Tasneef®
Life Environmentally Optimized

Rules for the Classification of Naval Ships

Effective from 1 January 2017

Part C

Machinery, Systems and Fire Protection

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GENERAL CONDITIONS

Definitions:

"*Administration*" means the Government of the State whose flag the Ship is entitled to fly or under whose authority the Ship is authorised to operate in the specific case.

"IACS" means the International Association of Classification Societies.

"*Interested Party*" means the party, other than the Society, having an interest in or responsibility for the Ship, product, plant or system subject to classification or certification (such as the owner of the Ship and his representatives, the ship builder, the engine builder or the supplier of parts to be tested) who requests the Services or on whose behalf the Services are requested.

"*Owner*" means the registered owner, the ship owner, the manager or any other party with the responsibility, legally or contractually, to keep the ship seaworthy or in service, having particular regard to the provisions relating to the maintenance of class laid down in Part A, Chapter 2 of the Rules for the Classification of Ships or in the corresponding rules indicated in the specific Rules.

"Rules" in these General Conditions means the documents below issued by the Society:

(i) Rules for the Classification of Ships or other special units;
(ii) Complementary Rules containing the requirements for product, plant, system and other certification or containing the requirements for the assignment of additional class notations;
(iii) Rules for the application of statutory rules, containing the rules to perform the duties delegated by Administrations;
(iv) Guides to carry out particular activities connected with Services;
(v) Any other technical document, as for example rule variations or interpretations.

"*Services*" means the activities described in Article 1 below, rendered by the Society upon request made by or on behalf of the Interested Party.

"Ship" means ships, boats, craft and other special units, as for example offshore structures, floating units and underwater craft.

"*Society*" or *"TASNEEF"* means Tasneef and/or all the companies in the Tasneef Group which provide the Services.

"*Surveyor*" means technical staff acting on behalf of the Society in performing the Services.

Article 1

1.1. The purpose of the Society is, among others, the classification and certification of ships and the certification of their parts and components. In particular, the Society:
(i) sets forth and develops Rules;
(ii) publishes the Register of Ships;
(iii) issues certificates, statements and reports based on its survey activities.

1.2. The Society also takes part in the implementation of national and international rules and standards as delegated by various G overnments.

1.3. The Society carries out technical assistance activities on request and provides special services outside the scope of classification, which are regulated by these general conditions, unless expressly excluded in the particular contract.

Article 2

2.1. The Rules developed by the Society reflect the level of its technical knowledge at the time they are published. Therefore, the Society, although committed also through its research and development services to continuous updating of the Rules, does not guarantee the Rules meet state-of-the-art science and technology at the time of publication or that they meet the Society's or others' subsequent technical developments.

2.2. The Interested Party is required to know the Rules on the basis of which the Services are provided. With particular reference to Classification Services, special attention is to be given to the Rules concerning class suspension, withdrawal and reinstatemen t. In case of doubt or inaccuracy, the Interested Party is to promptly contact the Society for clarification.
The Rules for Classification of Ships are published on the Society's website: www.tasneef.ae.

2.3. The Society exercises due care and skill:
(i) in the selection of its Surveyors
(ii) in the performance of its Services, taking into account the level of its technical knowledge at the time the Services are performed.

2.4. Surveys conducted by the Society include, but are not limited to, visual inspection and non-destructive testing. Unless otherwise required, surveys are conducted through sampling techniques and do not consist of comprehensive verification or monitoring of the Ship or of the items subject to certification. The surveys and checks made by the Society on board ship do not necessarily require the constant and continuous presence of the Surveyor. The Society may also commission laboratory testing, underwater inspection and other checks carried out by and under the responsibility of qualified service suppliers. Survey practices and procedures are selected by the Society based on its experience and knowledge and according to generally accepted technical standards in the sector.

Article 3

3.1. The class assigned to a Ship, like the reports, statements, certificates or any other document or information issued by the Society, reflects the opinion of the Society concerning compliance, at the time the Service is provided, of the Ship or product subject to certification, with the applicable Rules (given the intended use and within the relevant time frame).
The Society is under no obligation to make statements or provide information about elements or facts which are not part of th e specific scope of the Service requested by the Interested Party or on its behalf.

3.2. No report, statement, notation on a plan, review, Certificate of Classification, document or information issued or given as p art of the Services provided by the Society shall have any legal effect or implication other than a representation that, on the basis of the checks made by the Society, the Ship, structure, materials, equipment, machinery or any other item covered by such document or information meet the Rules. Any such document is issued solely for the use of the Society, its committees and clients or other duly authorised bodies and for no other purpose. Therefore, the Society cannot be held liable for any act made or document issued by other parties on the basis of the statements or information given by the Society. The validity, application, meaning and interpretation of a Certificate of Classification, or any other document or information issued by the Society in connection with its Services, is governed by the Rules of the Society, which is the sole subject entitled to make such interpretation. Any disagreement on technical matters between the Interested Party and the Surveyor in the carrying out of his functions shall be raised in writing as soon as possible with the Society, which will settle any divergence of opinion or dispute.

3.3. The classification of a Ship, or the issuance of a certificate or other document connected with classification or certificati on and in general with the performance of Services by the Society shall have the validity conferred upon it by the Rules of the Society at the time of the assignment of class or issuance of the certificate; in no case shall it amount to a statement or warranty of seaw orthiness,

structural integrity, quality or fitness for a particular purpose or service of any Ship, structur e, material, equipment or machinery inspected or tested by the Society.

3.4. Any document issued by the Society in relation to its activities reflects the condition of the Ship or the subject of certifi cation or other activity at the time of the check.

3.5. The Rules, surveys and activities performed by the Society, reports, certificates and other documents issued by the Society are in no way intended to replace the duties and responsibilities of other parties such as Governments, designers, ship builders, manufacturers, repairers, suppliers, contractors or sub-contractors, Owners, operators, charterers, underwriters, sellers or intended buyers of a Ship or other product or system surveyed.

These documents and activities do not relieve such parties from any fulfilment, warranty, responsibility, duty or obligation (also of a contractual nature) expressed or implied or in any case incumbent on them, nor do they confer on such parties any right, claim or cause of action against the Society. With particular regard to the duties of the ship Owner, the Services undertaken by the Society do not relieve the Owner of his duty to ensure proper maintenance of the Ship and ensure seaworthiness at all times. Likewise, t he Rules, surveys performed, reports, certificates and other documents issued by the Society are intended neither to guarantee the buyers of the Ship, its components or any other surveyed or certified item, nor to relieve the seller of the duties arising out of the law or the contract, regarding the quality, commercial value or characteristics of the item which is the subject of transaction.

In no case, therefore, shall the Society assume the obligations incumbent upon the above-mentioned parties, even when it is consulted in connection with matters not covered by its Rules or other documents.

In consideration of the above, the Interested Party undertakes to relieve and hold harmless the Society from any third party claim, as well as from any liability in relation to the latter concerning the Services rendered.

Insofar as they are not expressly provided for in these General Conditions, the duties and responsibilities of the Owner and Interested Parties with respect to the services rendered by the Society are described in the Rules applicable to the specific Service rendered.

Article 4

4.1. Any request for the Society's Services shall be submitted in writing and signed by or on behalf of the Interested Party. Such a request will be considered irrevocable as soon as received by the Society and shall entail acceptance by the applicant of all relevant requirements of the Rules, including these General Conditions. Upon acceptance of the written request by the Society, a contract between the Society and the Interested Party is entered into, which is regulated by the present General Conditions.

4.2. In consideration of the Services rendered by the Society, the Interested Party and the person requesting the service shall be jointly liable for the payment of the relevant fees, even if the service is not concluded for any cause not pertaining to the Society. In the latter case, the Society shall not be held liable for non-fulfilment or partial fulfilment of the Services requested. In the event of late payment, interest at the legal current rate increased by 1.5% may be demanded.

4.3. The contract for the classification of a Ship or for other Services may be terminated and any certificates revoked at the request of one of the parties, subject to at least 30 days' notice to be given in writing. Failure to pay, even in part, the fees due for Services carried out by the Society will entitle the Society to immediately terminate the contract and suspend the Services.

For every termination of the contract, the fees for the activities performed until the time of the termination shall be owed to the Society as well as the expenses incurred in view of activities already programmed; this is without prejudice to the right to compensation due to the Society as a consequence of the termination.

With particular reference to Ship classification and certification, unless decided otherwise by the Society, termination of the contract implies that the assignment of class to a Ship is withheld or, if already assigned, that it is suspended or withdrawn; any st atutory certificates issued by the Society will be withdrawn in those cases where provided for by agreements between the Society and the flag State.

Article 5

5.1. In providing the Services, as well as other correlated information or advice, the Society, its Surveyors, servants or agents operate with due diligence for the proper execution of the activity. However, considering the nature of the activities performed (see art. 2.4), it is not possible to guarantee absolute accuracy, correctness and completeness of any information or advice supplied. Express and implied warranties are specifically disclaimed.

Therefore, except as provided for in paragraph 5.2 below, and also in the case of activities carried out by delegation of Governments, neither the Society nor any of its Surveyors will be liable for any loss, damage or expense of whatever nature sustained by any person, in tort or in contract, derived from carrying out the Services.

5.2. Notwithstanding the provisions in paragraph 5.1 above, should any user of the Society's Services prove that he has suffered a loss or damage due to any negligent act or omission of the Society, its Surveyors, servants or agents, then the Society will pay compensation to such person for his proved loss, up to, but not exceeding, five times the amount of the fees charged for the specific services, information or opinions from which the loss or damage derives or, if no fee has been charged, a maximum of AED5,000 (Arab Emirates Dirhams Five Thousand only). Where the fees charged are related to a number of Services, the amount of the fees will be apportioned for the purpose of the calculation of the maximum compensation, by reference to the estimated time involved in the performance of the Service from which the damage or loss derives. Any liability for indirect or consequential loss, damage or expense is specifically excluded. In any case, irrespective of the amount of the fees charged, the maximum damages payable by the Society will not be more than AED5,000,000 (Arab Emirates Dirhams Five Millions only). Payment of compensation under this paragraph will not entail any admission of responsibility and/or liability by the Society and will be made without prejudice to the disclaimer clause contained in paragraph 5.1 above.

5.3. Any claim for loss or damage of whatever nature by virtue of the provisions set forth herein shall be made to the Society in writing, within the shorter of the following periods: (i) THREE (3) MONTHS from the date on which the Services were performed, or (ii) THREE (3) MONTHS from the date on which the damage was discovered. Failure to comply with the above deadline will constitute an absolute bar to the pursuit of such a claim against the Society.

Article 6

6.1. These General Conditions shall be governed by and construed in accordance with United Arab Emirates (UAE) law, and any dispute arising from or in connection with the Rules or with the Services of the Society, including any issues concerning responsibility, liability or limitations of liability of the Society, shall be determined in accordance with UAE law. The courts of the Dubai International Financial Centre (DIFC) shall have exclusive jurisdiction in relation to any claim or dispute which may arise out of or in connection with the Rules or with the Services of the Society.

6.2. However,

(i) In cases where neither the claim nor any counterclaim exceeds the sum of AED300,000 (Arab Emirates Dirhams Three Hundred Thousand) the dispute shall be referred to the jurisdiction of the DIFC Small Claims Tribunal; and

(ii) for disputes concerning non-payment of the fees and/or expenses due to the Society for services, the Society shall have the

right to submit any claim to the jurisdiction of the Courts of the place where the registered or operating office of the Interested Party or of the applicant who requested the Service is located.

In the case of actions taken against the Society by a third party before a public Court, the Society shall also have the right to summon the Interested Party or the subject who requested the Service before that Court, in order to be relieved and held harmless according to art. 3.5 above.

Article 7

7.1. All plans, specifications, documents and information provided by, issued by, or made known to the Society, in connection with the performance of its Services, will be treated as confidential and will not be made available to any other party other than the Owner without authorisation of the Interested Party, except as provided for or required by any applicable international, European or domestic legislation, Charter or other IACS resolutions, or order from a competent authority. Information about the status and validity of class and statutory certificates, including transfers, changes, suspensions, withdrawals of class, recommendations/conditions of class, operating conditions or restrictions issued against classed ships and other related information, as may be required, may be published on the website or released by other means, without the prior consent of the Interested Party.

Information about the status and validity of other certificates and statements may also be published on the website or released by other means, without the prior consent of the Interested Party.

7.2. Notwithstanding the general duty of confidentiality owed by the Society to its clients in clause 7.1 above, the Society's clients hereby accept that the Society may participate in the IACS Early Warning System which requires each Classification Society to provide other involved Classification Societies with relevant technical information on serious hull structural and engineering systems failures, as defined in the IACS Early Warning System (but not including any drawings relating to the ship which may be the specific property of another party), to enable such useful information to be shared and used to facilitate the proper working of the IACS Early Warning System. The Society will provide its clients with written details of such information sent to the involved Classification Societies.

7.3. In the event of transfer of class, addition of a second class or withdrawal from a double/dual class, the Interested Party undertakes to provide or to permit the Society to provide the other Classification Society with all building plans and drawings, certificates, documents and information relevant to the classed unit, including its history file, as the other Classification Society may require for the purpose of classification in compliance with the applicable legislation and relative IACS Procedure. It is the Owner's duty to ensure that, whenever required, the consent of the builder is obtained with regard to the provision of plans and drawings to the new Society, either by way of appropriate stipulation in the building contract or by other agreement.

In the event that the ownership of the ship, product or system subject to certification is transferred to a new subject, the latter shall have the right to access all pertinent drawings, specifications, documents or information issued by the Society or which has come to the knowledge of the Society while carrying out its Services, even if related to a period prior to transfer of ownership.

Article 8

8.1. Should any part of these General Conditions be declared invalid, this will not affect the validity of the remaining provisions.

EXPLANATORY NOTE TO PART C

1. Reference edition

The reference edition for Part C is this edition effective from 1st January 2015.

2. Effective date of the requirements

2.1 All requirements in which new or amended provisions with respect to those contained in the reference edition have been introduced are followed by a date shown in brackets.

The date shown in brackets is the effective date of entry into force of the requirements as amended by last updating. The effective date of all those requirements not followed by any date shown in brackets is that of the reference edition.

2.2 Item 5 below provides a summary of the technical changes from the preceding edition.

3. Rule Variations and Corrigenda

Until the next edition of the Rules is published, Rule Variations and/or corrigenda, as necessary, will be pub-lished on the Tasneef web site (www.tasneef.ae). Except in particular cases, paper copies of Rule Variations or corrigenda are not issued.

4. Rule subdivision and cross-references

4.1 Rule subdivision

The Rules are subdivided into five parts, from A to E.

Part A: Classification and Surveys

Part B: Hull and Stability

Part C: Machinery, Systems and Fire Protection

Part D: Service Notations

Part E: Additional Class Notations

Each Part consists of:

- Chapters
- Sections and possible Appendices
- Articles
- Sub-articles
- Requirements

Figures (abbr. Fig) and Tables (abbr. Tab) are numbered in ascending order within each Section or Appendix.

4.2 Cross-references

Examples: Pt A, Ch 1, Sec 1, [3.2.1]or Pt A, Ch 1, App 1, [3.2.1]

- Pt A means Part A

The part is indicated when it is different from the part in which the cross-reference appears. Otherwise, it is not indicated.

- Ch 1 means Chapter 1

The Chapter is indicated when it is different from the chapter in which the cross-reference appears. Otherwise, it is not indicated.

- Sec 1 means Section 1 (or App 1 means Appendix 1)

The Section (or Appendix) is indicated when it is different from the Section (or Appendix) in which the cross-reference appears. Otherwise, it is not indicated.

- [3.2.1] refers to requirement 1, within sub-article 2 of article 3.

Cross-references to an entire Part or Chapter are not abbreviated as indicated in the following examples:

- Part A for a cross-reference to Part A
- Part A, Chapter 1 for a cross-reference to Chapter 1 of Part A.

5. Summary of amendments introduced in the edition effective from 1st January 2017

This edition of the Rules for the Classification of Naval Ships contains amendments whose effective date is **1 January2017**.

The date of entry into force of each new or amended item is shown in brackets after the number of the item concerned

This edition of the Rules for the classification of Naval Ships is considered as a reference edition for future amendments.

Description of the amendments
The amendments involve both the framework of the Rules and the technical requirements.

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RULES FOR THE CLASSIFICATION OF NAVAL SHIPS

Part C
Machinery, Systems and Fire Protection

Chapters 1 **2 3 4**

CHAPTER 2
ELECTRICAL INSTALLATIONS

Section 1 General

Section 2 General Design Requirements

Section 3 System Design

Section 4 Rotating Machines

Section 5 Transformers

Section 6 Semiconductor Convertors

Section 7 Storage Batteries, Chargers and Uninterruptible Power Systems

Section 8 Switchgear and Controlgear Assemblies

Section 9 Cables

Section 10 Miscellaneous Equipment

Section 11 Location

Section 12 Installation

Section 13 High Voltage Installations

Section 14 Electric Propulsion Plant

Section 15 Testing

Appendix 1 Indirect Test Method for Synchronous Machines

CHAPTER 3
AUTOMATION

Section 1 General Requirements

Section 2 Design Requirements

Section 3 Programmable Electronic Systems

Section 4 Constructional Requirements

CHAPTER 4
FIRE PROTECTION, DETECTION AND EXTINCTION

Section 1 General

Section 2 Prevention of Fire and Explosion

Section 3 Suppression of Fire and Explosion Detection and Alarm

Section 4 Suppression of Fire and Explosion Control of Smoke Spread

Section 5 Suppression of Fire and Explosion Containment of Fire

Section 6 Suppression of Fire and Explosion Fire-fighting

Section 7 Suppression of Fire and Explosion Structural Integrity

Section 8 Escape

Section 9 Fire Control Plans

Section 10 Helicopter Facilities

Section 11 Alternative Design and Arrangements

Section 12 Protection of Vehicle Spaces and Ro-Ro Vehicle Spaces and Hangars

Section 13 Fire Safety Systems

Appendix 1 Carbon Dioxide Systems

Part C
Machinery, Systems and Fire Protection

Chapter 2
ELECTRICAL INSTALLATIONS

SECTION 1 GENERAL

1 Application

1.1 General

1.1.1 The requirements of this Chapter apply to electrical installations on ships. In particular, they apply to the components of electrical installations for essential services.

The other parts of the installation are to be so designed as not to introduce any malfunction to the ship and hazard to personnel.

1.2 References to other regulations and standards

1.2.1 The Society may refer to other regulations and standards when deemed necessary. These include the IEC publications, notably the IEC 60092 series and relevant requirements of the Naval Authority (e.g. STANAG 1008).

1.2.2 When referred to by the Society, publications by the International Electrotechnical Commission (IEC) or other internationally recognised standards, are those currently in force at the date of agreement for ship classification.

2 Documentation to be submitted

2.1

2.1.1 The documents listed in Tab 1 are to be submitted.

The list of documents requested is to be intended as guidance for the complete set of information to be submitted, rather than an actual list of titles.

The Society 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.

Unless otherwise agreed with the Society, documents for approval are to be sent in triplicate if submitted by the Shipyard and in four copies if submitted by the equipment supplier.

Documents requested for information are to be sent in duplicate.

In any case, the Society reserves the right to require additional copies when deemed necessary.

3 Definitions

3.1 General

3.1.1 Unless otherwise stated, the terms used in this Chapter have the definitions laid down by the IEC standards.

The definitions given in the following requirements also apply.

3.2 Essential services

3.2.1 Essential services are those services essential for propulsion, steering, pay-load and the safety of the ship, and services to ensure minimum comfortable conditions of habitability and protection of the environment.

Examples of equipment for esential services are the following:

Propulsion and steering:

- Steering gear
- Pumps for controllable pitch propellers
- Scavenging air blowers, fuel oil supply pumps, fuel valve cooling pumps, lubricating oil pumps and cooling water pumps for main and auxiliary engines and turbines necessary for the propulsion
- Forced draught fans, feed water pumps, water circulating pumps, condensate pumps, oil burning installations, for steam plants or steam turbines ship, and also for auxiliary boilers on ship where steam is used for equipment supplying essential services
- Azimuth thrusters which are the sole means for propulsion/steering with lubricating oil pumps, cooling water pumps
- Electrical equipment for electric propulsion plant with lubricating oil pumps and cooling water pumps
- Electric generators and associated power sources supplying the above equipment
- Hydraulic pumps supplying the above equipment
- Viscosity control equipment for fuel oil
- Control, monitoring and safety devices/systems for equipment for propulsion and steering gears
- Speed regulators dependent on electrical energy for main or auxiliary engines necessary for propulsion.

The lighting system for those parts of the ship normally accessible to and used by personnel is also considered (included as) an essential service, with the exception of the lighting system in the cabins provided that escape routes are adequately indicated in black out conditions.

Table 1 : Documents to be submitted *(1/1/2017)*

N°	I/A **(1)**	Documents to be submitted
1	A	Single line diagram of main power and lighting systems.
2	A	Electrical power balance.
3	I	Calculation of short-circuit currents for each installation in which the sum of rated power of the energy sources which may be connected contemporaneously to the network is greater than 500 kVA (kW).
4	A	List of circuits including, for each supply and distribution circuit, data concerning the nominal current, the cable type, length and cross-section, nominal and setting values of the protective and control devices.
5	A	Single line diagram and detailed diagram of the main switchboard.
6	A	Single line diagram and detailed diagram of the emergency switchboards.
7	A	Diagram of the most important section boards and motor control centres (above 100 kW).
8	A	Diagram of the general emergency alarm system, of the public address system and other intercommunication systems.
9	A	Detailed diagram of the navigation-light switchboard.
10	A	Diagram of the remote stop system (ventilation, fuel pump, fuel valves, etc.).
11	I	Schedule for recording of the type, location and maintenance cycle of batteries used for essential and emergency services.
12	A **(2)**	Selectivity and coordination of the electrical protection.
13	A **(3)**	Single line diagram.
14	A **(3)**	Principles of control system and power supply.
15	A **(3)**	Alarm and monitoring system including: • list of alarms and monitoring points • power supply diagram.
16	A **(3)**	Safety system including: • list of monitored parameters for safety system • power supply diagram.

(1) A: to be submitted for approval
I: to be submitted for information
(2) for high voltage installations
(3) for electric propulsion installations.

Vessel's safety:

- Windlasses
- Fuel oil transfer pumps and fuel oil treatment equipment
- Lubrication oil transfer pumps and lubrication oil treatment equipment
- Preheaters for fuel oil
- Sea water pumps
- Starting air and control air compressors
- Bilge, ballast and heeling pumps
- Fire pumps and other fire-extinguishing medium pumps
- Ventilation fans for engine and boiler rooms
- Navigation lights, aids and signals
- Internal safety communication equipment
- Fire detection and alarm systems
- Electrical equipment for watertight closing appliances
- Electric generators and associated power supplying the above equipment
- Hydraulic pumps supplying the above equipment
- Control, monitoring and safety devices/systems for vessel safety services.

Pay-load:

- Sensors
- Weapons
- Command and control systems
- Internal and external communications
- Signature control systems (such as degaussing, noise reduction, and so on)
- Aviation services
- Control, monitoring and safety devices/systems for payload
- Boats launching and recovery systems

Habitability:

- Cooking
- Heating
- Domestic refrigeration
- Mechanical ventilation
- Sanitary and fresh water
- Electric generators and associated power sources supplying the above equipment.

Protection of environment:

- System and equipment related to the environment protection

3.3 Safety voltage

3.3.1 A voltage which does not exceed 50 V a.c. r.m.s. between conductors, or between any conductor and earth, in a circuit isolated from the supply by means such as a safety isolating transformer.

3.3.2 A voltage which does not exceed 50 V d.c. between conductors or between any conductor and earth in a circuit isolated from higher voltage circuits.

3.4 Low-voltage systems

3.4.1 Alternating current systems with rated voltages greater than 50 V r.m.s. up to 1000 V r.m.s. inclusive and direct current systems with a maximum instantaneous value of the voltage under rated operating conditions greater than 50 V up to 1500 V inclusive.

3.5 High-voltage systems

3.5.1 Alternating current systems with rated voltages greater than 1000 V r.m.s. and direct current systems with a maximum instantaneous value of the voltage under rated operating conditions greater than 1500 V.

3.6 Basic insulation

3.6.1 Insulation applied to live parts to provide basic protection against electric shock.

Note 1: Basic insulation does not necessarily include insulation used exclusively for functional purposes.

3.7 Supplementary insulation

3.7.1 Independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of basic insulation.

3.8 Double insulation

3.8.1 Insulation comprising both basic insulation and supplementary insulation.

3.9 Reinforced insulation

3.9.1 A single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation.

Note 1: The term "single insulation system" does not imply that the insulation must be one homogeneous piece. It may comprise several layers which cannot be tested singly as supplementary or basic insulation.

3.10 Earthing

3.10.1 The earth connection to the general mass of the hull of the ship in such a manner as will ensure at all times an immediate discharge of electrical energy without danger.

3.11 Normal operational and habitable condition

3.11.1 A condition under which the ship as a whole, the machinery, services, means and aids ensuring propulsion, ability to steer, safe navigation, pay load, fire and flooding safety, internal and external communications and signals, means of escape, and emergency boat winches, as well as the designed comfortable conditions of habitability are in working order and functioning normally.

3.12 Emergency condition

3.12.1 A condition under which any services needed for normal operational and habitable conditions are not in working order due to failure of the main source of electrical power.

3.13 Main source of electrical power

3.13.1 A source intended to supply electrical power to a main switchboard for distribution to all services necessary for maintaining the ship in normal operational and habitable condition.

3.14 Dead ship condition

3.14.1 The condition under which the main propulsion plant, boilers and auxiliaries are not in operation due to the absence of power.

Note 1: Dead ship condition is a condition in which the entire machinery installation, including the power supply, is out of operation and the auxiliary services such as compressed air, starting current from batteries etc., for bringing the main propulsion into operation and for the restoration of the main power supply are not available.

3.15 Main generating station

3.15.1 The space in which a main source of electrical power is situated.

3.16 Main switchboard

3.16.1 A switchboard which is directly supplied by a main source of electrical power and is intended to distribute electrical energy to the ship's services.

3.17 Emergency switchboard

3.17.1 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 or the transitional source of emergency electrical power and is intended to distribute electrical energy to the emergency services.

3.18 Emergency source of electrical power

3.18.1 A source of electrical power, intended to supply the emergency switchboard in the event of failure of the supply from the main electrical power supply system.

3.19 Section boards

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

3.20 Distribution board

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

3.21 Final sub-circuit

3.21.1 That portion of a wiring system extending beyond the final required overcurrent protective device of a board.

3.22 Hazardous areas

3.22.1 Areas in which an explosive atmosphere is present, or may be expected to be present due to the presence of vapours, gases, flammable dusts or explosives in quantities such as to require special precautions for the construction, installation and use of electrical apparatus.

3.22.2 Hazardous areas are classified in zones based upon the frequency and the duration of the occurrence of explosive atmosphere.

3.22.3 Hazardous areas for explosive gas atmosphere are classified in the following zones:

- Zone 0: an area in which an explosive gas atmosphere is present continuously or is present for long periods
- Zone 1: an area in which an explosive gas atmosphere is likely to occur in normal operation
- Zone 2: an area in which an explosive gas atmosphere is not likely to occur in normal operation and if it does occur, is likely to do only infrequently and will exist for a short period only.

3.23 Certified safe-type equipment

3.23.1 Certified safe-type equipment is electrical equipment of a type for which a national or other appropriate authority has carried out the type verifications and tests necessary to certify the safety of the equipment with regard to explosion hazard when used in an explosive gas atmosphere.

