
2.3.3 Internal connections shall be made by heat proof terminals and wires and shall be corrosion resistant.

2.4 Deep-fat cooking equipment

Deep-fat cooking equipment shall be fitted with the following arrangements:

- an automatic or manual fire-extinguishing system tested to an international standard (1)

- a primary and backup thermostat with an alarm to alert the Operator in the event of failure of either thermostat

- arrangements for automatically shutting off the electrical power upon activation of the fire extinguishing system

- an alarm for indicating operation of the fire-extinguishing system in the galley where the equipment is installed

- controls for manual operation of the fire-extinguishing system which are clearly labelled for ready use by the crew

3. Non-sparking Fans

3.1 A fan is considered as non-sparking if in either normal or abnormal conditions it is unlikely to produce sparks.

3.2 The air gap between the impeller and the casing shall not be less than 0.1 of the shaft diameter in way of the impeller bearing, but not less than 2 mm. It need not be more than 13 mm.

3.3 Protection screens of not more than 13 mm square mesh are to be fitted in the inlet and outlet of ventilation ducts to prevent the entrance of objects into the fan housing.

3.4 The impeller and the housing in way of the impeller are to be made of alloys which are recognised as spark proof by appropriate test.

Electrostatic charges both in the rotating body and the casing are to be prevented by use of antistatic materials. Furthermore, the installation of the ventilation units is to be such as to ensure the safe bonding to the hull/structure of the units themselves.

3.5 Tests may not be required for fans having the following material combinations:

- impellers and/or housings of non-metallic material, due regard being paid to the elimination of static electricity

- impellers and housings of non-ferrous materials

- impellers of aluminium alloys or magnesium alloys and a ferrous (including austenitic stainless steel) housing on which a ring of suitable thickness on non-ferrous materials is fitted in way of the impeller

- any combination of ferrous (including austenitic stainless steel) impellers and housings with not less than 13 mm tip clearance

3.6 The following impellers and housings are considered as sparking and are not permitted:

- impellers of an aluminium alloy or magnesium alloy and a ferrous housing, regardless of tip clearance

- housing made of an aluminium alloy or a magnesium alloy and a ferrous impeller, regardless of tip clearance

- any combination of ferrous impeller and housing with less than 13 mm design tip clearance.

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(1) Reference is made to standard ISO 15371:2000 “Fire extinguishing systems for protection of galley deep-fat cooking equipment”
SECTION 16

SURVEYS and TESTS

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A. General

1. The following Rules apply to the testing of electrical and electronic installations, equipment and components.

2. Within the framework of their general quality assurance programme, manufacturers shall ensure that the products they manufacture conform to the specified requirements.

Records shall be made, containing quality-assurance measures and tests and shall be handed over to TL on request.

3. For certain installations, equipment and components, testing is required in the presence of a TL Surveyor according to these Rules, see C., D. and E. The tests and items for testing specified below constitute minimum requirements.

TL reserve the right to demand that tests also be performed on other items, either on the unit/installation or in the manufacturer's works.

4. For appliances of a new type or for equipment which is being used for the first time on units/installations with TL-Class, additional tests and trials are to be agreed between the manufacturer and TL, if the circumstances this require.

5. It is the aim of the tests to verify conformity with the requirements covered by the Rules for Construction, and to prove the suitability of equipment for its particular application.

6. Tests are divided into:
   - examinations of the technical documentation, see B.
   - tests in the manufacturer's works, see C.
   - tests on units/installations, see D.
   - tests for type approvals, see E.

B. Examinations of Technical Documentation

1. The list of documents subject to approval is specified in Section 1, C.

2. The documents which have been examined and approved shall be presented to the TL -Surveyor on request.

C. Tests in the Manufacturer's Works

1. Tests in the Presence of a TL -Surveyor

1.1 The tests shall be carried out on the basis of the Rules for Construction and the approved documents. They shall be performed in accordance with a recognized standard.

1.2 Machines, appliances and systems subject to testing in accordance with 2. are to be tested in the presence of a TL -Surveyor unless the preconditions for tests under the own responsibility of the manufacturer are fulfilled, see 3.

2. Machines, Appliances and Installations Subject to Testing

2.1 Electrical machines

For scope of tests see Section 15, A.

a) Generators and motors for offshore units.

b) Generators and motors for essential equipment, P ≥ 100 kW/ kVA.

c) Motors for jack-up systems.

d) Transformers P ≥ 100 kVA.

e) Autotransformers P ≥ 100 kVA.

2.2 Power electronics

For scope of tests see Section 7, G.

a) For electric propulsion plants see Section 12, A.
b) Essential equipment $P \geq 50\, \text{kW}/\text{kVA}$.

c) Battery charging $P \geq 2\, \text{kW}$.

2.3 **Switchboards**

For scope of tests see Section 5, H. and Section 6, E.3.

a) Main switchboards including switchboards for jack-up systems, if applicable.

b) Emergency switchboards.

c) Switchboards for electric propulsion plants of offshore units.

d) Distribution switchboards with connected power $\geq 500\, \text{kW}$.

e) Starters for motors in accordance with 2.1 b).