3.24 Environmental categories

3.24.1 Electrical equipment is classified into environmental categories according to the temperature range, vibration levels, and resistance to chemically active substances and to humidity.

The designation of the environmental categories is indicated by the EC Code in Tab 2.

The first characteristic numeral indicates the temperature range in which the electrical equipment operates satisfactorily, as specified in Tab 3.

The second characteristic numeral indicates the vibration level in which the electrical equipment operates satisfactorily, as specified in Tab 4.

3.24.2 The tests for verifying the additional and supplementary letters and the characteristic numeral of the environmental categories are defined in Ch 3, Sec 6.

Table 2 : EC Code

Code letter	First characteristic numeral	Second characteristic numeral	Additional letter	Supplementary letter
EC	(numerals 1 to 4)	(numerals 1 to 3)	(letter S) **(1)**	(letter C) **(2)**

(1) The additional letter S indicates the resistance to salt mist (exposed decks, masts) of the electrical equipment.

(2) The supplementary letter C indicates the relative humidity up to 80% (air conditioned areas) in which the electrical equipment operates satisfactorily.

Table 3 : First characteristic numeral *(1/1/2017)*

First characteristic numeral	Brief description of location	Temperature range °C	
1	Air conditioned areas	+ 5	+ 40
2	Enclosed spaces	+ 5	+ 45
3	Inside consoles or close to combustion engines and similar	+ 5	+ 70
4	Exposed decks, masts	- 25	+ 45

Table 4 : Second characteristic numeral

Second characteristic numeral	Brief description of location	Frequency range Hz	Displacement amplitude mm	Acceleration amplitude g
1	Machinery spaces, command and control stations, accommodation spaces, exposed decks, cargo spaces	from 2,0 to 13,2 from 13,2 to 100	1,0 -	- 0,7
2	Masts	from 2,0 to 13,2 from 13,2 to 50	3,0 -	- 2,1
3	On air compressors, on diesel engines and similar	from 2,0 to 25,0 from 25,0 to 100	1,6 -	- 4,0

3.25 Navigation Light (NL)

3.25.1 *(1/1/2017)*

Navigation Light (NL) means the following lights:

- masthead light, sidelights, sternlight, towing light, all-round light, flashing light as defined in Rule 21 of COLREGs (see Note 1),
- all-round flashing yellow light required for air-cushion vessels by Rule 23 of COLREGs,
- manoeuvring light required by Rule 34(b) of COLREGs.

Note 1: COLREGs means Convention on the International Regulations for Preventing Collisions at Sea, 1972, including their annexes.

SECTION 2 GENERAL DESIGN REQUIREMENTS

1 Environmental conditions

1.1 General

1.1.1 The electrical components of installations are to be designed and constructed to operate satisfactorily under the environmental conditions on board.

In particular, the conditions shown in the tables in this Article are to be taken into account.

Note 1: The environmental conditions are characterised by:

- one set of variables including climatic conditions (e.g. ambient air temperature and humidity), biological conditions, conditions dependent upon chemically active substances (e.g. salt mist) or mechanically active substances (e.g. dust or oil), mechanical conditions (e.g. vibrations or inclinations) and conditions dependent upon electromagnetic noise and interference, and
- another set of variables dependent mainly upon location on vessels, operational patterns and transient conditions.

1.2 Ambient air temperatures

1.2.1 For ships classed for unrestricted navigation, the ambient air temperature ranges shown in Tab 1 are applicable in relation to the various locations of installation.

1.2.2

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

- the equipment is not for use for emergency services.
- 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(s) is (are) capable of satisfactorily maintaining the design temperature.
- the equipment is able to be initially set to work safely up to a 45° ambient temperature until such time as the lower ambient temperature is achieved; the cooling equipment is to be rated for a 45 ° ambient temperature.
- audible and visual alarms are fitted, at a continually manned control station, to indicate any malfunction of the cooling units.

1.2.3

In accepting an ambient temperature less than 45° it is to be ensured that electrical cables are adequately rated throughout their length for the maximum ambient temperature to which they are exposed.

1.2.4

The equipment used for cooling and maintaining the lower ambient temperature is to be classified for a secondary essential service.

1.2.5 For ships classed for service in specific zones, the Society may accept different ranges for the ambient air temperature (e.g. for ships operating outside the tropical belt, the maximum ambient air temperature may be assumed as equal to + 40 °C instead of + 45 °C).

1.2.6 For ships classed for NBC service, adequate means of refrigeration are to be provided and electrical equipment has to withstand the maximum temperature expected in NBC condition.

Table 1 : Ambient air temperature *(1/1/2017)*

Location	Temperature range °C	
Enclosed spaces	+ 5	+ 45
Inside consoles or fitted on combustion engines and similar	+ 5	+ 70
Exposed decks	- 25	+ 45

1.3 Humidity

1.3.1 For ships classed for unrestricted service, the humidity ranges shown in Tab 2 are applicable in relation to the various locations of installation.

Table 2 : Humidity

Location	Humidity
General	95% at 55 °C
Air conditioned areas	Different values may be considered on a case by case basis

1.4 Cooling water temperatures

1.4.1 The temperatures shown in Tab 3 are applicable to ships classed for unrestricted service.

1.4.2 For ships classed for service in specific zones, the Society may accept different values for the cooling water temperature (e.g. for ships operating outside the tropical belt, the maximum cooling water temperature may be assumed as equal to + 25 °C instead of + 32 °C).

Table 3 : Water temperature

Coolant	Temperature range °C	
Sea water	0	+ 32

1.5 Salt mist

1.5.1 The applicable salt mist content in the air is to be 1 mg/m^3.

1.6 Inclinations

1.6.1 The inclinations applicable are those shown in Tab 4.

The Society may consider deviations from these angles of inclination taking into consideration the type, size and service conditions of the ships.

1.7 Vibrations

1.7.1 In relation to the location of the electrical components, the vibration levels given in Tab 5 are to be assumed.

1.7.2 The natural frequencies of the equipment, their suspensions and their supports are to be outside the frequency ranges specified.

Where this is not possible using a suitable constructional technique, the equipment vibrations are to be dumped so as to avoid unacceptable amplifications.

2 Quality of power supply

2.1 Voltage and frequency variation

2.1.1

All electrical appliances supplied from the main or emergency systems are to be so designed and manufactured that they are capable of operating satisfactorily under the normally occurring variations in voltage and frequency.

2.1.2

Unless otherwise stated in national or international standards, all equipment is to operate satisfactorily with the variations from its rated value shown in Tab 6 to Tab 8 subject to the following conditions.

a) For alternating current components, the voltage and frequency variations shown in Tab 6 are to be assumed.

b) For direct current components supplied by d.c. generators or converted by rectifiers, the voltage variations shown in Tab 7 are to be assumed.

c) For direct current components supplied by electrical batteries, the voltage variations shown in Tab 8 are to be assumed.

2.2 Harmonic distortions

2.2.1

For components intended for systems without substantially static converter loads and supplied by synchronous generators, it is assumed that the total voltage harmonic distortion does not exceed 5%, and the single harmonic does not exceed 3% of the nominal voltage.

2.2.2

For components intended for systems fed by static converters, and/or systems in which the static converter load predominates, it is assumed that:

- the single harmonics do not exceed 5% of the nominal voltage up to the 15th harmonic of the nominal frequency, decreasing to 1% at the 100th harmonic (see Fig 1), and that
- the total harmonic distortion does not exceed 10%.

Table 4 : Inclination of ship

Type of machinery, equipment or component	Angles of inclination, in degrees **(1)**			
	Athwartship		Fore-and-aft	
	static	dynamic **(3)**	static	dynamic **(4)**
Machinery and equipment relative to main electrical power installation	15	22,5	5	7,5
Machinery and equipment relative to the emergency power installation and crew and passenger safety systems of the ship (e.g. emergency source of power, emergency fire pumps, etc.)	22,5	22,5	10	10
Switchgear and associated electrical and electronic components and remote control systems **(2)**	22,5	22,5	10	10

(1) Athwartship and fore-and-aft angles may occur simultaneously in their most unfavourable combination.
(2) No undesired switching operations or functional changes may occur up to an angle of inclination of 45°.
(3) The period of dynamic inclination may be assumed equal to 10 s.
(4) The period of dynamic inclination may be assumed equal to 5 s.

Table 5 : Vibration levels

Location	Frequency range Hz	Displacement amplitude mm	Acceleration amplitude g
Machinery spaces, command and control stations, accommodation spaces, exposed decks, cargo spaces	from 2,0 to 13,2 from 13,2 to 100	1,0 -	- 0,7
On air compressors, on diesel engines and similar	from 2,0 to 25,0 from 25,0 to 100	1,6 -	- 4,0
Masts	from 2,0 to 13,2 from 13,2 to 50	3,0 -	- 2,1

Figure 1

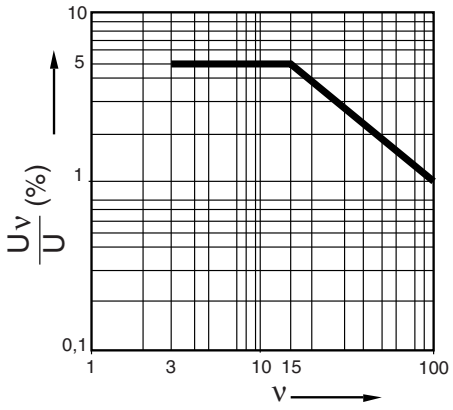


Table 6 : Voltage and frequency variations for a.c. distribution systems

Quantity in operation	Variations	
	Continuous	Transient
Voltage	+ 6% - 10%	± 20% (recovery time: 1,5 s)
Frequency	± 5%	± 10% (recovery time: 5 s)

Table 7 : Voltage variations for d.c. distribution systems

Parameters	Variations
Voltage tolerance (continuous)	± 10%
Voltage cyclic variation deviation	5%
Voltage ripple (a.c. r.m.s. over steady d.c. voltage)	10%

2.2.3

Higher values for the harmonic content (e.g. in electric propulsion plant systems) may be accepted on the basis of correct operation of all electrical devices.

Table 8 : Voltage variations for battery systems

Systems	Variations
Components connected to the battery during charging **(1)**	+30%, -25%
Components not connected to the battery during charging	+20%, -25%
(1) Different voltage variations as determined by the charging/discharging characteristics, including ripple voltage from the charging device, may be considered.	

3 Electromagnetic susceptibility

3.1

3.1.1 For electronic type components such as sensors, alarm panels, automatic and remote control equipment, protective devices and speed regulators, the conducted and radiated disturbance levels to be assumed are those given in Chapter 3.

Note 1: See also IEC Publication 60533 - "Electromagnetic Compatibility of Electrical and Electronic Installations in Ships and of Mobile and Fixed Offshore Units".

4 Materials

4.1 General

4.1.1 In general, and unless it is adequately protected, all electrical equipment is to be constructed of durable, flame-retardant, moisture-resistant materials which are not subject to deterioration in the atmosphere and at the temperatures to which they are likely to be exposed. Particular consideration is to be given to sea air and oil vapour contamination.

Note 1: The flame-retardant and moisture-resistant characteristics may be verified by means of the tests cited in IEC Publication 60092-101 or in other recognised standards.

4.1.2 Where the use of incombustible materials or lining with such materials is required, the incombustibility characteristics may be verified by means of the test cited in IEC Publication 60092-101 or in other recognised standards.

4.2 Insulating materials for windings

4.2.1 Insulated windings are to be resistant to moisture, sea air and oil vapour unless special precautions are taken to protect insulants against such agents.

4.2.2 The insulation classes given in Tab 9 may be used in accordance with IEC Publication 60085.

Table 9 : Insulation Classes

Class	Maximum continuous operating temperature °C
A	105
E	120
B	130
F	155
H	180

4.3 Insulating materials for cables

4.3.1 See Sec 9, [1.3].

5 Construction

5.1 General

5.1.1 All electrical apparatus is to be so constructed as not to cause injury when handled or touched in the normal manner.

5.1.2 The design of electrical equipment is to allow accessibility to each part that needs inspection or adjustment, also taking into account its arrangement on board.

5.1.3 Enclosures are to be of adequate mechanical strength and rigidity.

5.1.4 Enclosures for electrical equipment are generally to be of metal; other materials may be accepted for accessories such as connection boxes, socket-outlets, switches and luminaires. Other exemptions for enclosures or parts of enclosures not made of metal will be specially considered by the Society.

5.1.5 Cable entrance are not to impair the degree of protection of the relevant enclosure (see Sec 3, Tab 1).

5.1.6 All nuts and screws used in connection with current-carrying parts and working parts are to be effectively locked.

5.1.7 All equipment is generally to be provided with suitable, fixed terminal connectors in an accessible position for convenient connection of the external cables.

5.2 Degree of protection of enclosures

5.2.1 Electrical equipment is to be protected against the ingress of foreign bodies and water.

The minimum required degree of protection, in relation to the place of installation, is generally that specified in Sec 3, Tab 1.

5.2.2 The degrees of protection are to be in accordance with:

- IEC Publication No. 60529 for equipment in general
- IEC Publication No. 60034-5 for rotating machines.

5.2.3 For cable entries see [5.1.5].

6 Protection against explosion hazard

6.1 Protection against explosive gas or vapour atmosphere hazard

6.1.1 Electrical equipment intended for use in areas where explosive gas or vapour atmospheres may occur, is to be of a "safe type" suitable for the relevant flammable atmosphere and for shipboard use.

6.1.2 The following “certified safe type” equipment is considered:

- intrinsically-safe: Ex(ia) - Ex(ib)
- flameproof: Ex(d)
- increased safety: Ex(e)
- pressurised enclosure: Ex(p)
- encapsulated: Ex(m)
- sand filled: Ex(q)
- special protection: Ex(s)
- oil-immersed apparatus (see Note 1): Ex(o)

Note 1: Only when required by the application.

6.1.3 Other equipment complying with types of protection other than those in [6.1.2] may be considered by the Society, such as:

- simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically-safe circuits not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules
- electrical apparatus specifically designed and certified by the appropriate authority for use in Zone 0 or specially tested for Zone 2 (e.g. type “n” protection)
- equipment the type of which ensures the absence of sparks and arcs and of “hot spots” during its normal operation
- pressurised equipment
- equipment having an enclosure filled with a liquid dielectric, or encapsulated.

6.2 Protection against combustible dust hazard

6.2.1 Electrical appliances intended for use in areas where a combustible dust hazard may be present are to be arranged with enclosures having a degree of protection and maximum surface temperature suitable for the dust to which they may be exposed.

Note 1: Where the characteristics of the dust are unknown, the appliances are to have a degree of protection IP6X. For most dusts a maximum surface temperature of 135°C is considered adequate.

SECTION 3 SYSTEM DESIGN

1 Supply systems and characteristics of the supply

1.1 Supply systems

1.1.1 The following distribution systems may be used:

a) on d.c. installations:

- two-wire insulated
- two-wire with one pole earthed

b) on a.c. installations:

- three-phase three-wire with neutral insulated
- three-phase three-wire neutral directly earthed or through impedance
- three-phase four-wire neutral directly earthed or through impedance
- single-phase two-wire insulated
- single-phase two-wire with one phase earthed.

1.1.2 The hull return system of distribution is not to be used.

1.1.3 The requirement of [1.1.2] does not preclude under conditions approved by the Society the use of:

a) impressed current cathodic protective systems,

b) insulation level monitoring devices provided the circulation current does not exceed 30 mA under the most unfavourable conditions.

1.1.4 For the supply systems in HV installations, see Sec 13.

1.2 Maximum voltages

1.2.1 The maximum voltages for both alternating current and direct current low-voltage systems of supply for the ship's services are given in Tab 2.

1.2.2 Voltages exceeding those shown will be specially considered in the case of specific systems.

1.2.3 For high voltage systems see Sec 13.

2 Sources of electrical power

2.1 General

2.1.1 Electrical installations are to be such that:

a) All electrical auxiliary services necessary for maintaining the ship in normal operational and habitable conditions will be assured without recourse to the emergency source of electrical power.

b) Electrical services essential for safety will be assured under various emergency conditions.

c) When a.c. generators are involved, attention is to be given to the starting of squirrel-cage motors connected to the system, or other pay load consumers having pulse loads, particularly with regard to the effect of the magnitude and duration of the transient voltage change produced due to the maximum starting or pulse currents and the power factor. The voltage drop due to such currents is not to cause any motor already operating to stall or have any adverse effect on other equipment in use.

2.2 Main source of electrical power

2.2.1 A main source of electrical power is to be provided, of sufficient capability to supply all electrical auxiliary services necessary for maintaining the ship in normal operational and habitable conditions without recourse to the emergency source of electrical power.

2.2.2 For vessels propelled by electrical power and having two or more constant voltage propulsion generating sets which constitute the source of electrical energy for the ship's auxiliary services, see Sec 14.

2.2.3 When only one main source of electrical power is provided, it is to consist of at least two generating sets.

The capacity of the main generating sets is to be such that in the event of any one generating set being stopped it will still be possible to supply those services necessary to provide normal operational conditions.

Such capacity is, in addition, to be sufficient to start the largest motor and to supply pay-load consumers having pulse loads without causing any other motor to stop or having any adverse effect on other equipment in operation.

2.2.4 For the purpose of calculating the necessary capacity, it is essential to consider which consumers can be expected to be in use simultaneously, in the various operational conditions of the ship.

For a duplicated service, one being supplied electrically and the other non-electrically (see Note 1) (e.g. driven by the main engine), the electrical capacity is not included in the above calculation.

Note 1: It is assumed that the consumers not electrically driven are capable to operate satisfactorily in all conditions.

2.2.5 The services in [2.2.4] do not include:

- thrusters not forming part of the main propulsion or dynamic positioning system,
- refrigerators for air conditioning other than air refrigerator systems for satisfactory operation of essential services.

2.2.6 Further to the provisions above, the generating sets shall be such as to ensure that with any one generator or its primary source of power out of operation, the remaining generating sets shall be capable of providing the electrical services necessary to start the main propulsion plant from a "dead ship" condition.

2.2.7

The emergency source of electrical power may be used for the purpose of starting from a "dead ship" condition if its capability either alone or combined with that of any other source of electrical power is sufficient to provide at the same time those services required to be supplied in accordance with the provisions of [3.6.3] (items a, b, c, d).

2.2.8 The arrangement of the ship's main sources of electrical power shall be such that essential services can be maintained regardless of the speed and direction of rotation of the main propulsion machinery or shafting.

2.2.9 Generators driven by the propulsion plant (shaft generators) may be accepted as forming part of the main source of electrical power if, in all sailing and manoeuvring conditions, and including the propeller being stopped, the capacity of these generators is sufficient to provide the electrical power to comply with [2.2.3] and all further requirements, especially those of [2.2.6]. They are to be not less effective and reliable than the independent generating sets.

2.2.10

Generators and generator systems, having the ship's propulsion machinery as their prime mover but not forming part of the ship's main source of electrical power (see Note 1) may be used whilst the ship is at sea to supply electrical services required for normal operational and habitable conditions provided that:

a) there are sufficient and adequately rated additional generators fitted, which constitute the main source of electrical power required by [2.2.1], meeting the requirements of [2.2.9]
b) arrangements are fitted to automatically start one or more of the generators, constituting the main source of electrical power required by [2.2.1], in compliance with [3.3.4] and also upon the frequency variations exceeding ± 10% of the limits specified below
c) within the declared operating range of the generators and/or generator systems the specified limits for the voltage variations in IEC 60092-301 (see Note 3) and the frequency variations in Table 6 can be met
d) 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
e) where considered appropriate, load shedding arrangements are fitted to meet the requirements of [3.3.5] and [3.3.6]
f) on ships having remote control of the ship's propulsion machinery from the navigating bridge means are provided, or procedures be in place, so as to ensure that supplies to essential services are maintained during manoeuvring conditions in order to avoid a blackout situation (see Note 4).

Note 1: Such generator systems are those whose operation does not meet the requirements of IEC 60092-201, paragraph 6.2.3.

Note 2: IEC 60092-201 Electrical installations in ships - part 201: System design - General.

Note 3: IEC 60092-301 Electrical installations in ships - part 301: Equipment - Generators and motors.

Note 4: 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.

2.2.11 Where transformers, converters or similar appliances constitute an essential part of the electrical supply system, the system is to be so arranged as to ensure the same continuity of supply as stated in this sub-article.

This may be achieved by arranging at least two three-phase or three single-phase transformers so that with any one transformer not in operation, the remaining transformer(s) is (are) sufficient to ensure the supply to the services stated in [2.2.3].

Each transformer required is to be located as a separate unit with separate enclosure or equivalent.

Where single phase transformers are used, only one spare element is required for each different type of transformer if special precautions are taken to rapidly replace the faulty one.

2.2.12 For ships having qualified automation systems, see Part E, Chapter 2.

2.2.13 For starting arrangements for main generating sets, see Ch 1, Sec 2, [3.1].

2.3 Emergency source of electrical power

2.3.1

Where the main sources of electrical power are located in two or more compartments that are not contiguous with each other and separated in such a way to ensure the supply to the emergency services also in case of flooding of the maximum number of contiguous compartments according to stability regulation (see Part B), and where each source has its own independent self contained systems, including power distribution and control systems such that a fire in any one of the compartments or other casualty including the flooding of the maximum number of contiguous compartments according to stability regulation as above, will not affect the power distribution from the other main

sources, or to the services required by [3.6.3], the requirement of this section will be satisfied without the additional source of emergency electrical power (required by [2.3.2], provided that:

a) there is at least one generating set complying with the requirements from [2.3.5] to [2.3.15] and of sufficient capacity to meet the requirements of [3.6.3] in at least two non-contiguous (as prescribed above) compartments

b) the generator sets referred to in [2.3.1] (a) and their self contained systems are installed such that one of them remains operable after damage in any one compartment.

Particular care is to be paid in respect of availability of all the required auxiliary systems of the generating sets indicated above and, in particular to:

- Availability of fuel supply: attention is to be paid to the location of service tanks, to the risk of loose of fuel or contamination of the tank in case of damage of pipes connected to these and passing through damaged compartment and to the availability of treatment and transfer systems in case service tanks are not sufficient for the supply of the emergency loads for the time prescribed in [3.6.3].
- Availability of sea water cooling system and exhaust gas system (for ships with exhausts gas outlets which are submerged or close to the waterline) is to be ensured in all foreseeable trim and list correspondent to the flooded conditions.

2.3.2 A self-contained emergency source of electrical power shall be provided.

2.3.3 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 is understood to mean conditions, while the vessel is at sea, such as:

a) blackout situation

b) dead ship situation

c) routine use for testing

d) short-term parallel operation with the main source of electrical power for the purpose of load transfer.

Unless otherwise instructed by the Society, the emergency generator may be used during lay time in port for the supply of the ship mains, provided the requirements of [2.4] are complied with.

2.3.4 The electrical power available shall be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously.

2.3.5 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 stated in [3.6.3] for the period specified, if they depend upon an electrical source for their operation.

2.3.6 The transitional source of emergency electrical power, where required, is to be of sufficient capacity to supply at least the services stated in [3.6.6] for half an hour, if they depend upon an electrical source for their operation.

2.3.7 An indicator shall be mounted in a suitable place, in a continuously manned control position (e.g. platform control room), to indicate when the batteries constituting either the emergency source of electrical power or the transitional source of emergency electrical power are being discharged.

2.3.8 If the services which are to be supplied by the transitional source receive power from an accumulator battery by means of semiconductor convertors, means are to be provided for supplying such services also in the event of failure of the convertor (e.g. providing a bypass feeder or a duplication of convertor).

2.3.9

Where electrical power is necessary to restore propulsion, the capacity of the emergency source shall be sufficient to restore propulsion to the ship in conjunction to other machinery as appropriate, from a dead ship condition within 30 min. after blackout.

For the purpose of this requirement only, the dead ship condition and blackout are both understood to mean a condition under which the main propulsion plant, boilers and auxiliaries are not in operation and in restoring the propulsion, no stored energy for starting the propulsion plant, the main source of electrical power and other essential auxiliaries is to be assumed available. It is assumed that means are available to start the emergency generator at all times.

The emergency generator and other means needed to restore the propulsion are to have a capacity such that the necessary propulsion starting energy is available within 30 minutes of blackout/dead ship condition as defined above. Emergency generator or the other means stored starting energy is not to be directly used for starting the propulsion plant.

2.3.10 Provision shall be made for the periodic testing of the complete emergency system and shall include the testing of automatic starting arrangements, where provided.

2.3.11 For starting arrangements for emergency generating sets, see Ch 1, Sec 2, [3.1].

2.3.12 The emergency source of electrical power may be either a generator or an accumulator battery which shall comply with the requirements of [2.3.13] or [2.3.14], respectively.

2.3.13 Where the emergency source of electrical power is a generator, it shall be:

a) driven by a suitable prime mover with an independent supply of fuel, having a flashpoint (closed cup test) of not less than 43°C;

b) started automatically upon failure of the electrical supply to the emergency switchboard from the main source of electrical power and shall be automatically connected to the emergency switchboard; those services

referred to in [3.6.6] shall then be transferred automatically to the emergency generating set.

The automatic starting system and the characteristic of the prime mover shall be such as to permit the emergency generator to carry its full rated load as quickly as is safe and practicable, subject to a maximum of 45 s; and

c) provided with a transitional source of emergency electrical power according to [2.3.15].

2.3.14 Where here the emergency source of electrical power is an accumulator battery, it shall be capable of:

a) carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage;

b) automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and

c) immediately supplying at least those services specified in [3.6.6].

2.3.15 The transitional source of emergency electrical power required by [2.3.13] c) shall consist of an accumulator battery which shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage and be so arranged as to supply automatically in the event of failure of either the main or emergency source of electrical power at least the services in [3.6.6] if they depend upon an electrical source for their operation.

2.4 Use of emergency generator in port

2.4.1 To prevent the generator or its prime mover from becoming overloaded when used in port, arrangements are to be provided to shed sufficient non-emergency loads to ensure its continued safe operation.

2.4.2 The prime mover is to be arranged with fuel oil filters and lubrication oil filters, monitoring equipment and protection devices as requested for the prime mover for main power generation and for unattended operation.

2.4.3 The fuel oil supply tank to the prime mover is to be provided with a low level alarm, arranged at a level ensuring sufficient fuel oil capacity for the emergency services for the period of time as required in [3.6].

2.4.4 The prime mover is to be designed and built for continuous operation and should be subjected to a planned maintenance scheme ensuring that it is always available and capable of fulfilling its role in the event of an emergency at sea.

2.4.5 Fire detectors are to be installed in the location where the emergency generator set and emergency switchboard are installed.

2.4.6 Means are to be provided to readily change over to emergency operation.

2.4.7 Control, monitoring and supply circuits for the purpose of the use of the emergency generator in port are to be so arranged and protected that any electrical fault will not influence the operation of the main and emergency services.

When necessary for safe operation, the emergency switchboard is to be fitted with switches to isolate the circuits.

2.4.8 Instructions are to be provided on board to ensure that, even when the vessel is underway, all control devices (e.g. valves, switches) are in a correct position for the independent emergency operation of the emergency generator set and emergency switchboard.

These instructions are also to contain information on the required fuel oil tank level, position of harbour/sea mode switch, if fitted, ventilation openings, etc.

3 Distribution

3.1 Earthed distribution systems

3.1.1 System earthing is to be effected by means independent of any earthing arrangements of the non-current-carrying parts.

3.1.2 Means of disconnection are to be fitted in the neutral earthing connection of each generator so that the generator may be disconnected for maintenance or insulation resistance measurements.

3.1.3 Generator neutrals may be connected in common, provided that the third harmonic content of the voltage wave form of each generator does not exceed 5%.

3.1.4 Where a switchboard is split into sections operated independently or where there are separate switchboards, neutral earthing is to be provided for each section or for each switchboard. Means are to be provided to ensure that the earth connection is not removed when generators are isolated.

3.1.5 Where for final sub-circuits it is necessary to locally connect a pole (or phase) of the sub-circuits to earth after the protective devices (e.g. in automation systems or to avoid electromagnetic disturbances), provision (e.g. d.c./d.c. convertors or transformers) is to be made such that current unbalances do not occur in the individual poles or phases.

3.1.6 For high voltage systems see Sec 13.

3.2 Insulated distribution systems

3.2.1 Every insulated distribution system, whether primary or secondary (see Note 1), for power, heating or lighting, shall be provided with a device capable of continuously monitoring the insulation level to earth (i.e. the values of electrical insulation to earth) and of giving an audible and visual indication of abnormally low insulation values.

Note 1: A primary system is one supplied directly by generators. Secondary systems are those supplied by transformers or convertors.

3.2.2 For high voltage systems see Sec 13.

3.3 General requirements for distribution systems

3.3.1 The distribution system is to be such that the failure of any single circuit will not endanger or impair essential services.

3.3.2 No common switchgear (e.g. contactors for emergency stop) is to be used between the switchboard's bus-bars and two duplicated essential services.

3.3.3 The system shall be so arranged that the electrical supply will be maintained or immediately restored in the case of loss of any one of the generators in service. Automatic restart of equipment necessary for propulsion and steering and to ensure safety of the ship is also to be provided.

3.3.4

Where the electrical power is normally supplied by more than one generator set simultaneously in parallel operation, provision of protection, including automatic disconnection of sufficient non-essential services and, if necessary, essential services for habitability, are to be made to ensure that, in case of loss of any of these generating sets, the remaining ones are kept in operation to permit propulsion and steering and to ensure safety..

3.3.5

Where the electrical power is normally supplied by one generator, provision are to be made, upon loss of power, for automatic starting and connecting to the main switchboard of stand-by generator(s) of sufficient capacity with automatic restarting of the essential auxiliaries, in sequential operation if required. Starting and connection to the main switchboard of one generator is to be as rapid as possible, preferably within 30 seconds after loss of power.

Where prime movers with longer starting time are used, this starting and connection time may be exceeded upon approval from the Society.

3.3.6

Load shedding or other equivalent arrangements are to be provided to protect the generators against sustained overload.

3.3.7

The load shedding is to be automatic.

3.3.8

Non-essential services and services for habitable conditions may be shed to ensure the connected generator set or generator sets are not overloaded.

3.4 Main distribution of electrical power

3.4.1 Where more than one main generator is connected to a main switchboard, the main bus-bar is to be divided into at least two parts which are normally to be connected by circuit breakers or other approved means such as circuit breakers without tripping mechanisms or disconnecting switches by means of which bus-bars can be split safely and easily.

The connection of generating sets, associated auxiliaries and other duplicated equipment is to be equally divided between the parts as far as practicable, so that in the event of damage to one section of the switchboard the remaining parts are still supplied.

The same applies in case of main switchboards supplied by one generating set and connected to another main switchboard, being this connection considered as a connection of a second generator.

3.4.2 Two or more units serving the same consumer (e.g. main and standby lubricating oil pumps) are to be supplied by individual separate circuits without the use of common feeders, protective devices or control circuits. This requirement is satisfied when such units are supplied by separate cables from the a main switchboard or from two independent section boards.

3.4.3 A main electric lighting system, which is to provide illumination throughout those parts of the ship normally accessible to and used by personnel, is to be supplied from the main sources of electrical power.

3.5 Main distribution of electrical power by zones

3.5.1

The requirements of present paragraph [3.5] apply to ships with main distribution system arranged in such a way that the power supply of one zone (usually correspondent with the Main Vertical Zones defined in Ch 4, Sec 1, [2.22]) can be easily disconnected without affecting the power supply to essential and emergency services in other zones.

3.5.2

Notwithstanding the requirements in [2.2.10] and [3.3.1], when a distribution of electrical power by zones is adopted, the failure of any single circuit in one zone shall not endanger or impair essential services in the other zones and shall not render inoperative both the normal and emergency lighting systems in the zone interested by the fault.

The loss of both normal and emergency lightning systems in one zone in case of single failure may be accepted if the persons accommodated in the damaged zone can be easily accommodated in other zones and if adequate lightning is ensured (e.g. by means of fixed or movable lamps having their own dedicated accumulator batteries that, in normal condition, are continuously charged) for a transitional period sufficient to ensure a safe evacuation of the zone and, in any case, not shorter than half an hour.

3.5.3

In case of lose of one main source of electrical power due to flooding, fire or single failure, emergency services listed in [3.6.3] are to be supplied for the required periods outside the damaged zones.

3.6 Emergency distribution of electrical power

3.6.1 The emergency switchboard shall be supplied during normal operation from the main switchboard by an interconnector feeder which shall be adequately protected at the main switchboard against overload and short-circuit and which is to be disconnected automatically at the emergency switchboard upon failure of the main source of electrical power.

Where the system is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard at least against short-circuit.

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

3.6.3

The emergency source of electrical power shall be capable of supplying simultaneously at least the following services for the periods specified hereafter, if they depend upon an electrical source for their operation:

a) for a period of 3 hours, emergency lighting at every muster and embarkation station and over the sides;

b) for a period of 18 hours, emergency lighting:

   1) in all service and accommodation alleyways, stairways and exits, personnel lift cars and personnel lift trunks;

   2) in the machinery spaces and main generating stations including their control positions;

   3) in all control stations including platform control room and combat system control rooms, machinery control rooms, and at each main and emergency switchboard;

   4) at all stowage positions for firemen's outfits;

   5) at the steering gear; and

   6) at the fire pump referred to in e) below, at the sprinkler pump, if any, at the emergency bilge pump, if any, and at the starting positions of their motors;

c) for a period of 18 hours:

   1) the navigation lights and other lights required by the International Regulations for Preventing Collisions at Sea in force and/or by the Naval Authority;

   2) the radio installation and external communication systems required by SOLAS and or by the Naval Authority;

d) for a period of 18 hours:

   1) all internal communication equipment as required in an emergency [3.6.4];

   2) the shipborne navigational equipment as required by SOLAS and or by the Naval Authority, including those for flight assistance;

   3) the fire detection and fire alarm systems; and

   4) intermittent operation of the daylight signalling lamp, the ship's whistle, the manually operated call points and all internal signals (see [3.6.5]) that are required in an emergency, unless such services have an independent supply for the period of 18 hours from an accumulator battery suitably located for use in an emergency;

e) for a period of 18 hours:

   1) one of the fire pumps required by the relevant provisions of Chapter 4;

   2) the automatic sprinkler pump, if any; and

   3) one of the flooding pumps and all the equipment essential for the operation of electrically powered remote controlled bilge valves;

f) for the period of time required in Ch 1, Sec 11, the steering gear where it is required to be so supplied;

g) for a period of half an hour, any watertight doors required to be power operated together with their indicators and warning signals;

h) equipment necessary for ship's self defence or a selection of apparatus of the pay load to be defined case by case by the Naval Authority.

3.6.4 Internal communication equipment required in an emergency generally includes:

a) the means of communication between the navigating bridge and the steering gear compartment

b) the means of communication between the navigating bridge and the position in the machinery space or control room from which the engines are normally controlled

c) the means of communication for fire fighting and damage control

d) the means of communication for combat system operation

e) the public address system.

3.6.5 Internal signals required in an emergency generally include:

a) general alarm

b) watertight door alarm and indication system.

3.6.6 The transitional source of emergency electrical power shall supply for half an hour at least the following services if they depend upon an electrical source for their operation:

a) the lighting required by [3.6.3], items a), b) and c)1), for this transitional phase, the required emergency electric lighting, in respect of the machinery space and the accommodation and service spaces may be provided by

individual, automatically charged, relay operated accumulator lamps; and

b) all services required by [3.6.3] , items d)1), d)3) and d4) unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency.

It is also to supply power to close the watertight doors, but not necessarily all of them simultaneously, unless an independent temporary source of stored energy is provided and power to thire control, indication and alarm circuits, for half an hour.

3.7 Shore/Ship supply

3.7.1 Arrangements are to be made for supplying the electrical installation from a source on shore or elsewhere. A suitable connection box is to be installed on the ship in a convenient location to receive the flexible cable from outside.

3.7.2 Permanently fixed cables of adequate rating are to be provided for connecting the box to the main distribution system.

3.7.3 Where necessary for systems with earthed neutrals, the box is to be provided with an earthed terminal for connection between the shore's/ship's and ship's neutrals or for connection of a protective conductor.

3.7.4 The connection box is to contain a circuit-breaker or a switch-disconnector and fuses.

The shore connection is to be protected against short-circuit and overload; however, the overload protection may be omitted in the connection box if provided on the main switchboard.

3.7.5 Means are to be provided for checking the phase sequence of the incoming supply in relation to the ship's system.

3.7.6 The cable connection to the box is to be provided with at least one switch-disconnector on the main switchboard.

3.7.7 The shore connection is to be provided with an indicator at the main switchboard in order to show when the cable is energised.

3.7.8 At the connection box a notice is to be provided giving full information on the nominal voltage and frequency of the installation.

3.7.9 The switch-disconnector on the main switchboard is to be interlocked with the main generator circuit-breakers in order to prevent its closure when any generator is supplying the main switchboard.

3.7.10 Adequate means are to be provided to equalise the potential between the hull and the shore when the electrical installation of the ship is supplied from shore.

3.7.11 *(1/1/2017)*

Where high voltage shore connections are provided, the requirements of the additional class notation HVSC of Tasneef Rules for the classification of the ships are to be complied with.

3.8 Supply of motors

3.8.1 A separate final sub-circuit is to be provided for every motor required for an essential service (and for every motor rated at 1 kW or more).

3.8.2 Each motor is to be provided with controlgear ensuring its satisfactory starting.

Depending on the capacity of the generating plant or the cable network, it may be necessary to limit the starting current to an acceptable value.

Direct on line starters are accepted if the voltage drop does not exceed 15% of the network voltage.

3.8.3 Efficient means are to be provided for the isolation of the motor and its associated control gear from all live poles of the supply.

Where the control gear is mounted on or adjacent to a switchboard, a disconnecting switch in the switchboard may be used for this purpose.

Otherwise, a disconnecting switch within the control gear enclosure or a separate enclosed disconnecting switch is to be provided.

3.8.4 Where the starter or any other apparatus for disconnecting the motor is remote from the motor itself, one of the following is to be arranged:

a) provision for locking the circuit disconnecting switch in the OFF position

b) an additional disconnecting switch fitted near the motor

c) provision such that the fuses in each live pole or phase can be readily removed and retained by persons authorised to have access to the motor.

3.9 Specific requirements for special power services

3.9.1 For the supply and characteristics of the distribution of the following services see the requirements listed:

- Steering gear: Ch 1, Sec 11
- Fire-extinguishing and detecting systems: Ch 4, Sec 6 and Ch 4, Sec 13
- Permanently installed submergible bilge pump: Ch 1, Sec 10, [6]
- Ventilation fans: Ch 4, Sec 2, [2.1.2]
- Fuel pumps: Ch 1, Sec 10
- Pumps discharging overboard above the lightest water line and in way of the area of lifeboat and liferaft launching: Ch 1, Sec 10.

3.9.2 All power circuits terminating in a bunker or cargo space are to be provided with a multiple-pole switch outside the space for disconnecting such circuits.

3.10 Power supply to heaters

3.10.1 Each heater rated more than 16A is to be connected to a separate final circuit.

3.11 Power supply to lighting installations

3.11.1 Final sub-circuits for lighting supplying more than one lighting point and for socket-outlets are to be fitted with protective devices having a current rating not exceeding 16A.

3.12 Special lighting services

3.12.1 In spaces such as:

- main and large machinery spaces
- large galleys
- passageways
- stairways leading to boat-decks
- public spaces

there is to be more than one final sub-circuit for lighting such that failure of any one circuit does not reduce the lighting to an insufficient level.

3.12.2 Where the emergency installation is required, one of the circuits in [3.12.1] may be supplied from the emergency source of power.

3.12.3 All lighting circuits terminating in a bunker or dry holds are to be provided with a multiple-pole switch outside the space for disconnecting such circuits.

3.13 Navigation and signalling lights

3.13.1

Navigation and signalling lights are to be connected separately to a distribution board specially reserved for this purpose.

Signalling lights may be connected to the navigation light distribution board, or to a separate distribution board.

3.13.2

The navigation lights distribution board is to be supplied from two alternative circuits, one from the main source of power and one from the emergency source of power; see also [3.6].

The transfer of supply is to be practicable from the bridge, for example by means of a switch.

3.13.3 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 referred to in [3.13.1].

3.13.4 Where there are double navigation lights, i.e. lights with two lamps or where for every navigation light a spare is also fitted, the connections to such lights may run in a single cable provided that means are foreseen in the distribution board to ensure that only one lamp or light may be supplied at any one time.

3.13.5 Each navigation light is to 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 fitted, it is to be connected to a separate source of supply from that of the navigation lights, for example an accumulator (storage) battery.

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

A minimum level of visibility is to be assured in the case of use of dimmer devices on the signalling panel. On request of the Naval Authority dimmering of Navigation and signalling hights may be accepted.

3.14 General emergency alarm system

3.14.1 An electrically operated bell or klaxon or other equivalent warning system installed in addition to the ship's whistle or siren, for sounding the general emergency alarm signal, is to comply with the requirements of this subarticle.

3.14.2 The general emergency alarm system is to be supplemented by either a public address system complying with the requirements in [3.15] or other suitable means of communication.

3.14.3 Entertainment sound system is to be automatically turned off when the general alarm system is activated.

3.14.4 The system is to be continuously powered and is to have an automatic change-over to a standby power supply in case of loss of normal power supply.

An alarm is to be given in the event of failure of the normal power supply.

3.14.5 The system is to be powered by means of two circuits, one from the ship's main supply and the other from the emergency source of electrical power required by [2.3] and [3.6].

3.14.6 The system is to be capable of operation from the navigation bridge and, except for the ship's whistle, also from other strategic points

Note 1: Other strategic points are taken to mean those locations, other than the navigation bridge, from where emergency situations are intended to be controlled and the general alarm system can be activated. A fire control station or a platform control room should normally be regarded as strategic points.

3.14.7 The alarm is to continue to function after it has been triggered until it is manually turned off or is temporarily interrupted by a message on the public address system.

3.14.8 The alarm system is to be audible throughout all the accommodation and normal crew working spaces during normal operational condition.

3.14.9 For cables used for the general emergency alarm system, see [9.6].

3.15 Public address system

3.15.1 The public address system is to be a loudspeaker installation enabling the broadcast of messages into all spaces where people on board are normally present.

If not feasible, adequate additional visual indication is to be provided to indicate that a message is being broadcasted.

3.15.2 Where the public address system is used to supplement the general emergency alarm system as per [3.14.2], it is to be continuously powered from the emergency source of electrical power required by [2.3] and [3.6].

3.15.3 The system is to allow for the broadcast of messages from the navigation bridge and from other strategic points as above.

3.15.4 The system is not to require any action from the addressee.

3.15.5 Where an individual loudspeaker has a device for local silencing, an override arrangement from the control station(s), including the navigating bridge, is to be in place.

3.15.6 *(1/1/2017)*

For cables used for the public address system, see [9.6].

3.16 Combined general emergency alarm - public address system

3.16.1 Where the public address system is the only means for sounding the general emergency alarm signal and the fire alarm, in addition to the requirements of [3.14] and [3.15], the following are to be satisfied:

- the system automatically overrides any other input system when an emergency alarm is required
- the system automatically overrides any volume control provided to give the required output for the emergency mode when an emergency alarm is required
- the system is arranged to prevent feedback or other interference
- the system is arranged to minimise the effect of a single failure so that the alarm signal is still audible (above ambient noise levels) also in the case of failure of any one circuit or component, by means of the use of:
  - multiple amplifiers
  - segregated cable routes to public rooms, alleyways, stairways and control stations
  - more than one device for generating electronic sound signal
  - electrical protection for individual loudspeakers against short-circuits.

3.17 Control and indication circuits

3.17.1 For the supply of automation systems, including control, alarm and safety system, see the requirements of Chapter 3.

3.17.2 Control and indicating circuits relative to essential services are to be branched off from the main circuit in which the relevant equipment is installed. Equivalent arrangements may be accepted by the Society.

3.17.3 Control and indicating circuits relative to non-essential services may be supplied by distribution systems reserved for the purpose to the satisfaction of the Society.

3.18 Power supply to the speed control systems of main propulsion engines

3.18.1 Electrically operated speed control systems of main engines are to be fed from the main source of electrical power.

3.18.2 Where more than one main propulsion engine is foreseen, each speed control system is to be provided with an individual supply by means of separate wiring from the main switchboard or from two independent section boards.

Being the main busbars divided into two sections, the governors are, as far as practicable, to be supplied equally from the two sections.

3.18.3 In the case of propulsion engines which do not depend for their operation on electrical power, i.e. pumps driven from the main engine, the speed control systems are to be fed both from the main source of electrical power and from an accumulator battery for at least 15 minutes or from a similar supply source.

Such battery may also be used for other services such as automation systems, where foreseen.

3.19 Power supply to the speed control systems of generator sets

3.19.1 Each electrically operated control and/or speed control system of generator sets is to be provided with a separate supply from a main source of electric power and from an accumulator battery for at least 15 minutes or from a similar supply source.

3.19.2 The wiring supplying a main source of electrical power is to be from the main switchboard or from independent section boards.

Being the main busbars divided into two sections, the governors are, as far as practicable, to be supplied from the sections to which the relevant generators are connected.

4 Degrees of protection of the enclosures

4.1 General

4.1.1 The minimum required degree of protection for electrical equipment, in relation to the place of installation, is generally that specified in Tab 1.

The degree of protection of control panels intended for specific equipment and of consoles is to be at least IP 20 and evaluated case by case by the Society with the agreement of the Naval Authority.

4.1.2 In addition to the requirements of this paragraph, equipment installed in spaces with an explosion hazard is also subject to the provisions of Sec 2, [6].

4.1.3 The enclosures of electrical equipment for the monitoring and control of watertight doors which are situated below the bulkhead deck are to provide suitable protection against the ingress of water.

In particular, the minimum required degree of protection is to be:

- IPX7 for electric motors, associated circuits and control components
- IPX8 for door position indicators and associated circuit components
- IPX6 for door movement warning signals.

Note 1: The water pressure testing of the enclosures protected to IPX8 is to be based on the pressure that may occur at the location of the component during flooding for a period of 18 hours.

5 Diversity (demand) factors

5.1 General

5.1.1 The cables and protective devices of final sub-circuits are to be rated in accordance with their connected load.

5.1.2 Circuits supplying two or more final sub-circuits are to be rated in accordance with the total connected load subject, where justifiable, to the application of a diversity (demand) factor.

5.1.3 A diversity (demand) factor may be applied provided that the known or anticipated operating conditions in a particular part of an installation are suitable for the application of diversity.

6 Environmental categories of the equipment

6.1 Environmental categories

6.1.1 The environmental categories of the electrical equipment, in relation to the place of installation, are generally to be those specified in Tab 3.

6.1.2 For ships classed for NBC service, environmental category EC for all concerned equipment is to be at least EC 31 C or EC 33 C as applicable, unless higher temperatures may be expected.

Table 1 : Minimum required degrees of protection

Condition in location	Example of location	Switchboard Control gear Motor starters	Generators	Motors	Trans-formers	Lumi-naires	Heating appli-ances	Cooking appli-ances	Socket outiets	Accessories (e.g. switches, connection boxes)
Danger of touching live parts only	Dry accom-modation spaces Dry control rooms	I P 20	X **(1)**	I P 20	I P 20	I P 20	I P 20	X	I P 20	I P 20
Danger of dripping liq-uid and/for moderate mechanical damage	Control rooms, wheel-house, radio room	I P 22	X	I P 22	I P 22	I P 22	I P 22	I P22	I P 22	I P 22
	Engine and boiler rooms above floor	I P 22	I P 22	I P 22	I P 22	I P 22	I P 22	I P22	I P 44	I P 44
	Steering gear rooms	I P 22	I P 22	I P 22	I P 22	I P 22	I P 22	X	I P 44	I P 44
	Emergency machinery rooms	I P 22	I P 22	I P 22	I P 22	I P 22	I P 22	X	I P 44	I P 44
	General store rooms	I P 22	X	I P 22	I P 22	I P 22	I P 22	X	I P 22	I P 44
	Pantries	I P 22	X	I P 22	I P 22	I P 22	I P 22	I P 22	I P 44	I P 44
	Provision rooms	I P 22	X	I P 22	I P 22	I P 22	I P 22	X	I P 44	I P 44
	Ventilation ducts	X	X	I P 22	X	X	X	X	X	X

(1) The symbol "X" denotes equipment which it is not advised to install.

(2) Electric motors and starting transformers for lateral thrust propellers located in spaces similar to ballast pump rooms may have degree of protection IP22.

Condition in location	Example of location	Switchboard Control gear Motor starters	Generators	Motors	Trans-formers	Lumi-naires	Heating appli-ances	Cooking appli-ances	Socket outiets	Accessories (e.g. switches, connection boxes)
Increased danger of liquid and/for mechanical damage	Bathrooms and/or show-ers	X	X	X	X	I P 34	IP 44	X	I P 55	I P 55
	Engine and boiler rooms below floor	X	X	I P 44	X	I P 34	IP 44	X	X	I P 55
	Closed fuel oil separator rooms	I P 44	X	I P 44	I P 44	I P 34	I P 44	X	X	I P 55
	Closed lubri-cating oil separator rooms	I P 44	X	I P 44	I P 44	I P 34	I P 44	X	X	I P 55
Increased danger of liquid and mechanical damage	Ballast pump rooms	I P 44	X	I P 44 **(2)**	I P 44 **(2)**	I P 34	I P 44	X	I P 55	I P 55
	Refrigerated rooms	X	X	I P 44	X	I P 34	I P 44	X	I P 55	I P 55
	Galleys and laundries	I P 44	X	I P 44	I P 44	I P 34	I P 44	I P 44	I P 44	I P 44
	Public bath-rooms and shower	X	X	I P 44	I P 44	I P 34	I P 44	X	I P 44	I P 44
Danger of liquid spray-ing. Pres-ence of cargo dust. Serious mechanical damage. Aggressive fumes	Shaft or pipe tunnels in double bot-tom	I P 55	X	I P 55	I P 55	I P 55	I P55	X	I P 56	I P 56
	Holds for general cargo	X	X	I P 55	X	I P 55	I P55	X	I P 56	I P 56
	Ventilation trunks	X	X	I P 55	X	X	X	X	X	X
Danger of liquid in massive quantities	Open decks	I P 56	X	I P 56	X	I P 56	I P56	X	I P 56	I P 56

(1) The symbol "X" denotes equipment which it is not advised to install.

(2) Electric motors and starting transformers for lateral thrust propellers located in spaces similar to ballast pump rooms may have degree of protection IP22.

Table 2 : Maximum voltages for various ship services

Use		Maximum voltage V
For permanently installed and connected to fixed wiring	Power equipment	1000
	Cooking equipment	500
	Lighting	250
	Space heaters in accommodation spaces	250
	Control **(1)**, communication (including signal lamps) and instrumentation equipment	250
For permanently installed and connected by flexible cable	Power and heating equipment, where such connection is necessary because of the application (e.g. for moveable cranes or other hoisting gear)	1000
For socket-outlets supplying	Portable appliances which are not hand-held during operation (e.g. refrigerated containers) by flexible cables	1000
	Portable appliances and other consumers by flexible cables	250
	Equipment requiring extra precaution against electric shock where an isolating transformer is used to supply one appliance **(2) (3)**	250
	Equipment requiring extra precaution against electric shock with or without a safety transformer **(2) (3)** .	50

(1) For control equipment which is part of a power and heating installation (e.g. pressure or temperature switches for starting/stopping motors), the same maximum voltage as allowed for the power and heating equipment may be used provided that all components are constructed for such voltage. However, the control voltage to external equipment is not to exceed 500 V.

(2) Both conductors in such systems are to be insulated from earth.

(3) Equipment located in narrow and wet spaces such as machinery spaces provided with bilge spaces.

Table 3 : Required Environmental Categories

Location within main area				
Main Areas on Board	General	Inside cubicles, desks, etc.	On machinery such as internal combustion engines, compressors	Masts
Machinery Spaces	EC21	EC31	EC23	X **(1)**
Steering gear	EC23	EC33	X	X
Control Room, Accommodation, bridge	EC21 EC11C	EC31	X	X
Pump Room, Holds, Rooms with no Heating	EC41	X	X	X
Exposed Decks	EC41S	X	X	EC42S

(1) The symbol "X" denotes locations which are generally not applicable.

7 Electrical protection

7.1 General requirements for overcurrent protection

7.1.1 Electrical installations are to be protected against accidental overcurrents including short-circuit.

The choice, arrangement and performance of the various protective devices are to provide complete and coordinated automatic protection in order to ensure as far as possible:

- continuity of service in the event of a fault, through coordinated and discriminative action of the protective devices, up to the second level of the main switchboard
- elimination of the effects of faults to reduce damage to the system and the hazard of fire as far as possible.

Note 1: An overcurrent is a current exceeding the nominal current.

Note 2: A short-circuit is the accidental connection by a relatively low resistance or impedance of two or more points in a circuit which are normally at different voltages.

7.1.2 Devices provided for overcurrent protection are to be chosen according to the requirements, especially with regard to overload and shortcircuit.

Note 1: Overload is an operating condition in an electrically undamaged circuit which causes an overcurrent.

7.1.3 Systems are to be such as to withstand the thermal and electrodynamic stresses caused by the possible overcurrent, including short-circuit, for the admissible duration.

7.2 Short-circuit currents

7.2.1 In calculating the maximum prospective short-circuit current, the source of current is to include the maximum number of generators which can be simultaneously connected (as far as permitted by any interlocking arrangements), and the maximum number of motors which are normally simultaneously connected in the system.

The maximum number of generators or transformers is to be evaluated without taking into consideration short-term parallel operation (e.g. for load transfer) provided that suitable interlock is foreseen.

7.2.2 Short-circuit current calculations are to be performed in accordance with a method recognised by the Society, such as that given in IEC Publication 60363.

7.2.3 In the absence of precise data concerning the characteristics of generators, accumulator batteries and motors, the maximum short-circuit currents on the main bus-bars may be calculated as follows:

- for alternating current systems:

  $I_{ac} = 10\ I_{TG} + 3{,}5\ I_{TM}$

  $I_{pk} = 2{,}4\ I_{ac}$
- for direct current systems supplied by batteries:

  $I_p = K\ C_{10} + 6\ I_{TM}$

where:

I_p : Maximum short-circuit current

I_{ac} : r.m.s. value of the symmetrical component (at the instant T/2)

I_{pk} : Maximum peak value

I_{TG} : Rated current of all generators which can be connected simultaneously

C_{10} : Battery capacity in Ah for a discharge duration of 10 hours

K : Ratio of the short-circuit current of the batteries to C_{10}; (see Note 1)

I_{TM} : Rated current of all motors which are normally simultaneously connected in the system.

Note 1: For stationary batteries the following values may be assumed for guidance:

- vented lead-acid batteries: K = 8
- vented alkaline type batteries intended for discharge at low rates corresponding to a battery duration exceeding three hours: K = 15
- sealed lead-acid batteries having a capacity of 100 Ah or more or alkaline type batteries intended for discharge at high rates corresponding to a battery duration not exceeding three hours: K = 30.