2.4 **Boiler and thermal oil plants**

For scope of tests see Section 5, H.

2.5 **Electrical propulsion plants**

For scope of tests see Section 12, A.

2.6 **Computer systems**

For scope of tests see Section 9, D.

3. **Tests Under the Own Responsibility of the Manufacturer**

3.1 The products under 2.1 b), c); 2.2 b), c) and 2.3 d), e) may be tested on the manufacturer's own responsibility if the following preconditions are fulfilled:

- a QM system recognized by TL is available

- TL has carried out type tests of the products

- the tests under own responsibility have been agreed with TL

3.2 Reference is made to TL Rules, Additional Rules and Guidelines, Guidelines for the Inspection of Mechanical and Electrotechnical Products.

D. **Tests on Units/Installations**

1. **General**

The tests are divided into

- tests during construction

- tests at the building yard

- tests during sea trials for units or at operational location for installations

2. **Tests During Construction**

2.1 During the period of construction of the unit/installation, the systems shall be checked for conformity with the documents approved by TL and with the Rules for Construction.

2.2 Test Certificates for tests which have already been performed shall be presented to the TL -Surveyor on request.

2.3 **Protective measures**

Protective measures shall be checked:

a) protection against foreign bodies and water

b) protection against electric shock, such as protective earthing, protective separation or other measures as listed in Section 1, K.

c) measures of explosion protection. The design shall conform to the details on documents, submitted by the building yard for approval; see Section 1, D.

2.4 **Testing of the cable network**

Inspection and testing of cable installation and cable routing with regard to

a) Acceptability of cable routing with regard to

- separation of cable routes

- fire safety
- the reliable supply of emergency consumers.

b) Selection and fixation of cables.

c) Construction of watertight and fireproof bulkhead and deck penetrations.

d) Insulation resistance measurement.

e) For high-voltage installations, see Section 6.

3. Tests at the Building Yard

3.1 General

Proofs are required of the satisfactory condition and proper operation of the main and emergency power supply systems, the steering gear and the aids of manoeuvring, if applicable, as well as of all the other systems specified in the Rules for Construction.

Unless already required in the Rules for Construction, the tests to be performed shall be agreed with the TL Surveyor in accordance with the specific characteristics of the subject equipment.

3.2 Generators

3.2.1 A test run of the generator sets shall be conducted under normal operating conditions, and shall be reported.

3.2.2 For units, where electrical power is necessary to restore propulsion, it shall be proven that after black-out and dead ship condition (see Section 1, B.14.) the propulsion to the unit in conjunction with required machinery can be restored within 30 min. after black-out. The same conditions apply to the jackup system.

TL reserve the right to demand the proof of selective arrangement of the power supply system.

3.3 Storage batteries

The following shall be tested:

a) Installation of storage batteries.

b) Ventilation of battery rooms and boxes, and cross-sections of ventilation ducts.

c) Storage-battery charging equipment.

d) Required caution labels and information plates.

3.4 Switchgear

The following items shall be tested:

a) Accessibility for operation and maintenance.

b) Protection against the ingress of water and oil from ducts and pipes in the vicinity of the switchboards, and sufficient ventilation.

c) Equipment of main and emergency switchboards with insulated handrails, gratings and insulating floor coverings.

d) Correct settings and operation of protection devices and interlocks.

e) Independence manual operation of generating sets from common external voltage and automation systems (manual operation means local start/ stop and speed setting as well as voltage control, protection devices and synchronizing from switchboard).

TL reserve the right to demand the proof of selective arrangement of the power supply system.

3.5 Power electronics

The following items shall be tested:

a) Ventilation of the place of installation.

b) Function of the equipment and protection devices.

3.6 Power plants

The following items shall be tested:

a) Motor drives together with the driven machines, which shall, wherever possible, be subjected to the most severe anticipated operating conditions. This test shall include a
check of the settings of the motors’ short-circuit and overcurrent protection devices.

b) The emergency remote stops (see also Section 9, E.) of equipment such as
- engine room fans
- fuel pumps
- separators
- boiler blowers, etc.

3.7 Control, monitoring and safety systems

For these systems operational tests shall be performed, see Section 9. Further details for testing are to be agreed with TL.

3.8 Electrical propulsion plants

Regarding scope of tests see Section 12, A.

3.9 Computer systems

Regarding scope of tests see Section 9, D.

3.10 Explosion protection

A check is to be made that equipment in hazardous areas has been designed and installed in accordance with the relevant requirements defined in Section 13.

Design and installation of electrical equipment installed in hazardous areas shall conform to the listing prepared by the building yard, which is subject to approval by TL, see Section 1, C.1. See also 2.3 c).

3.11 Emergency shut-down system

Tests have to be carried out to simulate all cases for shut-down requirements which are defined in Section 9, E.

4. Overall Trials

These trials for the fully completed unit/installation will take place at the following locations:
- for self-propelled units the overall tests will be done at a sea trial
- for non-self-propelled units the overall tests will be done at the building yard, as far as possible
- for fixed installations, which are only completely erected on site, the overall tests will be done at the operational location
- for jack-up systems at a suitable, protected location: details to be agreed with TL.