7.3 Selection of equipment

7.3.1 *(1/1/2017)*

Circuit-breakers are to be suitable for isolation.

Circuit-breakers of withdrawable type are required where they are not suitable for isolation and on main and emergency switchboards.

7.3.2 Equipment is to be chosen on the basis of its rated current and its making/breaking capacity.

7.3.3 *(1/1/2017)*

In the selection of circuit-breakers with intentional short-time delay for short-circuit releaserelease (e.g. generator circuit-breakers), those of utilisation category B are to be used and they are to be selected also taking into account their rated short-time withstand current capacity (I_{cw}).

For circuit-breakers without intentional short-time delay for short-circuit release, circuit breakers of utilisation category A may be used and they are to be selected according to their rated service short-circuit breaking capacity (I_{cs}).

Note 1: For the purpose of these Rules, circuit breakers are distinguished according to the utilization categories A and B in compliance with IEC publication 60947-2 as follows:

- Utilisation category A: circuit-breakers not specifically intended for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, i.e. without an intentional short-time delay provided for selectivity under short-circuit conditions and therefore without a short-time withstand current rating (Icw).
- Utilisation category B: circuit-breakers specifically intended for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, i.e. with an intentional short-time delay (which may be adjustable) provided for selectivity under short-circuit conditions. Such circuit-breakers have a short-time withstand current rating (Icw).

7.3.4 For non-essential services and duplicated essential services, circuit-breakers may be selected according to their ultimate short-circuit breaking capacity (I_{cu}).

7.3.5 *(1/1/2017)*

Circuit breakers used in insulated systems are to comply with Annex H of IEC Publication 60947-2.

7.3.6 For switches, the making/breaking capacity is to be in accordance with utilisation category AC-22 A or DC-22 A (in compliance with IEC Publication 60947-3).

7.3.7 For fuse-switch disconnectors or switch-disconnector fuse units, the making/breaking capacity is to be in accordance with utilisation categories AC-23 A or DC-23 A (in compliance with IEC Publication 60947-3).

7.4 Protection against short-circuit

7.4.1 Protection against short-circuit currents is to be provided by circuit- breakers or fuses.

7.4.2 The rated short-circuit breaking capacity of every protective device is to be not less than the maximum pro-

spective value of the short-circuit current at the point of installation at the instant of contact separation.

7.4.3 The rated short-circuit making capacity of every mechanical switching device intended to be capable of being closed on short-circuit is to be not less than the maximum value of the short-circuit current at the point of installation.

On alternating current this maximum value corresponds to the peak value allowing for maximum asymmetry.

7.4.4 Every protective device or contactor not intended for short-circuit interruption is to be adequate for the maximum short-circuit current liable to occur at the point of installation having regard to the time required for the short-circuit to be removed.

7.4.5 The use of a protective device not having a short-circuit breaking or making capacity at least equal to the maximum prospective short-circuit current at the point where it is installed is not permitted in general.

Nevertheless, this solution may be accepted upon agreement of the Naval Authority, and provided that the following are complied with:

- the protective device not having a short-circuit breaking or making capacity at least equal to the maximum prospective short-circuit current at the point is backed up on the generator side by a fuse or by a circuit-breaker having at least the necessary short-circuit rating and not being the generator circuit-breaker;
- the same fuse or circuit-breaker is not to back up more than one circuit-breaker, except for circuits relevant to non essential services;
- the short-circuit performance of the back-up arrangement is to be equal to the requirements of IEC Publication 60947-2 for a single circuit-breaker having the same short-circuit performance category as the backed-up circuit-breaker and rated for the maximum prospective short-circuit level at the supply terminals of the arrangement.

7.4.6 Circuit-breakers with fuses connected to the load side may be used, provided the back-up fuses and the circuit-breakers are of coordinated design, in order to ensure that the operation of the fuses takes place in due time so as to prevent arcing between poles or against metal parts of the circuit-breakers when they are submitted to overcurrents involving the operation of the fuse.

7.4.7 When determining the performance requirements for the above-mentioned back-up protection arrangement, it is permissible to take into account the impedance of the various circuit elements of the arrangement, such as the impedance of a cable connection when the backed-up circuit-breaker is located away from the back-up breaker or fuse.

7.5 Continuity of supply and continuity of service

7.5.1 Selectivity is to be ensured as far as practicable.

7.5.2 The protection is to be so arranged that the circuit under failure is the only one isolated from the network and a fault in one service does not cause the loss of any other essential services.

7.5.3 Selectivity is not strictly required for groups of consumers when the failure of one of them jeopardises the operation of the whole system to which it belongs.

7.5.4 The protection of the emergency circuit is to be such that a failure in one circuit does not cause a loss of other emergency services.

7.6 Protection against overload

7.6.1 Devices provided for overload protection are to have a tripping characteristic (overcurrent-trip time) adequate for the overload ability of the elements of the system to be protected and for any discrimination requirements.

7.6.2 The use of fuses up to 320 A for overload protection is permitted.

7.7 Localisation of over-current protection

7.7.1 Short-circuit protection is to be provided for every non-earthed conductor.

7.7.2 Overload protection is to be provided for every non-earthed conductor; nevertheless, in insulated single-phase circuits or insulated three-phase circuits having substantially balanced loads, the overload protection may be omitted on one conductor.

7.7.3 Short-circuit and overload protective devices are not to interrupt earthed conductors, except in the case of multiple disconnection devices which simultaneously interrupt all the conductors, whether earthed or not.

7.7.4 Electrical protection is to be located as close as possible to the origin of the protected circuit.

7.8 Protection of generators

7.8.1 Generators are to be protected against short-circuits and overloads by multipole circuit-breakers.

7.8.2 Where a circuit-breaker is used:

a) the overload protection is to trip the generator circuit-breaker at an overload between 10% and 50%; for an overload of 50% of the rated current of the generator the time delay is not to exceed 2 minutes; however, the figure of 50% or the time delay of 2 minutes may be exceeded if the construction of the generator permits this

b) the setting of the short-circuit protection is to instantaneously trip the generator circuit-breaker at an overcurrent less than the steady short-circuit current of the generator. Short time delays (e.g. from 0,5 s to 1 s) may be introduced for discrimination requirements in "instantaneous" tripping devices.

7.8.3 For emergency generators the overload protection may, instead of disconnecting the generator automatically, give a visual and audible alarm in a permanently attended space.

7.8.4 After disconnection of a generator due to overload, the circuit-breaker is to be ready for immediate reclosure.

7.8.5 Generator circuit-breakers are to be provided with a reclosing inhibitor which prevents their automatic reclosure after tripping due to a short-circuit.

7.8.6 Generators having a capacity of 1500 kVA or above are to be equipped with a suitable protective device or system which, in the event of a short-circuit in the generator or in the supply cable between the generator and its circuit-breaker, will de-excite the generator and open the circuit-breaker (e.g. by means of differential protection).

7.8.7 Where the main source of electrical power is necessary for the propulsion of the ship, load shedding or other equivalent arrangements are to be provided to protect the generators against sustained overload.

7.8.8 Arrangements are to be made to disconnect or reduce automatically the excess load when the generators are overloaded in such a way as to prevent a sustained loss of speed and/or voltage (see Sec 2, Tab 6). The operation of such device is to activate a visual and audible alarm. A time delay of 5-20 s is considered acceptable.

7.8.9 When an overload is detected the load shedding system is to disconnect automatically, after an appropriate time delay, the circuits supplying the non-essential services and, if necessary, services for mantaining normal habitable conditions.

7.8.10 Alternating current generators arranged to operate in parallel are to be provided with reverse-power protection.

The protection is to be selected in accordance with the characteristics of the prime mover.

The following values are recommended:

- 2-6% of the rated power for turbogenerators
- 8-15% of the rated power for diesel generators.

The reverse-power protection may be replaced by other devices ensuring adequate protection of the prime movers.

7.8.11 Generators are to be provided with an undervoltage protection which trips the breaker if the voltage falls to 70% - 35% of the rated voltage.

For generators arranged for parallel operation, measures are to be taken to prevent the generator breaker from closing if the generator is not generating and to prevent the generator remaining connected to the busbars if voltage collapses.

The operation of the undervoltage release is to be instantaneous when preventing closure of the breaker, but it is to be delayed for selectivity purposes when tripping the breaker.

7.9 Protection of circuits

7.9.1 Each separate circuit shall be protected against short-circuit and against overload, unless otherwise specified in these Rules or where the Society may exceptionally otherwise permit.

7.9.2 Each circuit is to be protected by a multipole circuit-breaker or switch and fuses against overloads and short-circuits.

7.9.3 Circuits for lighting are to be disconnected on both non-earthed conductors; single-pole disconnection of final sub-circuits with both poles insulated is permitted only in accommodation spaces.

7.9.4 The protective devices of the circuits supplying motors are to allow excess current to pass during transient starting of motors.

7.9.5 Final sub-circuits which supply one consumer with its own overload protection (for example motors), may be provided with short-circuit protection only.

7.9.6 Steering gear control circuits are to be provided with short-circuit protection only (see Ch 1, Sec 11).

7.10 Protection of motors

7.10.1 Motors of rating exceeding 1 kW and all motors for essential services are to be protected individually against overload and short-circuit. The short-circuit protection may be provided by the same protective device for the motor and its supply cable (see [7.9.5]).

7.10.2 For motors intended for essential services, the overload protection may be replaced by an overload alarm (for steering gear motors see Ch 1, Sec 11).

7.10.3 The protective devices are to be designed so as to allow excess current to pass during the normal accelerating period of motors according to the conditions corresponding to normal use.

If the current/time characteristic of the overload protection device does not correspond to the starting conditions of a motor (e.g. for motors with extra-long starting period or transformers), provision may be made to suppress operation of the device during the acceleration period on condition that the short-circuit protection remains operative and the suppression of overload protection is only temporary.

7.10.4 For continuous duty motors the protective gear is to have a time delay characteristic which ensures reliable thermal protection against overload.

7.10.5 The protective devices are to be adjusted so as to limit the maximum continuous current to a value within the range 105% - 120% of the motor's rated full load current.

7.10.6 For intermittent duty motors the current setting and the delay (as a function of time) of the protective devices are to be chosen in relation to the actual service conditions of the motor.

7.10.7 Where fuses are used to protect polyphase motor circuits, means are to be provided to protect the motor against unacceptable overload in the case of single phasing.

7.10.8 Motors rated above 1 kW are to be provided with:

- undervoltage protection, operative on the reduction or failure of voltage, to cause and maintain the interruption

of power in the circuit until the motor is deliberately restarted or

- undervoltage release, operative on the reduction or failure of voltage, so arranged that the motor restarts automatically when power is restored after a power failure.

7.10.9 The automatic restart of a motor is not to produce a starting current such as to cause excessive voltage drop.

In the case of several motors required to restart automatically, the total starting current is not to cause an excessive voltage drop or sudden surge current; to this end, it may be necessary to achieve a sequence start.

7.10.10 The undervoltage protective devices are to allow the motor to be started when the voltage exceeds 85% of the rated voltage and are to intervene without fail when the voltage drops to less than approximately 20% of the rated voltage, at the rated frequency and with a time delay as necessary.

7.11 Protection of storage batteries

7.11.1 Batteries are to be protected against overload and short-circuit by means of fuses or multipole circuit-breakers at a position adjacent to the battery compartment.

Overcurrent protection may be omitted for the circuit to the starter motors when the current drawn is so large that is impracticable to obtain short-circuit protection.

7.11.2 Emergency batteries supplying essential services are to have short-circuit protection only.

7.12 Protection of shore power connection

7.12.1 Permanently fixed cables connecting the shore connection box to the main switchboard are to be protected by fuses or circuit-breakers (see [3.7]).

7.13 Protection of measuring instruments, pilot lamps and control circuits

7.13.1 Measuring circuits and devices (voltage transformers, voltmeters, voltage coils of measuring instruments, insulation monitoring devices etc.) and pilot lamps are to be protected against short-circuit by means of multipole circuit-breakers or fuses.

The protective devices are to be placed as near as possible to the tapping from the supply.

The secondary side of current transformers is not to be protected.

7.13.2 Control circuits and control transformers are to be protected against overload and short-circuit by means of multipole circuit-breakers or fuses on each pole not connected to earth.

Overload protection may be omitted for transformers with a rated current of less than 2 A on the secondary side.

The short-circuit protection on the secondary side may be omitted if the transformer is designed to sustain permanent short-circuit current.

7.13.3 Where a fault in a pilot lamp would impair the operation of essential services, such lamps are to be protected separately from other circuits such as control circuits.

Note 1: Pilot lamps connected via short-circuit-proof transformers may be protected in common with control circuits.

7.13.4 Circuits whose failure could endanger operation, such as steering gear control feeder circuits, are to be protected only against short-circuit.

7.13.5 The protection is to be adequate for the minimum cross-section of the protected circuits.

7.14 Protection of transformers

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

7.14.2 The protection against short-circuit is to be such as to ensure the selectivity between the circuits supplied by the secondary side of the transformer and the feeder circuit of the transformer.

7.14.3 When transformers are arranged to operate in parallel, means are to be provided so as to trip the switch on the secondary winding side when the corresponding switch on the primary side is open.

8 System components

8.1 General

8.1.1 The components of the electrical system are to be dimensioned such as to withstand the currents that can pass through them during normal service without their rating being exceeded.

8.1.2 The components of the electrical system are to be designed and constructed so as to withstand for the admissible duration the thermal and electro-dynamic stresses caused by possible overcurrents, including short-circuit.

9 Electrical cables

9.1 General

9.1.1 All electrical cables and wiring external to equipment shall be at least of a flame-retardant type, in accordance with IEC Publication 60332-1 and they have to comply with Sec 9.

9.1.2 In addition to the provisions of [9.1.1], when cables are laid in bundles, cable types are to be chosen in compliance with IEC Publication 60332-3 Category A, or other means (See Sec 12) are to be provided such as not to impair their original flame-retarding properties.

9.1.3 Where necessary for specific applications such as radio frequency or digital communication systems, which require the use of particular types of cables, the Society, with the agreement of the Naval Authority; may permit the

use of cables which do not comply with the provisions in [9.1.1] and [9.1.2].

9.1.4
Cables which are required to have fire-resisting characteristics are to comply with the requirements stipulated in [9.6].

9.2 Choice of insulation

9.2.1 The maximum rated operating temperature of the insulating material is to be at least 10°C higher than the maximum ambient temperature liable to occur or to be produced in the space where the cable is installed.

9.2.2 The maximum rated conductor temperature for normal and short-circuit operation, for the type of insulating compounds normally used for shipboard cables, is not to exceed the values stated in Tab 4. Special consideration will be given to other insulating materials.

9.2.3 PVC insulated cables are not to be used either in refrigerated spaces, or on decks exposed to the weather of ships classed for unrestricted service.

9.3 Choice of protective covering

9.3.1 The conductor insulating materials are to be enclosed in an impervious sheath of material appropriate to the expected ambient conditions where cables are installed in the following locations:

- on decks exposed to the weather,
- in damp or wet spaces (e.g. in bathrooms),
- in refrigerated spaces,
- in machinery spaces and, in general,
- where condensation water or harmful vapour may be present.

9.3.2 Where cables are provided with armour or metallic braid (e.g. for cables installed in hazardous areas), an overall impervious sheath or other means to protect the metallic elements against corrosion is to be provided.

9.3.3 An impervious sheath is not required for single-core cables installed in tubes or ducts inside accommodation spaces, in circuits with maximum system voltage 250V.

9.3.4 In choosing different types of protective coverings, due consideration is to be given to the mechanical action to which each cable may be subjected during installation and in service.

9.3.5 Single-core cables for a.c. circuits with rated current exceeding 20 A are to be either non-armoured or armoured with non-magnetic material.

9.4 Cables in refrigerated spaces

9.4.1 Cables installed in refrigerated spaces are to have a watertight or impervious sheath and are to be protected against mechanical damage. If an armour is applied on the sheath, the armour is to be protected against corrosion by a further moisture-resisting covering.

9.5 Cables in areas with a risk of explosion

9.5.1 For cables in areas with a risk of explosion, see [10].

Table 4 : Maximum rated conductor temperature

Type of insulating compound	Abbreviated designation	Maximum rated conductor temperature °C	
		Normal operation	Short-circuit
a) Thermoplastic:			
- based upon polyvinyl chloride or copolymer of vinyl chloride and vinyl acetate	PVC/A	60	150
b) Elastomeric or thermosetting:			
- based upon ethylene-propylene rubber or similar (EPM or EPDM)	EPR	85	250
- based upon high modulus or hardgrade ethylene propylene rubber	HEPR	85	250
- based upon cross-linked polyethylene	XLPE	85	250
- based upon rubber silicon	S 95	95	350
- based upon ethylene-propylene rubber or similar (EPM or EPDM) halogen free	HF EPR	85	250
- based upon high modulus or hardgrade halogen free ethylene propylene rubber	HF HEPR	85	250
- based upon cross-linked polyethylene halogen free	HF XLPE	85	250
- based upon rubber silicon halogen free	HF S 95	95	350
- based upon cross-linked polyolefin material for halogen free cable **(1)**	HF 85	85	250

(1) Used on sheathed cable only

9.6 Electrical services required to be operable under fire conditions and fire-resistant cables

9.6.1

Electrical services required to be operable under fire conditions are as follows:

- 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 fire pump
- Emergency lighting
- Fire and general alarms
- Fire detection systems
- Fire-extinguishing systems and fire-extinguishing media release alarms
- Low location lighting
- Public address systems
- Remote emergency stop/shutdown arrangements for systems which may support the propagation of fire and/or explosion.

9.6.2 *(1/1/2017)*

Where cables for services specified in [9.6.1] including their power supplies pass through high fire risk areas (see Note 1), and in addition for passenger ships, main vertical fire zones, other than those which they serve, they are to be so arranged that a fire in any of these areas or zones does not affect the operation of the service in any other area or zone. This may be achieved by either of the following measures:

a) Cables being of a fire-resistant type complying with IEC 60331-31 for cables of greater than 20 mm overall diameter, otherwise IEC 60331-21 or IEC 60331-2 for cables with an overall diameter not exceeding 20 mm, are installed and run continuous to keep the fire integrity within the high fire risk area (see Fig 1).

b) At least two loops/radial distributions run as widely apart as is practicable and so arranged that in the event of damage by fire at least one of the loops/radial distributions remains operational.

Systems that are fail safe or duplicated with cable runs as widely separated as is practicable may be exempted.

Note 1:

a) For the purpose of application of this item [9.6], the definition of "high fire risk areas" is the following:

(1) Machinery spaces as defined in Chapter 4

(2) Spaces containing fuel treatment equipment and other highly flammable substances

(3) Galley and Pantries containing cooking appliances

(4) Laundry containing drying equipment

(5) Spaces as defined by paragraphs (8), (12), (13), (14), (15) of Ch 4, Sec 5, [1.2.3]b);

b) Fire-resistant type cables are to be easily distinguishable.

c) For special cables, requirements in the following standards may be used:

(1) IEC60331-23: Procedures and requirements - Electric data cables

(2) IEC60331-25: Procedures and requirements - Optical fibre cables.

9.6.3 *(1/1/2017)*

The electrical cables to the emergency fire pump are not to pass through the machinery spaces containing the main fire pumps and their source(s) of power and prime mover(s).

They are to be of a fire resistant type, in accordance with [9.6.2] (a), where they pass through other high fire risk areas.

9.7 Cables for submerged bilge pumps

9.7.1 Cables and their connections to such pumps are to be capable of operating under a head of water equal to their distance below the bulkhead deck. The cable is to be impervious-sheathed and armoured, is to be installed in continuous lengths from above the bulkhead to the motor terminals and is to enter the air bell from the bottom.

9.8 Internal wiring of switchboards and other enclosures for equipment

9.8.1 For installation in switchboards and other enclosures for equipment, single-core cables may be used without further protection (sheath).

Other types of flame-retardant switchboard wiring may be accepted at the discretion of the Society.

9.9 Current carrying capacity of cables

9.9.1 The current carrying capacity for continuous service of cables given in Tab 5 to Tab 9 is based on the maximum permissible service temperature of the conductor also indicated therein and on an ambient temperature of 45°C.

9.9.2 The current carrying capacity cited in [9.9.1] is applicable, with rough approximation, to all types of protective covering (e.g. both armoured and non-armoured cables).

9.9.3 Values other than those shown in Tab 5 to Tab 9 may be accepted provided they are determined on the basis of calculation methods or experimental values approved by the Society.

9.9.4 When the actual ambient temperature obviously differs from 45°C, the correction factors shown in Tab 10 may be applied to the current carrying capacity in Tab 5 to Tab 9.

9.9.5 Where more than six cables are bunched together in such a way that there is an absence of free air circulating around them, and the cables can be expected to be under full load simultaneously, a correction factor of 0,85 is to be applied.

Figure 1

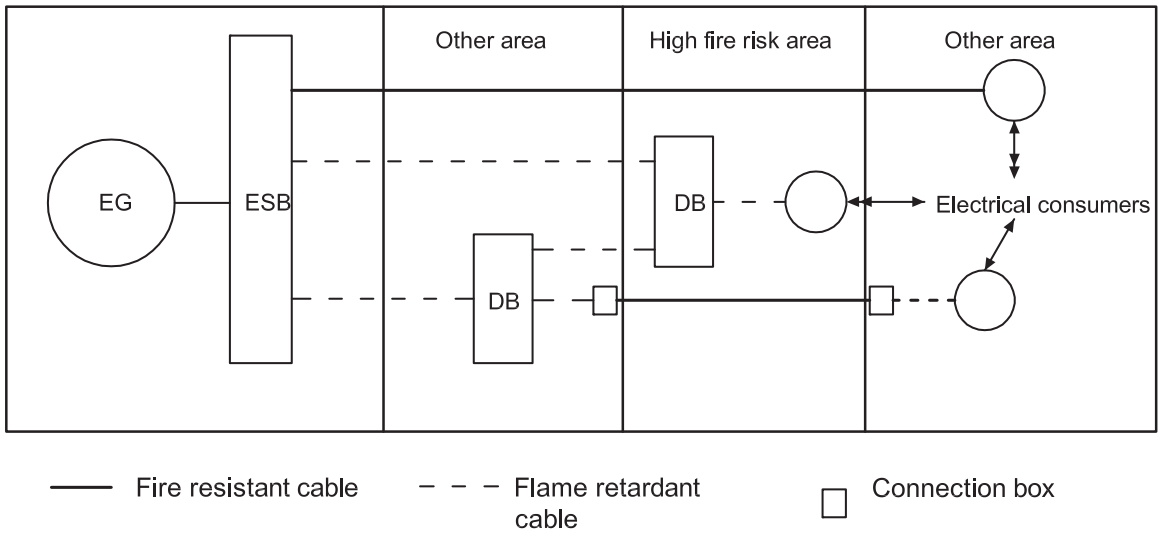


Table 5 : Current carrying capacity, in A in continuous service for cables based on maximum conductor operating temperature of 60°C (ambient temperature 45°C)

Nominal section mm²	Number of conductors		
	1	2	3 or 4
1	8	7	6
1,5	12	10	8
2,5	17	14	12
4	22	19	15
6	29	25	20
10	40	34	28
16	54	46	38
25	71	60	50
35	87	74	61
50	105	89	74
70	135	115	95
95	165	140	116
120	190	162	133
150	220	187	154
185	250	213	175
240	290	247	203
300	335	285	235

Table 6 : Current carrying capacity, in A in continuous service for cables based on maximum conductor operating temperature of 75°C (ambient temperature 45°C)

Nominal section mm²	Number of conductors		
	1	2	3 or 4
1	13	11	9
1,5	17	14	12
2,5	24	20	17
4	32	27	22
6	41	35	29
10	57	48	40
16	76	65	53
25	100	85	70
35	125	106	88
50	150	128	105
70	190	162	133
95	230	196	161
120	270	230	189
150	310	264	217
185	350	298	245
240	415	353	291
300	475	404	333

Table 7 : Current carrying capacity, in A in continuous service for cables based on maximum conductor operating temperature of 80°C (ambient temperature 45°C)

Nominal section mm²	Number of conductors		
	1	2	3 or 4
1	15	13	11
1,5	19	16	13
2,5	26	22	18
4	35	30	25
6	45	38	32
10	63	54	44
16	84	71	59
25	110	94	77
35	140	119	98
50	165	140	116
70	215	183	151
95	260	221	182
120	300	255	210
150	340	289	238
185	390	332	273
240	460	391	322
300	530	450	371

Table 8 : Current carrying capacity, in A in continuous service for cables based on maximum conductor operating temperature of 85°C (ambient temperature 45°C)

Nominal section mm²	Number of conductors		
	1	2	3 or 4
1	16	14	11
1,5	20	17	14
2,5	28	24	20
4	38	32	27
6	48	41	34
10	67	57	47
16	90	77	63
25	120	102	84
35	145	123	102
50	180	153	126
70	225	191	158
95	275	234	193
120	320	272	224
150	365	310	256
185	415	353	291
240	490	417	343
300	560	476	392

Table 9 : Current carrying capacity, in A in continuous service for cables based on maximum conductor operating temperature of 95°C (ambient temperature 45°C)

Nominal section mm²	Number of conductors		
	1	2	3 or 4
1	20	17	14
1,5	24	20	17
2,5	32	27	22
4	42	36	29
6	55	47	39
10	75	64	53
16	100	85	70
25	135	115	95
35	165	140	116
50	200	170	140
70	255	217	179
95	310	264	217
120	360	306	252
150	410	349	287
185	470	400	329
240	570	485	399
300	660	560	462

9.9.6 Where a cable is intended to supply a short-time load for 1/2-hour or 1-hour service (e.g. mooring winches or bow thruster propellers), the current carrying capacity obtained from Tab 5 to Tab 9 may be increased by applying the corresponding correction factors given in Tab 11.

In no case a period shorter than 1/2-hour is to be used, whatever the effective period of operation.

9.9.7 For supply cables to single services for intermittent loads (e.g. cargo winches or machinery space cranes), the current carrying capacity obtained from Tab 5 to Tab 9 may be increased by applying the correction factors given in Tab 12.

The correction factors are calculated with rough approximation for periods of 10 minutes, of which 4 minutes with a constant load and 6 minutes without load.

9.10 Minimum nominal cross-sectional area of conductors

9.10.1 In general the minimum allowable conductor cross-sectional areas are those given in Tab 13.

9.10.2 The nominal cross-sectional area of the neutral conductor in three-phase distribution systems is to be equal to at least 50% of the cross-sectional area of the phases, unless the latter is less than or equal to 16 mm². In such case the cross-sectional area of the neutral conductor is to be equal to that of the phase.

9.10.3 For the nominal cross-sectional area of:

- earthing conductors, see Sec 12, [2.3]
- earthing connections for distribution systems, see Sec 12, [2.5]
- neutral connections for three-phase systems, see Sec 8, [1.2.4].

9.11 Choice of cables

9.11.1 The rated voltage of any cable is to be not lower than the nominal voltage of the circuit for which it is used.

9.11.2 The nominal cross-sectional area of each cable is to be sufficient to satisfy the following conditions with reference to the maximum anticipated ambient temperature:

- the current carrying capacity is to be not less than the highest continuous load carried by the cable
- the voltage drop in the circuit, by full load on this circuit, is not to exceed the specified limits
- the cross-sectional area calculated on the basis of the above is to be such that the temperature increases which may be caused by overcurrents or starting transients do not damage the insulation.

9.11.3 The highest continuous load carried by a cable is to be calculated on the basis of the power requirements and of the diversity factor of the loads and machines supplied through that cable.

9.11.4 When the conductors are carrying the maximum nominal service current, the voltage drop from the main or emergency switchboard busbars to any point in the installation is not to exceed 6% of the nominal voltage.

For battery circuits with supply voltage less than 55 V, this value may be increased to 10%.

For the circuits of navigation lights, the voltage drop is not to exceed 5% of the rated voltage under normal conditions.

Table 10 : Correction factors for various ambient air temperatures

Maximum conductor temperature °C	Correction factors for ambient air temperature of :										
	35°C	40°C	45°C	50°C	55°C	60°C	65°C	70°C	75°C	80°C	85°C
60	1,29	1,15	1,00	0,82	-	-	-	-	-	-	-
75	1,15	1,08	1,00	0,91	0,82	0,71	0,58	-	-	-	-
80	1,13	1,07	1,00	0,93	0,85	0,76	0,65	0,53	-	-	-
85	1,12	1,06	1,00	0,94	0,87	0,79	0,71	0,61	0,50	-	-
95	1,10	1,05	1,00	0,95	0,89	0,84	0,77	0,71	0,63	0,55	0,45

Table 11 : Correction factors for short-time loads

½ -hour service		1-hour service		
Sum of nominal cross-sectional areas of all conductors in the cable mm²		Sum of nominal cross-sectional areas of all conductors in the cable mm²		Correlation factor
Cables with metallic sheath and armoured cables	Cables with non-metallic sheath and non-armoured cables	Cables with metallic sheath and armoured cables	Cables with non-metallic sheath and non-armoured cables	
up to 20	up to 75	up to 80	up to 230	1,06
21-41	76-125	81-170	231-400	1,10
41-65	126-180	171-250	401-600	1,15
66-95	181-250	251-430	601-800	1,20
96-135	251-320	431-600	-	1,25
136-180	321-400	601-800	-	1,30
181-235	401-500	-	-	1,35
236-285	501-600	-	-	1,40
286-350	-	-	-	1,45

Table 12 : Correction factors for intermittent service

Sun of nominal cross selectionel areas of all conductors in the cable mm²		Correction factor
Cables with metallic sheath and armoured cables	Cables without metallic sheath and non-amoured cables	
	S ≤ 5	1,10
	5 < S ≤ 8	1,15
	8 < S ≤ 16	1,20
S ≤ 4	16 < S ≤ 825	1,25
4 < S ≤ 7	25 < S ≤ 42	1,30
7 < S ≤ 17	42 < S ≤ 72	1,35
17 < S ≤ 42	72 < S ≤ 140	1,40
42 < S ≤ 110	140 < S	1,45
110 < S	-	1,50

Table 13 : Minimum nominal cross-sectional areas

Service	Nominal cross-sectional area	
	external wiring mm²	internal wiring mm²
Power, heating and lighting systems	1,0	1,0
Control circuits for power plant	1,0	1,0
Control circuits other than those for power plant	0,75	0,5
Control circuits for telecommunications, measurement, alarms	0,5	0,2
Telephone and bell equipment, not required for the safety of the ship or crew calls	0,2	0,1
Bus and data cables	0,2	0,1

10 Electrical installations in hazardous areas

10.1 Electrical equipment

10.1.1 No electrical equipment is to be installed in hazardous areas unless the Society 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 dusts, vapours or gases likely to be encountered.

10.1.2 Where electrical equipment of a safe type is permitted in hazardous areas it is to be selected with due consideration to the following:

a) risk of explosive dust concentration; see Sec 2, [6.2]:
   - degree of protection of the enclosure
   - maximum surface temperature

b) risk of explosive gas atmosphere; see Sec 2, [6.1]:
   - explosion group
   - temperature class.

10.1.3 Where electrical equipment is permitted in hazardous areas, all switches and protective devices are to interrupt all poles or phases and, where practicable, to be located in a non-hazardous area unless specifically permitted otherwise.

Such switches and equipment located in hazardous areas are to be suitably labelled for identification purposes.

10.1.4 For electrical equipment installed in Zone 0 hazardous areas, only the following types are permitted:

- certified intrinsically-safe apparatus Ex(ia)
- simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically-safe circuits of category "ia" not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules
- equipment specifically designed and certified by the appropriate authority for use in Zone 0.

10.1.5 For electrical equipment installed in Zone 1 hazardous areas, only the following types are permitted:

- any type that may be considered for Zone 0
- certified intrinsically-safe apparatus Ex(ib)
- simple electrical apparatus and components (e.g. thermocouples, photocells, strain gauges, junction boxes, switching devices), included in intrinsically-safe circuits of category "ib" not capable of storing or generating electrical power or energy in excess of limits stated in the relevant rules)
- certified flameproof Ex(d)
- certified pressurised Ex(p)
- certified increased safety Ex(e)
- certified encapsulated Ex(m)
- certified sand filled Ex(q)
- certified specially Ex(s)
- through runs of cable.

10.1.6 For electrical equipment installed in Zone 2 hazardous areas, only the following types are permitted:

- any type that may be considered for Zone 1
- tested specially for Zone 2 (e.g. type "n" protection)
- pressurised, and accepted by the Society in argeement with the Naval Authority
- encapsulated, and accepted by the Society in argeement with the Naval Authority
- the type which ensures the absence of sparks and arcs and of "hot spots" during its normal operation (minimum class of protection IP55).

10.1.7 When apparatus incorporates a number of types of protection, it is to be ensured that all are suitable for use in the zone in which it is located.

10.2 Electrical cables

10.2.1 Electrical cables are not to be installed in hazardous areas except as specifically permitted or when associated with intrinsically safe circuits.

10.2.2

All cables installed in Zone 0, Zone 1 and weather exposed areas classified Zone 2 are to be sheathed with at least one of the following:

a) a non-metallic impervious sheath in combination with braiding or other metallic covering

b) a copper or stainless steel sheath (for mineral insulated cables only).

10.2.3 All cables installed in non-weather exposed Zone 2 areas are to be provided with at least a non-metallic external impervious sheath.

10.2.4 Cables of intrinsically safe circuits are to have a metallic shielding with at least a non-metallic external impervious sheath.

10.2.5 The circuits of a category "ib" intrinsically safe system are not to be contained in a cable associated with a category "ia" intrinsically safe system required for a hazardous area in which only category "ia" systems are permitted.

10.3 Electrical installations in battery rooms

10.3.1

Only intrinsically safe apparatus and certified safe type lighting fittings may be installed in compartments assigned solely to large vented storage batteries; see Sec 11, [6.2].

The associated switches are to be installed outside such spaces.

Electric ventilator motors are to be outside ventilation ducts and, if within 3 m of the exhaust end of the duct, they are to be of an explosion-proof safe type. The impeller of the fan is to be of the non-sparking type.

Overcurrent protective devices are to be installed as close as possible to, but outside of, battery rooms.

Electrical cables other than those pertaining to the equipment arranged in battery rooms are not permitted.

10.3.2 Electrical equipment for use in battery rooms is to have minimum explosion group IIC and temperature class T1.

10.3.3 Standard marine electrical equipment may be installed in compartments assigned solely to valve-regulated sealed storage batteries.

10.3.4

Where vented (see Note 1) type batteries replace valve-regulated sealed (see Note 2) types, the requirements of Sec 11 are to be complied with.

Note 1: A vented battery is one in which the cells have a cover provided with an opening through which products of electrolysis and evaporation are allowed to escape freely from the cells to atmosphere.

Note 2: A valve-regulated battery is one in which cells are closed but have an arrangement (valve) which allows the escape of gas if the internal pressure exceeds a predetermined value.

10.4 Electrical equipment allowed in paint stores and in enclosed spaces leading to paint stores

10.4.1

Electrical equipment is to be installed in paint stores and in ventilation ducts serving such spaces only when it is essential for operational services.

Certified safe type equipment of the following type is acceptable:

a) intrinsically safe Exi

b) flameproof Exd

c) pressurised Exp

d) increased safety Exe

e) special protection Exs.

Cables (through-runs or terminating cables) of armoured type or installed in metallic conduits are to be used.

10.4.2

The minimum requirements for certified safe type equipment are as follows:

explosion group II B

temperature class T3.

10.4.3

Switches, protective devices and motor control gear of electrical equipment installed in a paint store are to interrupt all poles or phases and are preferably to be located in a non-hazardous space

10.4.4

In areas on open deck within 1m of inlet and exhaust ventilation openings or within 3 m of exhaust mechanical venti-

lation outlets, the following electrical equipment may be installed:

- electrical equipment with the type of protection as permitted in paint stores or
- equipment of protection class Exn or
- appliances which do not generate arcs in service and whose surface does not reach unacceptably high temperature or
- appliances with simplified pressurised enclosures or vapour-proof enclosures (minimum class of protection IP55) whose surface does not reach unacceptably high temperature
- cables as specified in [10.4.1].

10.4.5

The enclosed spaces giving access to the paint store may be considered as non-hazardous, provided that:

- the door to the paint store is a gas-tight door with self-closing devices without holding back arrangements
- the paint store is provided with an acceptable, independent, natural ventilation system ventilated from a safe area
- warning notices are fitted adjacent to the paint store entrance stating that the store contains flammable liquids.

Note 1: The paint stores and inlet and exhaust ventilation ducts under [10.4.4] are classified as Zone 1 and areas on open deck under [10.4.4] as Zone 2, as defined in IEC standard 60092-502, Electrical Installation in ships-part 502: Tankers-special features.

Note 2: A watertight door may be considered as being gas-tight.

10.5 Electrical installations in stores for welding gas (acetylene) bottles

10.5.1 The following equipment may be installed in stores for welding gas bottles provided that it is of a safe type appropriate for Zone 1 area installation:

- lighting fittings
- ventilator motors where provided.

10.5.2 Electrical cables other than those pertaining to the equipment arranged in stores for welding gas bottles are not permitted.

10.5.3 Electrical equipment for use in stores for welding gas bottles is to have minimum explosion group IIC and temperature class T2.

SECTION 4 ROTATING MACHINES

1 Constructional and operational requirements for generators and motors

1.1 Mechanical construction

1.1.1 Insuling materials, insulated windings and construction of electrical machines are to conform to the relevant requirements of Sec 2, [4] and Sec 2, [5].

1.1.2 Shafts are to be made of material complying with the provisions of Pt D, Ch 2, Sec 3 of the Rules for the Classification of Ships or, where rolled products are allowed in place of forgings, with those of Pt D, Ch 2, Sec 1 of the Rules for the Classification of Ships.

1.1.3 Where welded parts are foreseen on shafts and rotors, the provisions of Part D, Chaptert 5 of the Rules for the Classification of Ships are to apply.

1.1.4 Sleeve bearings are to be efficiently and automatically lubricated at all running speeds.

Provision is to be made for preventing the lubricant from gaining access to windings or other insulated or bare current carrying parts.

1.1.5 Means are to be provided to prevent bearings from being damaged by the flow of currents circulating between them and the shaft. According to the Manufacturer's requirements, electrical insulation of at least one bearing is to be considered.

1.1.6 For surface-cooled machines with an external fan installed on the open deck, adequate protection of the fan against icing is to be provided.

1.1.7 When liquid cooling is used, the coolers are to be so arranged as to avoid entry of water into the machine, whether by leakage or condensation in the heat exchanger, and provision is to be made for the detection of leakage.

1.1.8 *(1/1/2017)*

Motors cooled with a water jacket can be accepted for both propulsion and auxiliary services, however the use of water jacket cooled electric motors for propulsion is limited to installations with motor redundancy.

In motors cooled with a water jacket, internal water leakage sensors are to be provided.

The water jacket is to be pressure tested at not less than 1,5 times the working pressure after final machining.

1.1.9 Rotating machines whose ventilation or lubrication system efficiency depends on the direction of rotation are to be provided with a warning plate.

1.1.10 Generator and their excitation system which may be required to sustain overloads (for limited and specified periods of time) are to be designed so as to maintain network electrical characteristics within the prescribed limits.

1.2 Sliprings, commutators and brushes

1.2.1 Sliprings and commutators with their brushgear are to be so constructed that undue arcing is avoided under all normal load conditions.

1.2.2 The working position of brushgear is to be clearly and permanently marked.

1.2.3 Sliprings, commutators and brushgear are to be readily accessible for inspection, repairs and maintenance.

1.3 Terminal connectors

1.3.1 Suitable, fixed terminal connectors are to be provided in an accessible position for connection of the external cables.

1.3.2 All terminal connectors are to be clearly identified with reference to a diagram.

1.4 Electrical insulation

1.4.1 Insulating materials for windings and other current carrying parts are to comply with the requirements of Sec 2, [4.2] and Sec 2, [4.3].

2 Special requirements for generators

2.1 Prime movers, speed governors and overspeed protection

2.1.1 Prime movers for generators are to comply with the relevant requirements of Ch 1, Sec 2, [2.7].

2.1.2 When a.c. generators are to operate in parallel, the characteristics of speed governors are to comply with the provisions of [2.2].

2.2 A.c. generators

2.2.1 Alternators are to be so constructed that, when started up, they take up the voltage without the aid of an external electrical power source.

Where these provisions are not complied with, the external electrical power source is to be constituted by a battery installation in accordance with the requirements for electrical starting systems of auxiliary machinery (see Ch 1, Sec 2).

2.2.2 The voltage wave form is to be approximately sinusoidal, with a maximum deviation from the sinusoidal fundamental curve of 5% of the peak value.

2.2.3 Each alternator is to be provided with automatic means of voltage regulation.

2.2.4 For a.c. generating sets operating in parallel, the governing characteristics of the prime movers are to be such that, within the limits of 20% and 100% total load, the load on any generating set will not normally differ from its proportionate share of the total load by more than 15% of the rated power in kW of the largest machine or 25% of the rated power in kW of the individual machine in question, whichever is the lesser.

2.2.5 For a.c. generating sets intended to operate in parallel, means are to be provided to regulate the governor so as to permit an adjustment of load not exceeding 5% of the rated load at normal frequency.

2.2.6 When a.c. generators are operated in parallel, the reactive loads of the individual generating sets are not to differ from their proportionate share of the total reactive load by more than 10% of the rated reactive power of the largest machine, or 25% of that of the smallest machine, whichever is the lesser.

3 Testing of rotating machines

3.1 General

3.1.1 All machines are to be tested by the Manufacturer

3.1.2 Manufacturer's test records are to be provided for machines for essential services, for other machines they are to be available upon request.

3.1.3 All tests are to be carried out according to IEC Publication 60092-301.

3.1.4

All machines of 100 kW and over, intended for essential services are to be surveyed by the Society during testing and, if appropriate, during manufacturing.

3.2 Shaft material

3.2.1 Shaft material for electric propulsion motors and for main engine driven generators where the shaft is part of the propulsion shafting is to be certified by the Society.

3.2.2 Shaft material for other machines is to be in accordance with recognised international or national standards (See [1.1.2]).

3.3 Tests

3.3.1 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 Tab 1.

Table 1 : Tests to be carried out on electrical rotating machines

N°	Tests	a.c. Generators		Motors	
		Type test **(1)**	Routine test **(2)**	Type test **(1)**	Routine test **(2)**
1	Examination of the technical documentation, as appropriate, and visual inspection	X	X	X	X
2	Insulation resistance measurement	X	X	X	X
3	Winding resistance measurement	X	X	X	X
4	Verification of the voltage regulation system	X	X **(3)**		
5	Rated load test and temperature rise measurement	X		X	
6	Overload/overcurrent test	X	X **(4)**	X	X **(4)**
7	Verification of steady short-circuit conditions **(5)**	X			
8	Overspeed test	X	X	X **(6)**	X **(6)**
9	Dielectric strength test	X	X	X	X
10	No load test	X	X	X	X
11	Verification of degree of protection	X		X	

N°	Tests	a.c. Generators		Motors	
		Type test **(1)**	Routine test **(2)**	Type test **(1)**	Routine test **(2)**
12	Verification of bearings	X	X	X	X

(1) Type tests on prototype machine or tests on at least the first of a batch of machines.
(2) The report on routinely tested machines 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 50 kW/kVA.
(5) Verification of steady short circuit condition applies to synchronous generators only.
(6) Not applicable for squirrel cage motors.

Table 2 : Minimum insulation resistance

Rated voltage U_n, in V	Minimum test voltage, in V	Minimum insulation resistance, in MΩ
$U_n = 250$	$2\ U_n$	1
$250 < U_n \leq 1000$	500	1
$1000 < U_n \leq 7200$	1000	$U_n/1000 + 1$
$7200 < U_n \leq 15000$	5000	$U_n/1000 + 1$

4 Description of the test

4.1 Examination of the technical documentation, as appropriate, and visual inspection

4.1.1 Examination of the technical documentation

Technical documentation of machines rated at 100 kW (kVA) and over is to be available for examination by the Surveyor.

4.1.2 Visual inspection

A visual examination of the machine is to be made to ensure, as far as is practicable, that it complies with the technical documentation.

4.2 Insulation resistance measurement

4.2.1 Immediately after the high voltage tests the insulation resistances are to be measured using a direct current insulation tester between:

a) all current carrying parts connected together and earth,

b) 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 Tab 2. The insulation resistance is to be measured close to the operating temperature, or an appropriate method of calculation is to be used.

4.3 Winding resistance measurement

4.3.1 The resistances of the machine windings are to be measured and recorded using an appropriate bridge method or voltage and current method.

4.4 Verification of the voltage regulation system

4.4.1 The alternating current generator, together with its voltage regulation system, is to be verified in such a way that, at all loads from no load running to full load, the rated voltage at the rated power factor is maintained under steady conditions within ± 2.5%. These limits may be increased to ± 3.5% for emergency sets.

4.4.2 When the generator is driven at rated speed, giving its rated voltage, and is subjected to a sudden change of symmetrical load within the limits of specified current and power factor, the voltage is not to fall below 85% nor exceed 120% of the rated voltage

4.4.3 The voltage of the generator is then to be restored to within plus or minus 3% of the rated voltage for the main generator sets in not more than 1.5 s. For emergency sets, these values may be increased to plus or minus 4% in not more than 5 s.

4.4.4 In the absence of precise information concerning the maximum values of the sudden loads, the following conditions may be assumed: 60% of the rated current with a power factor of between 0.4 lagging and zero to be suddenly switched on with the generator running at no load, and then switched off after steady - state conditions have been reached.

4.5 Rated load test and temperature rise measurements

4.5.1 The temperature rises are to be measured at the rated output, voltage and frequency and for the duty for which the machine is rated and marked in accordance with the

testing methods specified in IEC Publication 60034-1, or by means of a combination of other tests.

The limits of temperature rise are those specified in Table 6 of IEC Publication 60034-1 adjusted as necessary for the ambient reference temperatures specified in Sec 2.

4.6 Overload/overcurrent tests

4.6.1 Overload test is to be carried out as a type test for generators as proof of overload capability of generators and the excitation system, for motors as proof of momentary excess torque as required in IEC Publication 60034-1. The overload test can be replaced at a routine test by an overcurrent test. The overcurrent test is to be proof of the current capability of the windings, wires, connections etc. of each machine. The overcurrent test can be performed at reduced speed (motors) or at short-circuit (generators).

4.6.2 In the case of machines for special uses (e.g. for windlasses), overload values other than the above may be considered.

4.7 Verification of steady short-circuit conditions

4.7.1 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 may be fitted in a tripping device for discrimination purposes.

4.8 Overspeed test

4.8.1 Machines are to withstand the overspeed test as specified in IEC Publication 60034-1. This test is not applicable for squirrel cage motors.

4.9 Dielectric strength test

4.9.1 New and completed rotating machines are to withstand a dielectric test as specified in IEC Publication 60034-1.

4.9.2 For high voltage machines an impulse test is to be carried out on the coils according to Sec 13.

4.9.3 When it is necessary to perform an additional high voltage test, this is to be carried out after any further drying, with a test voltage of 80% of that specified in IEC Publication 60034-1.

4.9.4 Completely rewound windings of used machines are to be tested with the full test voltage applied in the case of new machines.

4.9.5 Partially rewound windings are to be tested at 75% of the test voltage required for new machines. Prior to the test, the old part of the winding is to be carefully cleaned and dried.

4.9.6 Following cleaning and drying, overhauled machines are to be subjected to a test at a voltage equal to 1,5 times the rated voltage, with a minimum of 500 V if the rated voltage is less than 100 V, and with a minimum of 1000 V if the rated voltage is equal to or greater than 100 V.

4.9.7 A repetition of the high voltage test for groups of machines and apparatus is to be avoided if possible, but if a test on an assembled group of several pieces of new apparatus, each of which has previously passed its high voltage test, is performed, the test voltage to be applied to such assembled group is 80% of the lowest test voltage appropriate for any part of the group.

Note 1: For windings of one or more machines connected together electrically, the voltage to be considered is the maximum voltage that occurs in relation to earth.

4.10 No load test

4.10.1 Machines are to be operated at no load and rated speed whilst being supplied at rated voltage and frequency as a motor while generators are 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.

4.11 Verification of degree of ptoection

4.11.1 As specified in IEC Publication 60034-5.

4.12 Verification of bearings

4.12.1 Upon completion of the above tests, machines which have sleeve bearings are to be opened upon request for examination by the Surveyor, to establish that the shaft is correctly seated in the bearing shells.

SECTION 5 TRANSFORMERS

1 Constructional and operational requirements

1.1 Construction

1.1.1 Transformers, except those for motor starting, are to be double wound (two or more separate windings).

1.1.2 Transformers are normally to be of the dry, air-cooled type.

1.1.3 When a forced air cooling system is used, an alarm is to be activated in the event of its failure.

1.1.4 Liquid-cooled transformers may be used upon agreement of the Naval Authority and provided that:

- the liquid is non-toxic and of a type which does not readily support combustion
- the construction is such that the liquid is not spilled in inclined position
- temperature and pressure relief devices with an alarm are installed
- drip trays or other suitable arrangements for collecting the liquid from leakages are provided
- a liquid gauge indicating the normal liquid level range is fitted.

1.1.5 Transformers are to have enclosures with a degree of protection in accordance with Sec 3, Tab 1.

1.2 Terminals

1.2.1 Suitable fixed terminal connections are to be provided in an accessible position with sufficient space for convenient connection of the external cables.

1.2.2 Terminals are to be clearly identified.

1.3 Short-circuit conditions and parallel operation

1.3.1 In determining the voltage ratio and the impedance voltage of transformers, account is to be taken of the total permitted voltage drop from the main switchboard's busbars to the consumers (see Sec 3, [9.11.4]).

1.3.2 Transformers are to be constructed to withstand, without damage, the thermal and mechanical effects of a secondary terminal short-circuit for 2 s, with rated primary voltage and frequency.

For transformers of 1 MVA and over, this is to be justified with appropriate tests or documentation.

1.3.3 When transformers are so arranged that their secondary windings may be connected in parallel, they are to be identical and in particular they are to be of the same rated power, their winding connections are to be compatible, their rated voltage ratios are to be equal (with tolerances allowed) and their short-circuit impedance values, expressed as a percentage, are to have a ratio within 0,9 to 1,1.

1.4 Electrical insulation and temperature rise

1.4.1 Insulating materials for windings and other current carrying parts are to comply with the requirements of Sec 2.

1.4.2 All windings of air-cooled transformers are to be suitably treated to resist moisture, air salt mist and oil vapours.

1.4.3 The permissible limits of temperature rise with an ambient air temperature of 45°C for (natural or forced) air-cooled transformers are given in Tab 1. The temperature rises shown for windings refer to measurement by the resistance method while those for the core refer to the thermometer method.

1.4.4 For dry-type transformers cooled with an external liquid cooling system, the permissible limits of temperature rise with a sea water temperature of 32°C are 13°C higher than those specified in Tab 1.

1.4.5 For liquid-cooled transformers, the following temperature rises measured by the resistance method apply:

- 55°C where the fluid is cooled by air
- 68°C where the fluid is cooled by water.

Table 1 : Temperature rise limits for transformers

N°	Part of machine	Temperature rise by class of insulation °C				
		A	E	B	F	H
1	Windings	55	70	75	95	120
2	Cores and other parts: a) in contact with the windings b) not in contact with the windings	a) the same values as for the windings b) in no case is the temperature to reach values such as to damage either the core itself or other adjacent parts or materials				

1.5 Insulation tests

1.5.1 Transformers are to be subjected to a high voltage test in accordance with the procedure defined in Sec 4.

1.5.2 The test voltage is to be applied between each winding under test and the other windings not under test, core and enclosure all connected together.

Single-phase transformers for use in a polyphase group are to be tested in accordance with the requirements applicable to that group.

1.5.3 The r.m.s. value of the test voltage is to be equal to 2 U + 1000 V, with a minimum of 2500 V, where U is the rated voltage of the winding. The full voltage is to be maintained for 1 minute.

1.5.4 Partially rewound windings are to be tested at 75% of the test voltage required for new machines.

1.5.5 The insulation resistance of a new, clean and dry transformer, measured after the temperature rise test has been carried out (at or near operating temperature) at a voltage equal to 500 V d.c., is to be not less than 5 MΩ.

1.5.6 Transformers are to be subjected to an induced voltage insulation test by applying to the terminals of the winding under test a voltage equal to twice the rated voltage. The duration of the test is to be 60 s for any test frequency fp up to and including twice the rated frequency fn.

If the test frequency exceeds twice the rated frequency, the test time in seconds will be 120 f_n/f_p with a minimum of 15 s.

2 Testing

2.1 General

2.1.1 On new transformers intended for essential services the tests specified in [2.2] are to be carried out.

2.1.2 The manufacturer is to issue a test report giving, inter alia, information concerning the construction, type, serial number, insulation class and all other technical data relevant to the transformer, as well as the results of the tests required.

Such test reports are to be made available to the Society.

2.1.3 In the case of transformers which are completely identical in rating and in all other constructional details, it will be acceptable for the temperature rise test to be performed on only one transformer.

The results of this test and the serial number of the tested transformer are to be inserted in the test reports for the other transformers.

2.1.4 Where the test procedure is not specified, the requirements of IEC 60076 and 60726 apply.

2.1.5

The tests and, if appropriate, manufacture of transformers of 100 kVA and over (60 kVA when single phase) intended for essential services are to be attended by a Surveyor of the Society.

Transformers of 5 kVA up to the limit specified above are approved on a case by case basis, at the discretion of the Society, subject to the submission of adequate documentation and routine tests.

Note 1: An alternative inspection scheme may be agreed by the Society with the Manufacturer whereby the attendance of the Surveyor will not be required as indicated above.

2.2 Tests on transformers

2.2.1 Tests to be carried out on transformers are specified in Tab 2.

Table 2 : Tests to be carried out on transformers

N°	Tests	Type test **(1)**	Routine test **(2)**
1	Examination of the technical documentation, as appropriate, and visual inspection **(3)**	X	X
2	Insulation resistance measurement	X	X
3	High voltage test	X	X
4	Temperature rise measurement	X	
5	Induced voltage test	X	X
6	Voltage ratio	X	X

(1) Type test on prototype transformer or test on at least the first batch of transformers.

(2) The certificates of transformers routine tested are to contain the manufacturer's serial number of the transformer which has been type tested and the test result.

(3) A visual examination is to be made of the transformer to ensure, as far as practicable, that it complies with technical documentation.

SECTION 6 SEMICONDUCTOR CONVERTORS

1 Constructional and operational requirements

1.1 Construction

1.1.1 Semiconductor convertors are generally to comply with the requirements for switchgear assemblies (see Sec 8).

1.1.2 The monitoring and control circuits are generally to comply with the requirements of Chapter 3.

1.1.3 For liquid-cooled convertors the following provisions are to be satisfied:

- liquid is to be non-toxic and of low flammability
- drip trays or other suitable means are to be provided to contain any liquid leakages
- the resistivity of the cooling fluid in direct contact with semiconductor or other current carrying parts is to be monitored and an alarm initiated if the resistivity is outside the specified limits.