4.1 Onboard survey

Commissioning shall be carried out as part of the classification process, and shall concentrate on the installation on board as well as on the functioning of the total electrical system and parts.

Commissioning shall be witnessed by a TL surveyor and is regarded complete when all systems and equipment, including their control and monitoring systems are operating satisfactorily.

The site inspections shall be carried out to assess for:
- the electrical installation is in accordance with the requirements as per this rule
- the electrical installation is in accordance with the accepted or approved documentation
- the craftsmanship is acceptable.

Function tests are part of the TL’s verification of the installation’s compliance with the requirements in the Rules and approved documentation.

At the site survey, the following documentation shall be available for TL’s surveyor:
- design documentation
- TL certificates for equipment required certified
- approved ‘Hazardous Area Classification Drawing’
Section 16 – Surveys and Tests

E. Type Approvals

1. General

The requirements are applicable, but not confined, to all electrical, electronic and programmable equipment which are intended to be type approved for control, monitoring, alarm and protection systems for use in offshore units.

1.1 The installations, equipment and assemblies mentioned in 2. are subject to mandatory type approval for mobile units.

The type approval procedure shall normally consist of the design approval, type testing, and issuance of type approval certificate.

1.2 For fixed installations type approval is also recommended, but if this is not suitable, components may be approved by TL case by case.

1.3 Type tests shall be carried out in the presence of a representative of TL either in the manufacturer's works or, by agreement, in suitable institutions.

1.4 Type tests are carried out according to TL Rules, Additional Rules and Guidelines, Guidelines for the Performance of Type Approvals and defined standards.

1.5 Type tested installations, apparatuses and assemblies shall be used within the scope of valid Construction Rules only. The suitability for the subject application shall be ensured.

1.6 TL Head Office will decide case by case if tests carried out by other recognized institutions may be considered as equivalent to TL type tests.

2. Installations, Apparatuses and Assemblies Subject to Type testing

2.1 Electrical installations

2.1.1 For cables and accessories see Section 15, F. and G.

- cables and insulated wires
sealing compounds and packing systems for bulkhead- and deck penetrations
- Cable trays/protective casings made of plastic materials are to be type tested in accordance with TL- R E 16;
- busbar trunking systems for the installation

For guidance on testing, refer to TL- G 73.

2.1.1 For switchgear see Section 5, H.
- circuit-breakers, load switches, disconnect switches and fuses for direct connection to the main busbars or unfused distribution busbars of main, emergency and propulsion switchboards
- standardized switchgear units manufactured in series with reduced clearance- and creepage distances, see Section 5, F.3

2.1.2 For generator protection devices, see Section 4, A.
- short-circuit protection
- overcurrent protection
- reverse-power protection
- automatically synchronizing device,
- underfrequency protection
- over- and undervoltage protection
- differential protection
- earth fault monitoring

2.2 Steering gears and rudder propeller systems

For steering gear and rudder-propeller systems see Section 12, A. and B.

2.2.1 Input devices such as
- phase failure relays
- level sensors

2.2.2 Steering gear control systems with all components important for the function, e.g.
- steering mode selector switch

2.3 Machinery control

For machinery control systems, see Section 9.
- open and closed loop control for speed and power of internal combustion engines (main and auxiliary engines) and electrical actuators, see also Section 9, C.11.
- safety devices

2.4 Safety systems

For safety systems, see Section 9, C.
- fire detection and alarm systems
- gas detection system

2.5 Escape direction system

For low level escape direction systems which are electrically supplied see Section 10, A.

2.6 Computer systems

Software shall be approved in association with hardware. References of software and hardware are to be specified in the type approval certificate.

Basic software of standard type used as tools for operation of a computer based system may be accepted without type approval at the discretion of TL.
In case of separate approval of software, an assessment certificate may be issued, at the request of the manufacturer, in accordance with the requirements of the appropriate system category.

For computer systems, see Section 9, D. These tests apply only to the propulsion part of self-propelled mobile units.

### 2.6.1 Loading instruments

Loading instrument approval consists of:

- approval of hardware
- approval of basic software
- approval of application software, consisting in data verification which results in the Endorsed Test Condition
- installation testing.

### 2.7 Propulsion control with automation

For self propelled units with automated and/or remotely controlled propulsion system see Section 12, A.3.

### 3. Exceptions

Instead of the stipulated type approvals in well-founded cases routine tests in the presence of TL Surveyor may be carried out. An agreement with TL prior to testing is required.
SECTION 17

SPARE PARTS

1. In order to be able to restore machinery operation of offshore installations and units in case of a failure or of wear and tear, spare parts for the essential equipment including the tools necessary for mounting shall be available on board.

For mobile offshore units in addition the manoeuvring capability in the event of damage at sea shall be maintained.

Therefore spare parts for the main propulsion plant and the essential equipment shall be available aboard of each unit together with the necessary tools.

2. The amount of spare parts shall be documented and a corresponding list shall be carried aboard.