1.1.4 Where forced cooling is used, the temperature of the heated cooling medium is to be monitored.

If the temperature exceeds a preset value an alarm is to be given and the shutdown of the convertor is to be activated.

1.1.5 Where forced (air or liquid) cooling is provided, it is to be so arranged that the convertor cannot be or remain loaded unless effective cooling is maintained.

Alternatively, other effective means of protection against overtemperature may be provided.

1.1.6 Stacks of semiconductor elements, and other equipment such as fuses, or control and firing circuit boards etc., are to be so arranged that they can be removed from equipment without dismantling the complete unit.

1.1.7 Semiconductor convertors are to be rated for the required duty having regard to the peak loads, system transient and overvoltage and to be dimensioned so as to withstand the maximum short-circuit currents foreseen at the point of installation for the time necessary to trip the protection of the circuits they supply.

1.2 Protection

1.2.1

Semiconductor elements are to be protected against short-circuit by means of devices suitable for the point of installation in the network.

1.2.2 Overcurrent or overvoltage protection is to be installed to protect the convertor. When the semiconductor convertor is designed to work as an inverter supplying the network in transient periods, precautions necessary to limit the current are to be taken.

1.2.3 Semiconductor convertors are not to cause distortion in the voltage wave form of the power supply at levels exceeding the voltage wave form tolerances at the other user input terminals.

1.2.4 An alarm is to be provided for tripping of protective devices against overvoltages and overcurrents in electric propulsion convertors and for convertors for the emergency source of power.

1.3 Parallel operation with other power sources

1.3.1 For convertors arranged to operate in parallel with other power sources, load sharing is to be such that under normal operating conditions overloading of any unit does not occur and the combination of paralleled equipment is stable.

1.4 Temperature rise

1.4.1 The permissible limit of temperature rise of the enclosure of the semiconductors is to be assessed on the basis of an ambient air temperature of 45°C or sea water temperature of 32°C for water-cooled elements, taking into account its specified maximum permissible temperature value.

1.4.2 The value of the maximum permissible temperature of the elements at the point where this can be measured (point of reference) is to be stated by the manufacturer.

1.4.3 The value of the mean rated current of the semiconductor element is to be stated by the manufacturer.

1.5 Insulation test

1.5.1 The test procedure is that specified in IEC Publication 60146.

1.5.2 The effective value of the test voltage for the insulation test is to be as shown in Tab 1.

Table 1 : Test voltages for high voltage test on static convertors

$\frac{U_m}{\sqrt{2}} = U$ in V **(1)**	Test voltage V
$U \leq 60$	600
$60 < U \leq 90$	900
$90 < U$	2 U + 1000 (at least 2000)

(1) U_m: highest crest value to be expected between any pair of terminals.

2 Testing

2.1 General

2.1.1 Convertors intended for essential services are to be subjected to the tests stated in [2.2].

2.1.2

The manufacturer is to issue a test report giving information on the construction, type, serial number and all technical data relevant to the convertor, as well as the results of the tests required.

Note 1: An alternative inspection scheme may be agreed by the Society with the Manufacturer whereby the attendance of the Surveyor will not be required as indicated above.

2.1.3 In the case of convertors which are completely identical in rating and in all other constructional details, it will be acceptable for the rated current test and temperature rise measurement stipulated in [2.2] not to be repeated.

2.1.4

The tests and, if appropriate, manufacture of convertors of 50 kVA and over intended for essential services are to be attended by a Surveyor of the Society.

2.2 Tests on convertors

2.2.1 Convertors are to be subjected to tests in accordance with Tab 2.

Type tests are the tests to be carried out on a prototype convertor or the first of a batch of convertors, and routine tests are the tests to be carried out on subsequent convertors of a particular type.

2.2.2 Final approval of convertors is to include complete function tests after installation on board, performed with all ship's systems in operation and in all characteristic load conditions.

Table 2 : Tests to be carried out on static convertors

N°	Tests	Type test **(1)**	Routine test **(2)**
1	Examination of the technical documentation, as appropriate, and visual inspection **(3)** including check of earth continuity	X	X
2	Light load function test to verify all basic and auxiliary functions	X	X
3	Rated current test	X	
4	Temperature rise measurement	X	
5	Insulation test (high voltage test and insulation resistance measurement)	X	X
6	Protection of the convertors in case of failure of forced cooling system	X	X

(1) Type test on prototype convertor or test on at least the first batch of convertors.

(2) The certificates of convertors routine tested are to contain the manufacturer's serial number of the convertor which has been type tested and the test result.

(3) A visual examination is to be made of the convertor to ensure, as far as practicable, that it complies with technical documentation.

SECTION 7 STORAGE BATTERIES, CHARGERS AND UNINTERRUPTIBLE POWER SYSTEMS

1 Constructional requirements for batteries

1.1 General

1.1.1 The requirements of this Section apply to permanently installed storage batteries (not to portable batteries).

1.1.2 Storage batteries may be of the lead-acid or nickel-alkaline type, due consideration being given to the suitability for any specific application.

Other types of storage batteries of satisfactorily proven design (e.g. silver/zinc) may be accepted provided they are suitable for shipboard use to the satisfaction of the Society.

1.1.3 Cells are to be assembled in suitable crates or trays equipped with handles for convenient lifting.

1.2 Vented batteries

1.2.1 Vented batteries are those in which the electrolyte can be replaced and freely releases gas during periods of charge and overcharge.

1.2.2 Vented batteries are to be constructed to withstand the movement of the ship and the atmosphere (salt mist, oil etc.) to which they may be exposed.

1.2.3 Battery cells are to be so constructed as to prevent spilling of electrolyte at any inclination of the battery up to 40° from the vertical.

1.2.4 It is to be possible to check the electrolyte level and the pH.

1.3 Valve-regulated sealed batteries

1.3.1 Valve-regulated sealed batteries are batteries whose cells are closed under normal conditions but which have an arrangement which allows the escape of gas if the internal pressure exceeds a predetermined value. The cells cannot normally receive addition to the electrolyte.

Note 1: The cells of batteries which are marketed as "sealed" or "maintenance free" are fitted with a pressure relief valve as a safety precaution to enable uncombined gas to be vented to the atmosphere; they should more properly be referred to as valve-regulated sealed batteries. In some circumstances the quantity of gas vented can be up to 25% of the equivalent vented design. The design is to take into consideration provision for proper ventilation.

1.3.2 Cell design is to minimise risks of release of gas under normal and abnormal conditions.

1.4 Tests on batteries

1.4.1 The battery autonomy is to be verified on board in accordance with the operating conditions.

2 Constructional requirements for chargers

2.1 Characteristics

2.1.1 Chargers are to be adequate for the batteries for which they are intended and provided with a voltage regulator.

2.1.2 In the absence of indications regarding its operation, the battery charger is to be such that the completely discharged battery can be recharged to 80% capacity within a period of 10 hours without exceeding the maximum permissible charging current. A charging rate other than the above (e.g. fully charged within 6 hours for batteries for starting of motors) may be required in relation to the use of the battery.

2.1.3 For floating service or for any other condition where the load is connected to the battery while it is on charge, the maximum battery voltage is not to exceed the safe value of any connected apparatus.

Note 1: Consideration is to be given to the temperature variation of the batteries.

2.1.4 The battery charger is to be designed so that the charging current is set within the maximum current allowed by the manufacturer when the battery is discharged and the floating current to keep the battery fully charged.

2.1.5 Trickle charging to neutralise internal losses is to be provided. An indication is to be provided to indicate a charging voltage being present at the charging unit.

2.1.6 Protection against reversal of the charging current is to be provided.

2.1.7 Battery chargers are to be constructed to simplify maintenance operation. Indications are to be provided to visualise the proper operation of the charger and for troubleshooting.

2.2 Tests on chargers

2.2.1 Battery chargers are to be subjected to tests in accordance with Tab 1.

Type tests are the tests to be carried out on a prototype charger or the first of a batch of chargers, and routine tests are the tests to be carried out on subsequent chargers of a particular type.

2.2.2 The electronic components of the battery chargers are to be constructed to withstand the tests required in Ch 3, Sec 6.

2.2.3

The tests of battery chargers of 50 kVA and over intended for essential services are to be attended by a Surveyor of the Society.

Note 1: An alternative inspection scheme may be agreed by the Society with the Manufacturer whereby the attendance of the Surveyor will not be required as indicated above.

3 Uninterruptible power system (UPS) units as alternative and/or transitional power

3.1 Application

3.1.1

These requirements for UPS units apply when providing an alternative power supply or transitional power supply to services as defined in Sec 3, [2.3].

3.2 Definitions

3.2.1

Uninterruptible Power System (UPS) - combination of convertors, switches and energy storage means, for example batteries, constituting a power system for maintaining continuity of load power in case of input power failure

Off-line UPS unit - a UPS unit where under normal operation the output load is powered from the bypass line (raw mains) and only transferred to the inverter if the bypass supply fails or goes outside preset limits. This transition will invariably result in a brief (typically 2 to 10 ms) break in the load supply.

Line interactive UPS unit - an off-line UPS unit where the bypass line switches to stored energy power when the input power goes outside the preset voltage and frequency limits.

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 a break in the event of the supply input failing or going outside preset limits.

3.3 Design and construction

3.3.1

UPS units are to be constructed in accordance with IEC 62040 or an acceptable and relevant national or international standard.

3.3.2

The operation of the UPS is not to depend upon external services.

3.3.3

The type of UPS unit employed, whether off-line, line interactive or on-line, is to be appropriate to the power supply requirements of the connected load equipment.

3.3.4

An external bypass is to be provided.

3.3.5

The UPS unit is to be monitored and audible and visual alarm is to be given in a normally attended location for:

- power supply failure (voltage and frequency) to the connected load,
- earth fault,
- operation of a battery protective device,
- when the battery is being discharged, and
- when the bypass is in operation for on-line UPS units.

3.4 Location

3.4.1 *(1/1/2017)*

The UPS unit providing an alternative power supply or transitional power supply to services as defined in Sec 1, [3.2.1] is to be suitably located for use in an emergency.

3.4.2

UPS units using 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 or an acceptable and relevant national or international standard.

3.5 Performance

3.5.1 *(1/1/2017)*

The output power is to be maintained for the duration required for the connected emergency services as stated in Sec 1, [3.2.1].

3.5.2

No additional circuits are to be connected to the UPS unit without verification that the latter has adequate capacity. The UPS battery capacity is, at all times, to be capable of supplying the designated loads for the time specified in the regulations.

3.5.3

On restoration of the input power, the rating of the charge unit is to be sufficient to recharge the batteries while maintaining the output supply to the load equipment.

3.6 Testing and survey

3.6.1

UPS units of 50 kVA and over are to be surveyed by the Society during manufacturing and testing.

3.6.2

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.

3.6.3

Where the supply is to be maintained without a break following a power input failure, this is to be verified after installation by means of a practical test.

Table 1 : Tests to be carried out on battery chargers

N°	Tests	Type test **(1)**	Routine test **(2)**
1	Examination of the technical documentation, as appropriate, and visual inspection **(3)** including check of earth continuity	X	X
2	Functional tests (current and voltage regulation, quick, slow, floating charge, alarms)	X	X
3	Temperature rise measurement	X	
4	Insulation test (high voltage test and insulation resistance measurement)	X	X

(1) Type test on prototype battery charger or test on at least the first batch of battery chargers.

(2) The certificates of battery chargers routine tested are to contain the manufacturer's serial number of the battery charger which has been type tested and the test result.

(3) A visual examination is to be made of the battery charger to ensure, as far as practicable, that it complies with technical documentation.

SECTION 8 SWITCHGEAR AND CONTROLGEAR ASSEMBLIES

1 Constructional requirements for main and emergency switchboards

1.1 Construction

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

1.1.2 Where the framework, panels and doors of the enclosure are of steel, suitable measures are to be taken to prevent overheating due to the possible circulation of eddy currents.

1.1.3 Insulating material for panels and other elements of the switchboard is at least to be moisture-resistant and flame-retardant.

1.1.4 Switchboards are to be of dead front type, with enclosure protection according to Sec 3, Tab 1.

1.1.5 Switchboards are to be provided with insulated handrails or handles fitted in an appropriate position at the front of the switchboard. Where access to the rear is necessary for operational or maintenance purposes, an insulated handrail or insulated handles are to be fitted.

1.1.6 Where the aggregate capacity of generators connected to the main busbars exceeds 100 kVA, a separate cubicle for each generator is to be arranged with flame-retardant partitions between the different cubicles. Similar partitions are to be provided between the generator cubicles and outgoing circuits.

1.1.7 Instruments, handles or push-buttons for switchgear operation are to be placed on the front of the switchboard. All other parts which require operation are to be accessible and so placed that the risk of accidental touching of live parts, or accidental making of short-circuits and earthings, is reduced as far as practicable.

1.1.8 Where it is necessary to make provision for the opening of the doors of the switchboard, this is to be in accordance with one of the following requirements:

a) opening is to necessitate the use of a key or tool (e.g. when it is necessary to replace a lamp or a fuse-link)

b) all live parts which can be accidentally touched after the door has been opened are to be disconnected before the door can be opened

c) the switchboard is to include an internal barrier or shutter with a degree of protection not less than IP2X shielding all live parts such that they cannot accidentally be touched when the door is open. It is not to be possible to remove this barrier or shutter except by the use of a key or tool.

1.1.9 All parts of the switchboard are to be readily accessible for maintenance, repair or replacement. In particular, fuses are to be able to be safely inserted and withdrawn from their fuse-bases.

1.1.10 Hinged doors which are to be opened for operation of equipment on the door or inside are to be provided with fixing devices for keeping them in open position.

1.1.11 Means of isolation of the circuit-breakers of generators and other important parts of the installation are to be provided so as to permit safe maintenance while the main busbars are alive.

1.1.12 Where components with voltage exceeding the safety voltage are mounted on hinged doors, the latter are to be electrically connected to the switchboard by means of a separate, flexible protective conductor.

1.1.13 All measuring instruments and all monitoring and control devices are to be clearly identified with indelible labels of durable, flame-retardant material.

1.1.14 The rating of each circuit, together with the rating of the fuse or the appropriate setting of the overload protective device (circuit-breaker, thermal relay etc.) for each circuit is to be permanently indicated at the location of the fuse or protective device.

1.2 Busbars and bare conductors

1.2.1 Busbars are to be of copper or of copper-surrounded aluminium alloy if suitable for use in the marine environment and if precautions are taken to avoid galvanic corrosion.

1.2.2 All connections are to be so made as to inhibit corrosion.

1.2.3 Busbars are to be dimensioned in accordance with IEC 60092-302.

The mean temperature rise of busbars is not to exceed 45°C under rated current condition with an ambient air temperature of 45°C (see also Sec 2, [1.2.6]) and is not to have any harmful effect on adjacent components. Higher values of temperature rise may be accepted to the satisfaction of the Society.

1.2.4 The cross-section of neutral connection on an a.c. three-phase, four-wire system is to be at least 50% of the cross-section for the corresponding phases.

1.2.5 Bare main busbars, excluding the conductors between the main busbars and the supply side of outgoing units, are to have the minimum clearances and creepage distances given in Tab 1.

The values shown apply to clearances and creepage distances between live parts as well as between live parts and exposed conductive parts.

Table 1 : Clearance and creepage distances

Rated insulation voltage a.c. r.m.s. or d.c. V	Minimum clearance mm	Minimum creepage distance mm
≤ 250	15	20
> 250 to ≤ 690	20	25
> 690	25	35

Note 1: Clearance is the distance between two conductive parts along a string stretched the shortest way between such parts. Creepage distance is the shortest distance along the surface of an insulating material between two conductive parts.

1.2.6 Reduced values as specified in IEC 60092-302 may be accepted for type tested and partially type tested assemblies.

The reference values for the evaluation of the minimum clearances and creepage distances for these assemblies are based on the following:

- pollution degree 3 (conductive pollution occurs, or dry non-conductive pollution occurs which becomes conductive due to condensation which is expected)
- overvoltage category III (distribution circuit level)
- inhomogenous field conditions (case A)
- rated operational voltage 1000 V a.c., 1500 V d.c.
- group of insulating material IIIa.

Special consideration is to be given to equipment located in spaces where a pollution degree higher than 3 is applicable, e.g. in diesel engine rooms.

1.2.7 Busbars and other bare conductors with their supports are to be mechanically dimensioned and fixed such that they can withstand the stresses caused by short-circuits.

1.2.8 Busbars and bare conductors are to be protected, where necessary, against falling objects (e.g. tools, fuses or other objects).

1.3 Internal wiring

1.3.1 Insulated conductors for internal wiring of auxiliary circuits of switchboards are to be constructed in accordance with Sec 9, [1.1.5].

1.3.2 All insulated conductors provided for in [1.3.1] are to be of flexible construction and of the stranded type.

1.3.3 Connections from busbars to protective devices are to be as short as possible. They are to be laid and secured in such a way to minimise the risk of a short-circuit.

1.3.4 All conductors are to be secured to prevent vibration and are to be kept away from sharp edges.

1.3.5 Connections leading to indicating and control instruments or apparatus mounted in doors are to be installed such that they cannot be mechanically damaged due to movement of the doors.

1.3.6 Non-metallic trays for internal wiring of switchboards are to be of flame-retardant material.

1.3.7 Control circuits are to be installed and protected such that they cannot be damaged by arcs from the protective devices.

1.3.8 Where foreseen, fixed terminal connectors for connection of the external cables are to be arranged in readily accessible positions.

1.4 Switchgear and controlgear, protective devices

1.4.1 *(1/1/2017)*

Switchgear and controlgear are to comply with IEC 60947 series adjusted as necessary for the ambient air reference temperature specified in Sec 2, Tab 1 and to be type tested or type approved when required in accordance with Sec 15.

1.4.2 The characteristics of switchgear, controlgear and protective devices for the various consumers are to be in compliance with Sec 3, [7].

1.4.3 *(1/1/2017)*

For high voltage switchgear and controlgear see Sec 13, [7].

1.4.4 *(1/1/2017)*

For materials and construction, see Sec 2, [4] and Sec 2, [5].

1.4.5 *(1/1/2017)*

Power-driven circuit-breakers are to be equipped with an additional separate drive operated by hand.

1.4.6 *(1/1/2017)*

Power circuit-breakers with a making capacity exceeding 10 kA are to be equipped with a drive which performs the make operation independently of the actuating force and speed.

1.4.7 *(1/1/2017)*

Where the conditions for closing the circuit-breaker are not satisfied (e.g. if the undervoltage trip is not energised), the closing mechanism is not to cause the closing of the contacts.

1.4.8 *(1/1/2017)*

All circuit-breakers rated more than 16 A are to be of the trip-free type, i.e. the breaking action initiated by overcurrent or undervoltage releases is to be fulfilled independently of the position of the manual handle or other closing devices.

1.4.9 *(1/1/2017)*

Short-circuit releases are generally to be independent of energy supplied from circuits other than that to be protected. Tripping due to short-circuit is to be reliable even in the event of a total loss of voltage in the protected circuit.

1.4.10 *(1/1/2017)*

Short-circuit releases for generators are to be equipped with reclosing inhibitors and are to be delayed for selective tripping.

1.4.11 *(1/1/2017)*
Overload releases or relays are to operate reliably at any voltage variation of the supply voltage in the protected circuit.

1.4.12 *(1/1/2017)*
Undervoltage relays or releases are to cause the circuit-breaker to open if the voltage drops to 70%-35% of the rated voltage.

1.4.13 *(1/1/2017)*
Shunt releases are to ensure the disconnection of the circuit-breaker even when the supply voltage of the release drops to 85% of the rated supply voltage.

1.4.14 *(1/1/2017)*
The reverse power protection device is to respond to the active power regardless of the power factor, and is to operate only in the event of reverse power.

1.4.15 *(1/1/2017)*
Single-phase failure devices in three-phase circuits are to operate without a time lag.

1.4.16 *(1/1/2017)*
Insulation monitoring devices are to continuously monitor the insulation resistance to earth and trigger an alarm should the insulation resistance fall below a predetermined value.

The measuring current of such devices is not to exceed 30 mA in the event of a total short to earth.

1.5 Fuses

1.5.1 *(1/1/2017)*
Low voltage fuses are to comply with IEC Publication 60269 series and are to be type tested or type approved when required in accordance with Sec 15, [2.1.1].

1.5.2 *(1/1/2017)*
For high voltage fuses see Sec 13, [6].

1.6 Auxiliary circuits

1.6.1 Auxiliary circuits are to be designed in such a manner that, as far as practicable, faults in such circuits do not impair the safety of the system. In particular, control circuits are to be designed so as to limit the dangers resulting from a fault between the control circuit and earth (e.g. inadvertent operation or malfunction of a component in the installation), also taking account of the earthing system of their supply.

1.6.2 Auxiliary circuits of essential systems are to be independent of other auxiliary circuits.

1.6.3 Common auxiliary circuits for groups of consumers are permitted only when the failure of one consumer jeopardises the operation of the entire system to which it belongs.

1.6.4 Auxiliary circuits are to be branched off from the main circuit in which the relevant switchgear is used.

1.6.5 The supply of auxiliary circuits by specifically arranged control distribution systems will be specially considered by the Society.

1.6.6 Means are to be provided for isolating the auxiliary circuits as well when the main circuit is isolated (e.g. for maintenance purposes).

1.6.7 For the protection of auxiliary circuits see Sec 3, [7.13].

1.7 Instruments

1.7.1 The upper limit of the scale of every voltmeter is to be not less than 120% of the rated voltage of the circuit in which it is installed.

1.7.2
The upper limit of the scale of every ammeter is to be not less than 130% of the normal rating of the circuit in which it is installed.

1.7.3 Fire-resisting cables are to be clearly labelled with the indication of the standard according to which this characteristic has been verified.

1.7.4 The upper limit of the scale of every wattmeter is to be not less than 120% of the rated voltage of the circuit in which it is installed.

1.7.5 Wattmeters for use with a.c. generators which may be operated in parallel are to be capable of indicating 15% reverse power.

1.7.6 For wattmeters using one current circuit only, the measurement of the current of all generators is to be made in the same phase.

1.7.7 The rated value of the measure read, at full load, is to be clearly indicated on the scales of instruments.

1.7.8 Frequency meters are to have a scale at least ± 5% of the nominal frequency.

1.7.9 The secondary windings of instrument transformers are to be earthed.

1.7.10 Each a.c. generator not operated in parallel is to be provided with:

- 1 voltmeter
- 1 frequency meter
- 1 ammeter in each phase or 1 ammeter with a selector switch to enable the current in each phase to be read
- 1 three-phase wattmeter in the case of generators rated more than 50 kVA.

1.7.11 Each a.c. generator operated in parallel is to be provided with:

- 1 three-phase wattmeter
- 1 ammeter in each phase or 1 ammeter with a selector switch to enable the current in each phase to be read.

1.7.12 For paralleling purposes the following are to be provided:

- 2 voltmeters
- 2 frequency meters
- 1 synchroscope and synchronising indicating lamps or equivalent means.

A switch is to be provided to enable one voltmeter and one frequency meter to be connected to each generator before the latter is connected to the busbars.

The other voltmeter and frequency meter are to be permanently connected to the busbars.

1.7.13 Each secondary distribution system is to be provided with one voltmeter.

1.7.14 Switchboards are to be fitted with means for monitoring the insulation level of insulated distribution systems as stipulated in Sec 3, [3.2.1].

1.7.15 The main switchboard is to be fitted with a voltmeter or signal lamp indicating that the cable between the shore-connection box and the main switchboard is energised (see Sec 3, [3.7.7]).

1.7.16 For each d.c. power source (e.g. convertors, rectifiers and batteries), one voltmeter and one ammeter are to be provided, except for d.c. power sources for starting devices (e.g. starting motor for emergency generator).

2 Constructional requirements for section boards and distribution boards

2.1 Construction

2.1.1 Section boards and distribution boards are to be constructed, insofar as applicable, as specified for main and emergency switchboards.

2.1.2 All parts which require operation in normal use are to be placed on the front.

2.1.3 Distribution switchboards which are provided with two or more supply circuits arranged for automatic standby connection are to be provided with positive indication of which of the circuits is feeding the switchboard.

3 Testing

3.1 General

3.1.1 Switchboards are to be subjected to the tests specified from [3.2] to [3.4].

3.1.2 The manufacturer is to issue the relative test reports providing information concerning the construction, serial number and technical data relevant to the switchboard, as well as the results of the tests required.

3.1.3 The tests are to be carried out prior to installation on board.

3.1.4 The test procedures are as specified in IEC 60092-302.

3.1.5

The attendance of the Surveyor is not required for low voltage distribution panels and single starters having nominal current of 100 A or less, except those intended for steering gear motors.

3.2 Inspection of equipment, check of wiring and electrical operation test

3.2.1 It is to be verified that the switchboard:

- complies with the approved drawings
- maintains the prescribed degree of protection
- is constructed in accordance with the relevant constructional requirements, in particular as regards creepage and clearance distances.

3.2.2 The connections, especially screwed or bolted connections, are to be checked for adequate contact, possibly by random tests.

3.2.3 Depending on the complexity of the switchboard it may be necessary to carry out an electrical functioning test. The test procedure and the number of tests depend on whether or not the switchboard includes complicated interlocks, sequence control facilities, etc. In some cases it may be necessary to conduct or repeat this test following installation on board.

3.3 High voltage test

3.3.1 The test is to be performed with alternating voltage at a frequency between 25 and 100 Hz of approximately sinusoidal form.

3.3.2 The test voltage is to be applied:

- between all live parts connected together and earth
- between each polarity and all the other polarities connected to earth for the test.

During the high voltage test, measuring instruments, ancillary apparatus and electronic devices may be disconnected and tested separately in accordance with the appropriate requirements.

3.3.3 The test voltage at the moment of application is not to exceed half of the prescribed value. It is then to be increased steadily within a few seconds to its full value. The prescribed test voltage is to be maintained for 1 minute.

3.3.4 The value of the test voltage for main and auxiliary circuits is given in Tab 2 and Tab 3.

3.4 Measurement of insulation resistance

3.4.1 Immediately after the high voltage test, the insulation resistance is to be measured using a device with a direct current voltage of at least 500 V.

3.4.2 The insulation resistance between all current carrying parts and earth (and between each polarity and the other polarities) is to be at least equal to 1 MΩ.

Table 2 : Test voltages for main circuits

Rated insulation voltage U_i V	Test voltage c.a (r.m.s.) V
$U_i \leq 60$	1000
$60 < U_i \leq 300$	2000
$300 < U_i \leq 660$	2500
$660 < U_i \leq 800$	3000
$800 < U_i \leq 1000$	3500

Table 3 : Test voltage for auxiliary circuits

Rated insulation voltage U_i V	Test voltage c.a (r.m.s.) V
$U_i \leq 12$	250
$12 < U_i \leq 60$	500
$U_i > 60$	$2\ U_i$ + 1000 (at least 1500)

SECTION 9 CABLES

1 Constructional requirements

1.1 Construction

1.1.1 Cables are generally to be constructed in accordance with IEC Publications of the series 60092-3.., as well with the provisions of this Chapter.

1.1.2 Regarding smoke emission and halogen acid gas content, cables are to be in compliance with IEC 60754-1, 60754-2, 61034-1, 61034-2.

1.1.3 Optical fibre cables are to be constructed in accordance with IEC 60794.

1.1.4 Flexible cables constructed according to national standards will be specially considered by the Society.

1.1.5 Cables other than those specified in IEC Publications are subject to special consideration by the Society in each case. Those for general purposes are to be constructed of materials having characteristics which produce a cable at least equivalent to those constructed from materials referred to in IEC Publications or a cable recognised in compliance with Standard recognized by the Society and acceptable to the Naval Authority .

1.1.6 IInsulated wiring for auxiliary circuits of switchboards and control gears may be constituted by cables with a single conductor of the stranded type for all sections, in accordance with the Publications cited in [1.1.1] and without further protection.

The insulated wiring is to be at least of the flame-retardant type according to IEC 60332-1 and in accordance with IEC 60754-1, 60754-2, 61034-1 and 61034-2. Equivalent types of flame-retardant switchboard wires will be specially considered by the Society.

1.2 Conductors

1.2.1 Conductors are to be of annealed electrolytic copper with a resistivity not exceeding 17,241 Ω mm^2/km at 20°C according to IEC 60228.

1.2.2 Individual conductor wires of rubber-insulated cables and cables having cross sectional area less than 10 mm are to be tinned or coated with a suitable alloy.

1.2.3 All conductors are to be stranded, except for cables of nominal cross-sectional area 2,5 mm^2 and less (provided that adequate flexibility of the finished cable is assured).

1.2.4 For the minimum nominal cross-sectional areas permitted, see Sec 3, [9.10].

1.3 Insulating materials

1.3.1 The materials used for insulation are to comply with IEC 60092-351 and to have the thicknesses specified for each type of cable in the relevant standard. The maximum permissible rated temperature is specified for the various materials.

1.3.2 Materials and thicknesses other than those in [1.3.1] will be specially considered by the Society.

1.4 Inner covering, fillers and binders

1.4.1 The cores of a multicore cable are to be laid up. The spaces between the cores are to be filled so as to obtain an assembly having an essentially circular cross-section. The filling may be omitted in multicore cables having a conductor cross-sectional area not exceeding 4 mm^2.

When a non-metallic sheath is applied directly over the inner covering or the fillers, it may substitute partially for the inner covering or fillers.

1.4.2 The materials used, the binders and the thicknesses of the inner coverings are generally to be in accordance with IEC Publications of the series 60092-3.., in relation to the type of cable.

1.5 Protective coverings (armour and sheath)

1.5.1 Metallic armour, if not otherwise protected against corrosion, is to be protected by means of a coating of protective paint (see Sec 3, [9.3]).

1.5.2 The paint is to be non-flammable and of adequate viscosity. When dry, it is not to flake off.

1.5.3 The materials and construction used for (metal) armour are to be in accordance with IEC 60092-350 and their dimensions are to be those specified for each type of cable in the relevant standard.

1.5.4 The materials used for sheaths are to be in accordance with IEC 60092-359 and are to have the thicknesses specified for each type of cable in the relevant standard.

The quality of the materials is to be adequate to the service temperature of the cable.

1.5.5 Materials other than those in [1.5.3] and [1.5.4] will be specially considered by the Society.

1.6 Identification

1.6.1 Each cable is to have clear means of identification so that the manufacturer can be determined.

1.6.2 Fire non propagating cables are to be clearly labelled with indication of the standard according to which this characteristic has been verified and, if applicable, of the category to which they correspond.

1.6.3
Fire-resisting cables are to be clearly labelled with the indication of the standard according to which this characteristic has been verified.

2 Testing

2.1 Type tests

2.1.1 Type tests are to be in accordance with the relevant IEC 60092-3.. Series Publications and IEC 60332-1, IEC 60332-3 Category A, IEC 60754-1, IEC 60754-2, IEC 61034-1, IEC 61034-2, and IEC 60331 where applicable or with standard recognized by the acceptable to the Naval Authority.

2.2 Routine tests

2.2.1 Every length of finished cable is to be subjected to the tests specified in [2.2.2].

2.2.2 The following routine tests are to be carried out:

a) visual inspection

b) check of conductor cross-sectional area by measuring electrical resistance

c) high voltage test

d) insulation resistance measurement

e) dimensional checks (as necessary).

2.2.3 The manufacturer is to issue a statement providing information on the type and characteristics of the cable, as well as the results of the tests required and the Type Approval Certificates.

2.2.4 The test procedure is as specified in IEC 60092-350.

2.2.5
Power cables for electrical propulsion systems, other than internal wiring in switchboards, are to be type approved and tested for acceptance in the presence of the Surveyor.

Acceptance tests are to include at least:

a) a high voltage test

b) insulation resistance measurement.

2.2.6 Where an alternative scheme, e.g. a certified quality assurance system, is recognised by the Society, attendance of the Surveyor may not be required.

SECTION 10 MISCELLANEOUS EQUIPMENT

1 Lighting fittings

1.1 Applicable requirements

1.1.1 Lighting fittings are to comply with IEC Publications 60598 and 60092-306.

Lighting fittings complying with other standards will be specially considered by the Society.

1.2 Construction

1.2.1 The temperature of terminals for connection of supplying cables is not to exceed the maximum conductor temperature permitted for the cable (see Sec 3, [9.9]).

Where necessary, luminaires are to be fitted with terminal boxes which are thermally insulated from the light source.

1.2.2 Wires used for internal connections are to be of a temperature class which corresponds to the maximum temperature within the luminaire.

1.2.3 The temperature rise of parts of luminaires which are in contact with the support is not to exceed 50°C. The rise is not to exceed 40°C for parts in contact with flammable materials.

1.2.4 The temperature rise of surface parts which can easily be touched in service is not to exceed 15°C.

1.2.5 High-power lights with higher surface temperatures than those in [1.2.2] and [1.2.3] are to be adequately protected against accidental contact.

2 Accessories

2.1 Applicable requirements

2.1.1 Accessories are to be constructed in accordance with the relevant IEC Publications, and in particular with Publication 60092-306.

2.2 Construction

2.2.1 Enclosures of accessories are to be of metal having characteristics suitable for the intended use on board, or of flame-retardant insulating material.

2.2.2 Terminals are to be suitable for the connection of stranded conductors, except in the case of rigid conductors for mineral-insulated cables.

3 Plug-and-socket connections

3.1 Applicable requirements

3.1.1 *(1/1/2017)*

Plug-and-socket connections are to comply with IEC Publication 60092-306 and with the following additional standards in relation to their use:

- in accommodation spaces, day rooms and service rooms (up to 16 A, 250 V a.c.): IEC Publication 60083 or 60320, as applicable
- for power circuits (up to 250 A, 690 V a.c.): IEC Publication 60309
- for electronic switchgear: IEC Publications, e.g. 60130 and 60603
- for refrigerated containers: ISO 1496-2
- for high voltage shore connections: IEC Publications 62613-1 and 62613-2.

4 Heating and cooking appliances

4.1 Applicable requirements

4.1.1 Heating and cooking appliances are to comply with the relevant IEC Publications (e.g. those of series 60335), with particular attention to IEC 60092-307.

4.2 General

4.2.1 Heating elements are to be enclosed and protected with metal or refractory material.

4.2.2 The terminals of the power supply cable are not to be subjected to a higher temperature than that permitted for the conductor of the connection cable.

4.2.3 The temperature of parts which are to be handled in service (switch knobs, operating handles and the like) is not to exceed the following values:

- 55°C for metal parts
- 65°C for vitreous or moulded material.

4.3 Space heaters

4.3.1 The casing or enclosure of heaters is to be so designed that clothing or other flammable material cannot be placed on them.

4.3.2 The temperature of the external surface of space heaters is not to exceed 60°C.

4.3.3 Space heaters are to be provided with a temperature limiting device without automatic reconnection which automatically trips all poles or phases not connected to

earth when the temperature exceeds the maximum permissible value.

4.4 Cooking appliances

4.4.1 Live parts of cooking appliances are to be protected such that any foods or liquids which boil over or spill do not cause short-circuits or loss of insulation.

4.5 Fuel oil and lube oil heaters

4.5.1 In continuous-flow fuel oil and lube oil heaters, the maximum temperature of the heating elements is to be below the boiling point of the oil.

4.5.2 Each oil heater is to be provided with a thermostat maintaining the oil temperature at the correct level.

4.5.3 In addition to the thermostat in [4.5.2], each oil heater is to be provided with a temperature limiting device without automatic reconnection, and with the sensing device installed as close as possible to the heating elements and permanently submerged in the liquid.

4.6 Water heaters

4.6.1 Water heaters are to be provided with a thermostat and safety temperature limiter.

SECTION 11 LOCATION

1 General

1.1 Location

1.1.1 The degree of protection of the enclosures and the environmental categories of the equipment are to be appropriate to the spaces or areas in which they are located; see Sec 3, Tab 1, Sec 3, Tab 3 and Sec 2, [5.2.2].

1.2 Areas with a risk of explosion

1.2.1 Except where the installation of equipment for explosive gas atmosphere is provided for by the Rules, electrical equipment is not to be installed where flammable gases or vapours are liable to accumulate; see Sec 3, [10].

2 Main electrical system

2.1 Location in relation to the emergency system

2.1.1 The arrangement of the emergency electrical system is to be such that a fire or other casualty in spaces containing the emergency source of electrical power, associated converting equipment, if any, the emergency switchboard and the emergency lighting switchboard will not render inoperative the main electric lighting system and the other primary essential services.

2.2 Main switchboard

2.2.1 Main switchboards, lighting distribution boards, transformers and converting equipment are to be so placed relative to their associated generator(s) so that, as far as practicable, the integrity of the main system of supply is affected only by a fire or other casualty in one space. Switchboards are to be located, as close as practicable to their associated generators.

2.2.2 An environmental enclosure for a 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 switchboards from generators.

3 Emergency electrical system

3.1 Spaces for the emergency source

3.1.1 The emergency source of electrical power, associated transforming equipment, if any, transitional source of emergency power, emergency switchboard and emergency lighting switchboard shall be located above the uppermost continuous deck and shall be readily accessible from the open deck.

They shall not be located forward of the collision bulkhead.

3.1.2 The spaces containing the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency electrical power and the emergency switchboard are not to be contiguous to the boundaries of machinery spaces of Category A or those spaces containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard.

Where this is not practicable, the contiguous boundaries are to be Class A60.

3.2 Location in relation to the main electrical system

3.2.1 The location of the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency power, the emergency switchboard and the emergency lighting switchboard in relation to the main source of electrical power, associated transforming equipment, if any, and the main switchboard shall be such as to ensure to the satisfaction of the Society that a fire or other casualty in the space containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard or in any machinery space of Category A will not interfere with the supply, control and distribution of emergency electrical power.

3.2.2 The arrangement of the main electrical system is to be such that a fire or other casualty in spaces containing the main source of electrical power, associated converting equipment, if any, the main switchboard and the main lighting switchboard will not render inoperative the emergency electric lighting system and the other emergency services other than those located within the spaces where the fire or casualty has occurred.

3.3 Emergency switchboard

3.3.1 The emergency switchboard shall be installed as near as is practicable to the emergency source of electrical power.

3.3.2 Where the emergency source of electrical power is a generator, the emergency switchboard shall be located in the same space unless the operation of the emergency switchboard would thereby be impaired.

3.4 Emergency battery

3.4.1 No accumulator battery fitted in accordance with the provisions of Sec 3, [2.3] shall be installed in the same space as the emergency switchboard.

4 Distribution boards

4.1 Distribution boards for cargo spaces and similar spaces

4.1.1 Distribution boards containing multipole switches for the control of power and lighting circuits in bunkers and cargo spaces are to be situated outside such spaces.

4.2 Distribution board for navigation lights

4.2.1 The distribution board for navigation lights is to be placed in an accessible position on the bridge.

5 Cable runs

5.1 General

5.1.1 Cable runs are to be selected so as to be as far as practicable accessible, with the exception of single cables, situated behind walls or ceilings constructed of incombustible materials, supplying lighting fittings and socket-outlets in accommodation spaces, or cables enclosed in pipes or conduits for installation purposes.

5.1.2 Cable runs are to be selected so as to avoid action from condensed moisture and from dripping of liquids.

5.1.3 Connection and draw boxes are to be accessible.

5.1.4 Cables are generally not to be installed across expansion joints. Where this is unavoidable, however, a loop of cable of length proportional to the expansion of the joint is to be provided (see Sec 12, [7.2.2]).

5.2 Location of cables in relation to the risk of fire and overheating

5.2.1 Cables and wiring serving essential or emergency power, lighting, internal communications or signals are, so far as is practicable, to be routed clear of galleys, laundries, machinery spaces of Category A and their casings and other high fire risk areas, except for supplying equipment in those spaces.

5.2.2 When it is essential that a circuit functions for some time during a fire and it is unavoidable to carry the cable for such a circuit through a high fire risk area (e.g. cables connecting fire pumps to the emergency switchboard), the cable is to be of a fire-resistant type or adequately protected against direct exposure to fire.

5.2.3 Main cable runs (see Note 1) and cables for the supply and control of essential services are, as far as is practicable, to be kept away from machinery parts having an increased fire risk (see Note 2) unless:

- the cables have to be connected to the subject equipment,
- the cables are protected by a steel bulkhead or deck, or
- the cables in that area are of the fire-resisting type.

Note 1: Main cable runs are for example:

- cable runs from generators and propulsion motors to main and emergency switchboards
- cable runs directly above or below main and emergency switchboards, centralised motor starter panels, section boards and centralised control panels for propulsion and essential auxiliaries.

Note 2: Machinery, machinery parts or equipment handling combustibles are considered to present an increased fire risk.

5.2.4 Cables and wiring serving essential or emergency power, lighting, internal communications or signals are to be arranged, as far as practicable, 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.

5.2.5 Cables are to be arranged as remote as possible from sources of heat such as hot pipes, resistors, etc. Where installation of cables near heat sources cannot be avoided, and where there is consequently a risk of damage to the cables by heat, suitable shields are to be installed, or other precautions to avoid overheating are to be taken, for example use of ventilation, heat insulation materials or special heat-resisting cables.

5.3 Location of cables in relation to electromagnetic interference

5.3.1 For the installation of cables in the vicinity of radio equipment or of cables belonging to electronic control and monitoring systems, steps are to be taken in order to limit the effects of unwanted electromagnetic interference (see Ch 3, Sec 5).

5.4 Services with a duplicate feeder

5.4.1 Duplicated supplies and associated control cables for essential services (e.g. steering gear circuits) are to follow different routes which are to be as far apart as practicable, separated both vertically and horizontally.

5.5 Emergency circuits

5.5.1 Cables supplying emergency circuits are not to run through spaces containing the main source of electrical power, associated transforming equipment, if any, the main switchboard and the main lighting switchboard, except for cables supplying emergency equipment located within such spaces (see [3.2.2]).

6 Storage batteries

6.1 General

6.1.1 Batteries are to be located where they are not exposed to excessive heat, extreme cold, spray, steam or other conditions which would impair performance or accelerate deterioration. They are to be installed in such a way that no damage may be caused to surrounding appliances by the vapours generated.

6.1.2 Storage batteries are to be suitably housed, and compartments (rooms, lockers or boxes) used primarily for their accommodation are to be properly constructed and efficiently ventilated so as to prevent accumulation of flammable gas.

6.1.3 Starter batteries are to be located as close as practicable to the engine or engines served.

6.1.4 Accumulator batteries shall not be located in sleeping quarters except where hermetically sealed to the satisfaction of the Society.

6.1.5 Lead-acid batteries and alkaline batteries are not to be installed in the same compartment (room, locker, box), unless of valve-regulated sealed type.

6.2 Large vented batteries

6.2.1 Batteries connected to a charging device of power exceeding 2 kW, calculated from the maximum obtainable charging current and the nominal voltage of the battery (hereafter referred to as "large batteries") are to be installed in a room assigned to batteries only.

Where this is not possible, they may be arranged in a suitable locker on deck.

6.2.2 Rooms assigned to large batteries are to be provided with mechanical exhaust ventilation.

Natural ventilation may be employed for boxes located on open deck.

6.2.3 The provisions of [6.2.1] and [6.2.2] also apply to several batteries connected to charging devices of total power exceeding 2 kW calculated for each one as stated in [6.2.1].

6.3 Moderate vented batteries

6.3.1 Batteries connected to a charging device of power between 0,2 kW and 2 kW calculated as stated in [6.2.1] (hereafter referred to as "moderate batteries") are to be arranged in the same manner as large batteries or placed in a box or locker in suitable locations such as machinery spaces, storerooms or similar spaces. In machinery spaces and similar well-ventilated compartments, these batteries may be installed without a box or locker provided they are protected from falling objects, dripping water and condensation where necessary.

6.3.2 Rooms, lockers or boxes assigned to moderate batteries are to be provided with natural ventilation or mechanical exhaust ventilation, except for batteries installed without a box or locker (located open) in well-ventilated spaces.

6.3.3 The provisions of [6.3.1] and [6.3.2] also apply to several batteries connected to charging devices of total power between 0,2 kW and 2 kW calculated for each one as stated in [6.2.1].

6.4 Small vented batteries

6.4.1 Batteries connected to a charging device of power less than 0,2 kW calculated as stated in [6.2.1] (hereafter referred to as "small batteries") are to be arranged in the same manner as moderate or large batteries, or without a box or locker, provided they are protected from falling objects, or in a box in a ventilated area.

6.4.2 Boxes for small batteries may be ventilated only by means of openings near the top to permit escape of gas.

6.5 Ventilation

6.5.1 The ventilation of battery compartments is to be independent of ventilation systems for other spaces.

6.5.2 The quantity of air expelled (by natural or forced ventilation) for compartments containing vented type batteries is to be at least equal to:

$$Q = 110 \cdot I \cdot n$$

where:

Q : Quantity of air expelled, in litres per hour

I : Maximum current delivered by the charging equipment during gas formation, but not less than one quarter of the maximum obtainable charging current in amperes

n : Number of cells in series.

6.5.3 The quantity of air expelled (by natural or forced ventilation) for compartments containing valve-regulated sealed batteries is to be at least 25% of that given in [6.5.2].

6.5.4 Ducts are to be made of a corrosion-resisting material or their interior surfaces are to be painted with corrosion-resistant paint.

6.5.5 Adequate air inlets (whether connected to ducts or not) are to be provided near the floor of battery rooms or the bottom of lockers or boxes (except for that of small batteries).

Air inlet may be from the open air or from another space (for example from machinery spaces).

6.5.6 Exhaust ducts of natural ventilation systems:

a) are to be run directly from the top of the compartment to the open air above (they may terminate in the open or in well-ventilated spaces)

b) are to terminate not less than 90 cm above the top of the battery compartment

c) are to have no part more than 45° from the vertical

d) are not to contain appliances (for example for barring flames) which may impede the free passage of air or gas mixtures.

Where natural ventilation is impracticable or insufficient, mechanical exhaust ventilation is to be provided.

6.5.7 In mechanical exhaust ventilation systems:

a) electric motors are to be outside the exhaust ducts and battery compartment and are to be of safe type if installed within 3 m from the exhaust of the ventilation duct

b) fans are to be so constructed and of a material such as to render sparking impossible in the event of the impeller touching the fan casing

c) steel or aluminium impellers are not to be used

d) the system is to be interlocked with the charging device so that the battery cannot be charged without ventilation (trickle charge may be maintained)

e) a temperature sensor is to be located in the battery compartment to monitor the correct behaviour of the battery in cases where the battery element is sensitive to temperature.

6.5.8 For natural ventilation systems for deck boxes:

a) holes for air inlet are to be provided on at least two opposite sides of the box

b) the exhaust duct is to be of ample dimensions

c) the duct is to terminate at least 1,25 m above the box in a goose-neck or mushroom-head or the equivalent

d) the degree of protection is to be in accordance with Sec 3, Tab 1.

SECTION 12 INSTALLATION

1 General

1.1 Protection against injury or damage caused by electrical equipment

1.1.1 All electrical equipment is to be so installed as not to cause injury when handled or touched in the normal manner.

1.1.2 All electrical equipment is to be installed in such a way that live parts cannot be inadvertently touched, unless supplied at a safety voltage.

1.1.3 For protective earthing as a precaution against indirect contact, see [2].

1.1.4 Equipment is to be installed so as not to cause malfunctions due to electromagnetic interference.

1.2 Protection against damage to electrical equipment

1.2.1 Electrical equipment is to be so placed that as far as practicable it is not exposed to risk of damage from water, steam, oil or oil vapours.

1.2.2 The air supply for internal ventilation of electrical equipment is to be as clean and dry as practicable; cooling air for internal ventilation is not to be drawn from below the floor plates in engine and/or boiler rooms.

1.2.3 Equipment is to be so mounted that its enclosing arrangements and the functioning of the built-in equipment will not be affected by distortions, vibrations and movements of the ship's structure or by other damage liable to occur.

1.2.4 If electrical fittings, not of aluminium, are attached to aluminium, suitable provision is to be made to prevent galvanic corrosion.

1.3 Accessibility

1.3.1 Equipment is to be so installed that sufficient space is available for inspection and maintenance as required for all its parts (see [6.1.3]).

2 Earthing of non-current carrying parts

2.1 Parts which are to be earthed

2.1.1 Exposed metal parts of both fixed and portable electrical machines or equipment which are not intended to be live but which are liable under fault conditions to become live and similar metal parts inside non-metallic enclosures are to be earthed unless the machines or equipment are:

a) supplied at a voltage not exceeding 50 V direct current or 50 V, root mean square between conductors, achieved without the use of auto-transformers (safety voltage); or

b) constructed in accordance with the principle of double insulation.

2.1.2 To minimise shock from high frequency voltage induced by the radio transmitter, handles, handrails and other metal elements on the bridge or open decks are to be in electrical connection with the hull or superstructures.

2.2 Methods of earthing

2.2.1 Metal frames or enclosures of apparatus and electrical machinery may be fixed to, and in metallic contact with, the ship's structure, provided that the surfaces in contact are clean and free from rust, scale or paint when installed and are firmly bolted together.

2.2.2 For metal frames or enclosures which are not earthed as specified in [2.2.1], earthing connections complying with [2.3] and [2.4] are to be used.

2.2.3 For requirements regarding the earthing of coverings of cables and the mechanical protection of cables, see [7.11] and [7.12].

2.3 Earthing connections

2.3.1 Every earthing connection is to be of copper or other corrosion-resistant material and is to be securely installed and protected, where necessary, against damage and electrolytic corrosion.

2.3.2 The nominal cross-sectional area of each copper earthing connection is to be not less than that required in Tab 1.

Earthing connections of other metals are to have conductance at least equal to that specified for a copper earthing connection.

Table 1 : Cross-sectional area of earth-continuity conductors and earthing connections

<table>
<tr><td colspan="2">Type of earthing connection</td><td>Cross-sectional area of associated current carrying conductor</td><td colspan="2">Minimum cross-sectional area of copper earthing connection</td></tr>
<tr><td>1</td><td>Earth-continuity conductor in flexible cable or flexible cord</td><td>any</td><td colspan="2">Same as current carrying conductor up to and including 16 mm^2 and one half above 16 mm^2 but at least 16 mm^2</td></tr>
<tr><td>2</td><td>Earth-continuity conductor incorporated in fixed cable</td><td>any</td><td colspan="2">a) for cables having an insulated earth-continuity conductor
• a cross-section equal to the main conductors up to and including 16 mm^2, but minimum 1,5 mm^2
• a cross-section not less than 50% of the cross-section of the main conductor when the latter is more than 16 mm^2, but at least 16 mm^2
b) for cables with a bare earth wire in direct contact with the lead sheath</td></tr>
<tr><td></td><td></td><td></td><td>Cross-section of main conductor mm^2</td><td>Earthing connection mm^2</td></tr>
<tr><td></td><td></td><td></td><td>1 ÷ 2,5
4 ÷ 6</td><td>1
1,5</td></tr>
<tr><td>3</td><td>Separate fixed earthing conductor</td><td>≤ 2,5 mm^2</td><td colspan="2">Same as current carrying conductor subject to minimum of 1,5 mm^2 for stranded earthing connection or 2,5 mm^2 for unstranded earthing connection</td></tr>
<tr><td></td><td></td><td>> 2,5 mm^2 but ≤ 120 mm^2</td><td colspan="2">One half the cross-sectional area of the current carrying conductor, subjected to a minimum of 4 mm^2</td></tr>
<tr><td></td><td></td><td>> 120 mm^2</td><td colspan="2">70 mm^2</td></tr>
</table>

2.3.3 Metal parts of portable appliances are to be earthed, where required (see [2.1.1]), by means of an earth-continuity conductor in the flexible supply cable or cord, which has the cross-sectional area specified in Tab 1 and which is earthed, for example, through the associated plug and socket.

2.3.4 The lead sheathing or armour of cables is never to be relied upon as the sole means of earthing.

2.4 Connection to the ship's structure

2.4.1 Every connection of an earth-continuity conductor or earthing lead to the ship's structure is to be secured by means of a screw of brass or other corrosion-resistant material of diameter not less than 6 mm.

2.4.2 Such earthing connection is not to be used for other purposes.

2.4.3 The connection described in [2.4.1] is to be located in an accessible position where it may readily be checked.

2.5 Earthed distribution systems

2.5.1 The system earthing of earthed distribution systems is to be effected by means independent of any earthing arrangements of non-current carrying parts and is to be connected to the hull at one point only

2.5.2 In an earthed distribution system in which the earthing connection does not normally carry current, this connection is to conform with the requirements of [2.3], except that the lower limit of 70 mm^2 (see Tab 1) does not apply.

2.5.3 The earthing connection is to be in an accessible position where it may readily be inspected and disconnected for insulation testing.

2.6 Aluminium superstructures

2.6.1 When aluminium superstructures are insulated from the steel hull to prevent electrolytic corrosion, they are to be secured to the hull by means of a separate bonding connection.

2.6.2 The connections are to be adequately close together and are to have a resistance less than 0.1 Ω.

2.6.3 The connections are to be located where they may readily be inspected.

3 Rotating machines

3.1 General

3.1.1 Every rotating machine is preferably to be installed with the shaft in the fore-and-aft direction. Where a rotating machine of 100 kW and over is installed athwartship, or vertically, it is to be ensured that the design of the bearings and the arrangements for lubrication are satisfactory to withstand the rolling specified in Sec 2, Tab 4.

4 Semiconductor convertors

4.1 Semiconductor power convertors

4.1.1 Naturally air-cooled semiconductor convertors are to be installed such that the circulation of air to and from the stacks or enclosures is not impeded and that the temperature of the cooling inlet air to convertor stacks does not exceed the ambient temperature for which the stacks are specified.

5 Vented type storage batteries

5.1 General

5.1.1 Batteries are to be arranged so that each cell or crate of cells is accessible from the top and at least one side to permit replacement and periodical maintenance.

5.1.2 Cells or crates are to be carried on insulating supports of material non-absorbent to the electrolyte (e.g. treated wood).

5.1.3 Cells are to be securely chocked by means of insulating material non-absorbent to the electrolyte, e.g. strips of treated wood. Special mechanical precautions are to be taken to prevent the emergency battery from being damaged by the shock.

5.1.4 Provision is to be made for the free circulation of air.

5.2 Protection against corrosion

5.2.1 The interior of battery compartments (rooms, lockers, boxes) including all metal parts subject to the electrolyte is to be protected against the deteriorating effect of the latter by electrolyte-resistant coating or other equivalent means, unless corrosion-resistant materials are used.

5.2.2 Interior surfaces of metal shelves for battery cells, whether or not grouped in crates or trays, are to be protected by a lining of electrolyte-resistant material, watertight and carried up to at least 75 mm on all sides. In particular, linings are to have a minimum thickness of 1,5 mm, if of lead sheet for lead-acid batteries, and of 0,8 mm, if of steel for alkaline batteries.

Alternatively, the floor of the room or locker is to be lined as specified above to a height of at least 150 mm.

5.2.3 Battery boxes are to be lined in accordance with [5.2.2] to a height of at least 75 mm.

6 Switchgear and controlgear assemblies

6.1 Main switchboard

6.1.1 A main switchboard is to be so arranged as to give easy access as may be needed to apparatus and equipment, without danger to personnel.

6.1.2 An unobstructed space is to be left in front of the switchboard wide enough to allow access for operation; such width is generally about 1 metre.

When withdrawable equipment is contained in the switchboard, the width of the space is to be not less than 0,5 m when the equipment is fully withdrawn.

Reduced widths may be considered for small ships.

6.1.3 Where necessary, an unobstructed space is to be provided at the rear of the switchboard ample to permit maintenance; in general, the width of this passage is to be not less than 0,6 m, except that this may be reduced to 0,5 m in way of stiffeners and frames, and the height sufficient for the operation foreseen.

6.1.4 If necessary, the clear height above the switchboard specified by the manufacturer is to be maintained for pressure relief in the event of a short-circuit.

6.1.5 When the voltage exceeds the safety voltage, non-conducting mats or gratings are to be provided at the front and rear of the switchboard as necessary,

6.1.6 Piping and conduits are not to be installed in the same space of main switchboards.

Where this is unavoidable, pipes and conduits are to have welded joints only or to be provided with protection against spray from steam or pressurised liquids or dripping.

Alternatively the degree of protection of the switchboard is to be adequately increased.

6.2 Emergency switchboard

6.2.1 For the installation of the emergency switchboard, the same requirements apply as given in [6.1] for the installation of the main switchboard.

6.3 Section boards and distribution boards

6.3.1 For the installation of section and distribution boards, the same requirements apply, as far as applicable, as given in [6.1] for the installation of the main switchboard.

6.3.2 Piping and conduits are not to be installed directly above boards, electrical panels and consoles or in their vicinity.

7 Cables

7.1 General

7.1.1 Cables having insulating materials with different maximum permissible conductor temperatures are not to be bunched together.

Where this is not practicable, the cables are to be so installed that no cable reaches a temperature higher than its rating.

7.1.2 Cables having a protective covering which may damage the covering of more vulnerable cables are not to be bunched with the latter.

7.1.3 Cables having a bare metallic sheath (e.g. of copper) or braid or armour are to be installed in such a way that galvanic corrosion by contact with other metals is prevented.

7.1.4 All cables and wiring external to equipment are to be so installed as not to impair their original flame-retarding properties.

To this end, the following methods may be used:

a) the use of cables which have been tested in accordance with IEC Publication 60332-3 Category A or an equivalent test procedure for cables installed in bunches, or

b) the use of fire stops having at least B0 penetrations fitted as follows (see Fig 1, Fig 2, Fig 3 and Fig 4):
   - cable entries at the main and emergency switchboard
   - where cables enter engine control rooms
   - cable entries at centralised control panels for propulsion machinery and essential auxiliaries
   - at each end of totally enclosed cable trunks
   - at every second deck or approximately 6 metres for verticals runs and every 14 metres for horizontal runs in enclosed and semi-enclosed spaces

c) the use of fire protection coating applied to at least 1 metre in every 14 metres on horizontal cable runs and over the entire length of vertical cable runs for cables installed in enclosed and semi-enclosed spaces.

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 trunks.

These precautions apply in particular to bunches of 5 or more cables in areas with a high fire risk (such as Category A machinery spaces, galleys etc.) and to bunches of more than 10 cables in other areas.

7.2 Radius of bend

7.2.1 The internal radius of bend for the installation of cables is to be chosen according to the type of cable as recommended by the manufacturer.

Its value is generally to be not less than the figure given in Tab 2.

7.2.2 Where the installation of cables across expansion joints is unavoidable, the minimum internal radius of the loop at the end of the travel of the expansion joint is to be not less than 12 times the external diameter of the cable.

Figure 1 : Totally enclosed trunks

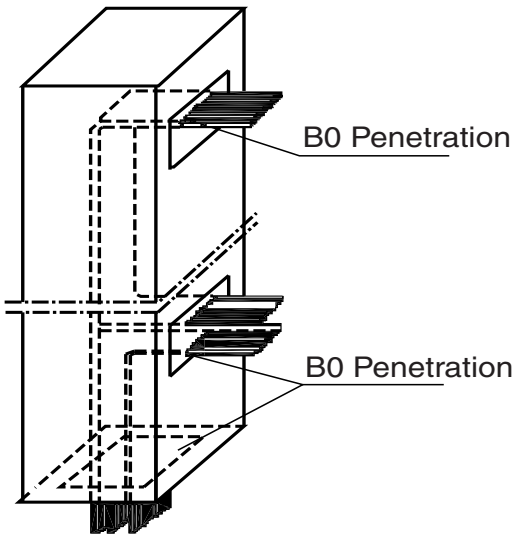


Table 2 : Bending radii

Cable construction		Overall diameter of cable (D)	Minimum internal radius of bend
Insulation	Outer covering		
Thermoplastic or thermosetting with circular copper conductors	Unarmoured or unbraided	≤ 25 mm	4 D
		> 25 mm	6 D
	Metal braid screened or armoured	Any	6 D
	Metal wire armoured Metal tape armoured or metal-sheathed	Any	6 D
	Composite polyester/metal laminate tape screened units or collective tape screening	Any	8 D
Thermoplastic or thermosetting with shaped copper conductors	Any	Any	8 D

Figure 2 : Non-totally enclosed trunks, vertical

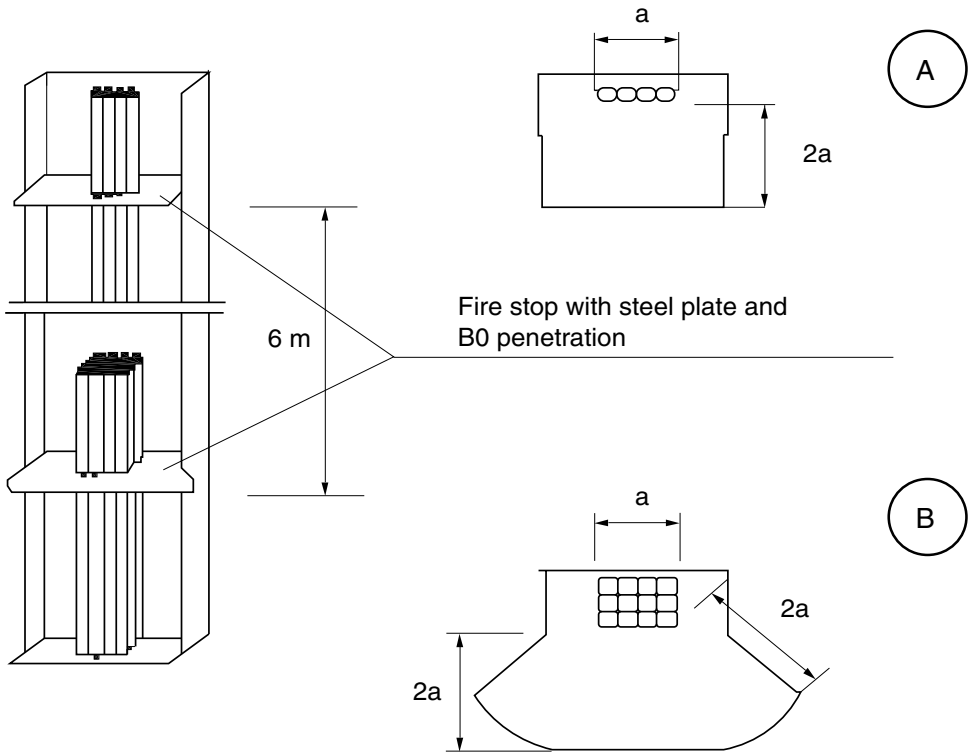


Figure 3 : Non-totally enclosed trunks, horizontal

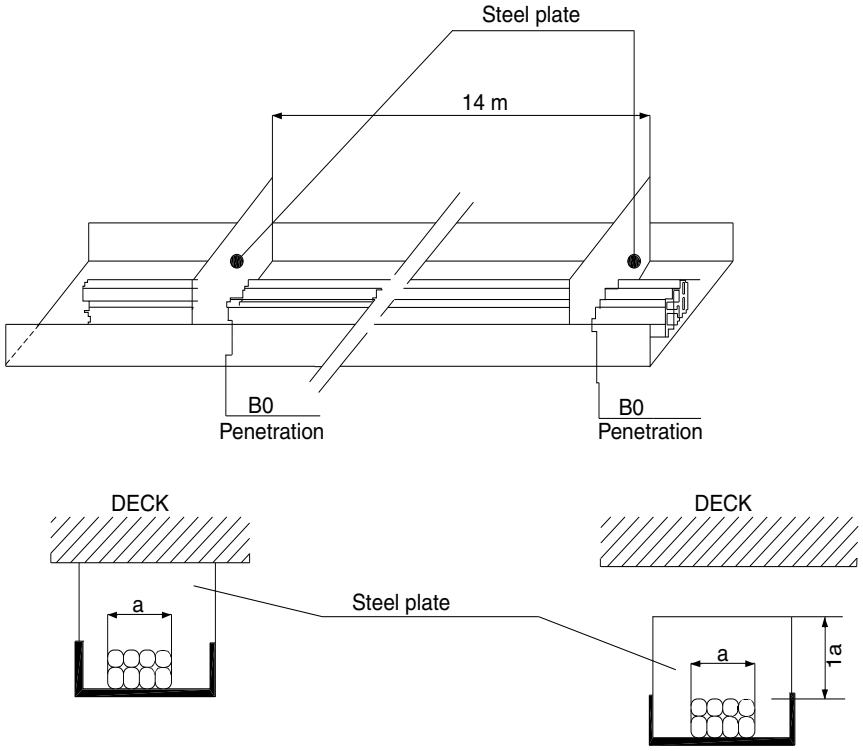
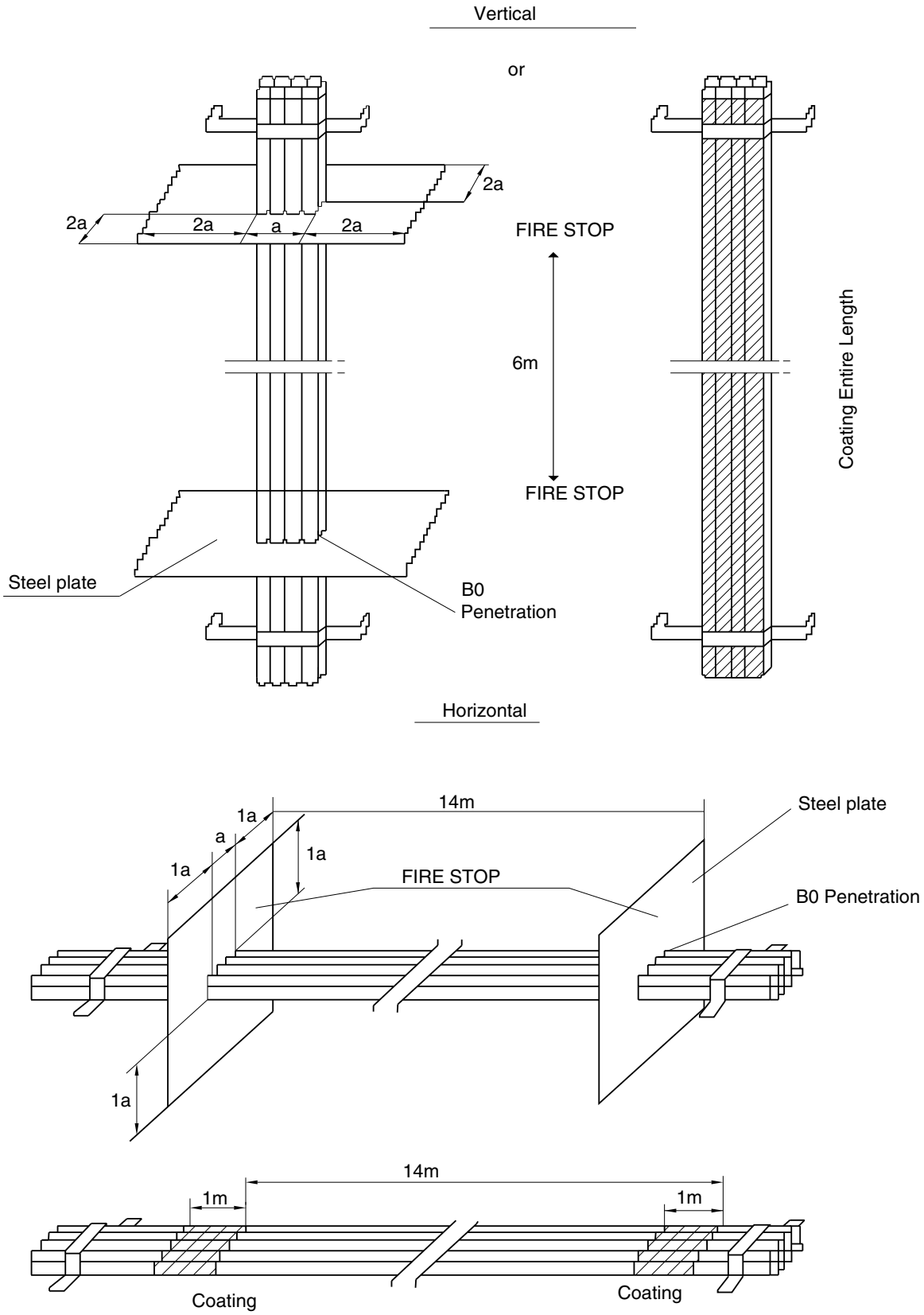


Figure 4 : Open cables runs



7.3 Fixing of cables

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

7.3.2 The supports (tray plates, separate support brackets or hanger ladders) and the corresponding accessories are to be of robust construction and of corrosion-resistant material or suitably treated before erection to resist corrosion.

When cables are installed directly on aluminium structures, fixing devices of aluminium or suitably treated steel are to be used.

7.3.3 With the exception of cables installed in pipes, conduits, trunkings or special casings, cables are to be fixed by means of clips, saddles or straps of suitable material, in order to tighten the cables without their coverings being damaged.

7.3.4 Cable clips or straps made from a material other than metal are to be manufactured of a flame-retardant material.

7.3.5 The distances between fastenings and between supports are to be suitably chosen according to the type and number of cables and the probability of vibration.

7.3.6 When cables are fixed by means of clips or straps made from a material other than metal and these cables are not laid on top of horizontal cable supports (e.g. in the case of vertical installation), suitable metal clips or saddles spaced not more than 1 metre apart are to be used in addition in order to prevent the release of cables during a fire.

7.3.7 Suspended cables of fire-resisting type are to be fixed by means of steel straps spaced not more than 500 mm apart.

7.4 Mechanical protection

7.4.1 Cables exposed to risk of mechanical damage are to be protected by metal casing, profiles or grids or enclosed in metal pipes or conduits, unless the cable covering (e.g. armour or sheath) provides adequate mechanical protection.

7.4.2 In situations where there would be an exceptional risk of mechanical damage, cables are to be protected by metal casing, trunkings or conduits, even when armoured, if the ship's structure or attached parts do not afford sufficient protection for the cables.

7.4.3 For the protection of cables passing through decks, see [7.5.3].

7.4.4 Metal casing used for mechanical protection of cables is to be effectively protected against corrosion.

7.5 Penetrations of bulkheads and decks

7.5.1 If cables have to pass without adequate support through non-watertight bulkheads and generally through holes drilled in sheets of structural steel, these holes are to be fitted with glands or bushings of suitable material.

7.5.2

If cables have to pass through a watertight bulkhead or deck, the penetration is to be effected in a watertight manner.

Either suitable individual watertight glands for single cables or boxes containing several cables and filled with a flame-retardant packing may be used for this purpose. Whichever type of penetration is used, the watertight integrity of the bulkheads or deck is to be maintained. Cable penetrations are to be type approved.

7.5.3 Cables passing through decks and continuing vertically are to be protected against mechanical damage to a suitable height above the deck.

7.5.4 Where cables pass through bulkheads or decks separating areas with a risk of explosion, arrangements are to be such that hazardous gas or dust cannot penetrate through openings for the passage of cables into other areas.

7.5.5 Where cables pass through a bulkhead or deck which is required to have some degree of fire integrity, penetration is to be so effected as to ensure that the required degree of fire integrity is not impaired.

7.6 Expansion joints

7.6.1 If there is reason to fear that a tray plate, pipe or conduit may break because of the motion of the ship, different load conditions and temperature variations, appropriate expansion joints are to be provided.

This may apply in particular in the case of cable runs on the weather deck.

7.7 Cables in closed pipes or conduits

7.7.1 Closed pipes or conduits are to have such internal dimensions and radius of bend as will permit the easy drawing in and out of the cables which they are to contain; the internal radius of bend is to be not less than that permitted for cables and, for pipes exceeding 63 mm external diameter, not less than twice the external diameter of the pipe where this value is greater.

7.7.2 Closed pipes and conduits are to be suitably smooth on the interior and are to have their ends shaped or bushed in such a way as not to damage the cable covering.

7.7.3 The space factor (ratio of the sum of the cross-sectional areas corresponding to the external diameters of the cables to the internal cross-sectional areas of the pipe or conduit) is to be not greater than 0,4.

7.7.4 If necessary, openings are to be provided at the highest and lowest points so as to permit air circulation and ensure that the heat from the cables can be dissipated, and to obviate the possibility of water accumulating at any part of the pipe or conduit.

7.7.5 Vertical trunking for electrical cables is to be so constructed as not to jeopardise the required passive fire protection between the spaces.

7.7.6 Metal pipes or conduits are to be protected against corrosion.

7.7.7 Non-metallic pipes or conduits are to be flame-retardant.

7.8 Cables in casings or trunking and conduits with removable covers

7.8.1 Covers are to be removable and when they are open, cables are to be accessible.

7.8.2 Materials used are to comply with [7.7.6] and [7.7.7].

7.8.3 If the fixing of covers is by means of screws, the latter are to be of non-rusting material and arranged so as not to damage the cables.

7.8.4 Means are to be provided to ensure that the heat from the cables can be dissipated and water accumulation is avoided (see [7.7.4]).

7.9 Cable ends

7.9.1 Terminations in all conductors are to be so made as to retain the original electrical, mechanical, flame-retarding properties of the cable.

7.9.2 Where mechanical clamps are not used, the ends of all conductors having a cross-sectional area greater than 4 mm^2 are to be fitted with soldering sockets or compression-type sockets of sufficient size to contain all the strands of the conductor.

7.10 Joints and tappings (branch circuit)

7.10.1 Cable are not to include joints. Where absolutely necessary, cable joints are to be carried out by a junction method approved by the Society in agreement with the Naval Authority, with rebuilding of the insulation and protective coverings.

7.10.2 Joints in all conductors are to be so made as to retain the original electrical (continuity and isolation), mechanical (strength and protection), flame-retarding and, where necessary, fire-resisting properties of the cable.

7.10.3 Tappings (branch circuits) are to be made via suitable connections or in suitable boxes of such design that the conductors remain adequately insulated and protected from atmospheric action and are fitted with terminals or busbars of dimensions appropriate to the current rating.

7.10.4 Cables for safety voltages are not to terminate in the same connection boxes as cable for higher voltages unless separated by suitable means.

7.11 Earthing and continuity of metal coverings of cables

7.11.1 All metal coverings of cables are to be electrically connected to the metal hull of the ship.

7.11.2 Metal coverings are generally to be earthed at both ends of the cable, except for [7.11.3] and [7.11.4].

7.11.3 Single-point earthing is admitted for final sub-circuits (at the supply end), except for those circuits located in areas with a risk of explosion.

7.11.4 Earthing is to be at one end only in those installations (intrinsically safe circuits, control circuits, etc.) where it is required for technical or safety reasons.

7.11.5 Metal coverings of single-core a.c. cables and special d.c. cables with high "ripple" content (e.g. for thyristor equipment) are to be earthed at one point only (e.g. at the mid-point).

7.11.6 The electrical continuity of all metal coverings of cables throughout the length of the latter, particularly at joints and tappings, is to be ensured.

7.11.7 The metal covering of cables may be earthed by means of glands intended for the purpose and so designed as to ensure an effective earth connection.

The glands are to be firmly attached to, and in effective electrical contact with, a metal structure earthed in accordance with these requirements.

7.11.8 The metal covering of cables may also be earthed by means of clamps or clips of corrosion-resistant material making effective contact with the covering and earthed metal.

7.12 Earthing and continuity of metal pipes, conduits and trunking or casings

7.12.1 Metal casings, pipes, conduits and trunking are to be effectively earthed.

7.12.2 Pipes or conduits may be earthed by being screwed into a metal enclosure, or by nuts on both sides of the wall of a metallic enclosure, provided the surfaces in contact are clean and free from rust, scale or paint and that the enclosure is in accordance with these requirements on earthing.

The connection is to be painted immediately after assembly in order to inhibit corrosion.

7.12.3 Pipes and conduits may be earthed by means of clamps or clips of corrosion-resistant metal making effective contact with the earthed metal.

7.12.4 Pipes, conduits or trunking together with connection boxes of metallic material are to be electrically continuous.

7.12.5 All joints in metal pipes and conduits used for earth continuity are to be soundly made and protected, where necessary, against corrosion.

7.13 Precautions for single-core cables for a.c.

7.13.1 For the earthing of metal coverings see [7.11.5].

7.13.2 Where it is necessary to use single-core cables for alternating current circuits rated in excess of 20 A, the

requirements of [7.13.3] to [7.13.7] are to be complied with.

7.13.3 Conductors belonging to the same circuit are to be contained within the same pipe, conduit or trunking, unless this is of non-magnetic material.

7.13.4 Cable clips are to include cables of all phases of a circuit unless the clips are of non-magnetic material.

7.13.5 In the installation of two, three or four single-core cables forming respectively single-phase circuits, three-phase circuits, or three-phase and neutral circuits, the cables are to be in contact with one another, as far as possible. In any event, the distance between the external covering of two adjacent cables is to be not greater than one diameter.

7.13.6 When single-core cables having a current rating greater than 250 A are installed near a steel bulkhead, the clearance between the cables and the bulkhead is to be at least 50 mm, unless the cables belonging to the same circuit are installed in trefoil twisted formation.

7.13.7 Magnetic material is not to be used between single-core cables of a group. Where cables pass through steel plates, all the conductors of the same circuit are to pass through a plate or gland, so made that there is no magnetic material between the cables, and the clearance between the cables and the magnetic material is to be no less than 75 mm, unless the cables belonging to the same circuit are installed in trefoil twisted formation.

7.14 Cables in refrigerated spaces

7.14.1 For the types of cables permitted in refrigerated spaces, see Sec 3, [9.4].

7.14.2 Power cables installed in refrigerated spaces are not to be covered by thermal insulation. Moreover, such cables are not to be placed directly on the face of the refrigerated space unless they have a thermoplastic or elastomeric extruded.

7.14.3 Power cables entering a refrigerated space are to pass through the walls and thermal insulation at right angles, in tubes sealed at each end and protected against oxidation.

7.15 Cables in areas with a risk of explosion

7.15.1 For the types of cables permitted in areas with a risk of explosion, see Sec 3, [10.2].

7.15.2 For penetration of bulkheads or decks separating areas with a risk of explosion, see [7.5.4].

7.15.3 Cables of intrinsically safe circuits are to be separated from the cables of all other circuits (minimum 50 mm).

7.16 Cables in the vicinity of radio equipment

7.16.1 All cables between antennas and transmitters are to be routed separately of any other cable.

7.16.2 Where it is necessary to use single-core cables, the arrangement of conductors is to be such as to avoid complete or partial loops.

7.17 Cables for submerged bilge pumps

7.17.1 See Sec 3, [9.7].

8 Various appliances

8.1 Lighting fittings

8.1.1 Lighting fittings are to be so arranged as to prevent temperature rises which could damage the cables and wiring.

Note 1: Where the temperature of terminals of lighting fittings exceeds the maximum conductor temperature permitted for the supplied cable (see Sec 3, [9.9]), special installation arrangements, such as terminal boxes thermally insulated from the light source, are to be provided.

8.1.2 Lighting fittings are to be so arranged as to prevent surrounding material from becoming excessively hot.

8.1.3 Lighting fittings are to be secured in place such that they cannot be displaced by the motion of the vessel.

8.2 Heating appliances

8.2.1 Space heaters are to be so installed that clothing, bedding and other flammable material cannot come in contact with them in such a manner as to cause risk of fire.

Note 1: To this end, for example, hooks or other devices for hanging garments are not to be fitted above space heaters or, where appropriate, a perforated plate of incombustible material is to be mounted above each heater, slanted to prevent hanging anything on the heater itself.

8.2.2 Space heaters are to be so installed that there is no risk of excessive heating of the bulkheads or decks on which or next to which they are mounted.

8.2.3 Combustible materials in the vicinity of space heaters are to be protected by suitable incombustible and thermal-insulating materials.

8.3 Heating cables and tapes or other heating elements

8.3.1 Heating cables and tapes or other heating elements are not to be installed in contact with combustible materials.

Where they are installed close to such materials, they are to be separated by means of a non-flammable material.

SECTION 13 HIGH VOLTAGE INSTALLATIONS

1 General

1.1 Field of application

1.1.1 The following requirements apply to a.c. three-phase systems with nominal voltage exceeding 1kV, the nominal voltage being the voltage between phases.

If not otherwise stated herein, construction and installation applicable to low voltage equipment generally apply to high voltage equipment.

1.2 Nominal system voltage

1.2.1 The nominal system voltage is not to exceed 15 kV.

Note 1: Where necessary for special application, higher voltages may be accepted by the Society.

1.3 High-voltage, low-voltage segregation

1.3.1 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.

2 System Design

2.1 Distribution

2.1.1 Network configuration for continuity of ship services

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.

2.1.2 Earthed neutral systems

In the event of an 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.

It is to be assured that at least one source neutral to ground connection is available whenever the system is in the energised mode. Electrical equipment in directly earthed neutral or other neutral earthed systems is to withstand the current due to a single phase fault against earth for the time necessary to trip the protection device.

2.1.3 Neutral disconnection

Means of disconnection are to be fitted in the neutral earthing connection of each generator so that the generator may be disconnected for maintenance and for insulation resistance measurement.

2.1.4 Hull connection of earthing impedance

All earthing impedances are to be connected to the hull. The connection to the hull is to be so arranged that any circulating currents in the earth connections do not interfere with radio, radar, communication and control equipment circuits.

2.1.5 Divided systems

In systems with neutral earthed, connection of the neutral to the hull is to be provided for each section.

2.1.6 Means of disconnection are to be fitted in the star point connected to earth of each alternator before the resistor so that the alternator may be disconnected for maintenance and insulation resistance measurement.

2.1.7 All earthing resistors are to be connected to the hull. In order to eliminate possible interference with radio, radar and communication systems, it is recommended that earthing resistors should be bonded together on the hull side of the resistors by means of bonding independent of that provided by the hull.

2.1.8 Alternators running in parallel may have a common neutral connection to earth provided they are suitably designed to avoid excessive circulating currents.

This is particularly important if the alternators are of different size and make. Alternators in which the third harmonic content does not exceed 5% may be considered adequate.

Note 1: This would mostly occur with a neutral bus with a single grounding resistor with the associated neutral switching. Where individual resistors are used, circulation of the third harmonic currents between paralleled alternators is minimised.

2.1.9 In systems with earthed neutral, resistors or other current-limiting devices for the connection of the neutrals to the hull are to be provided for each section in which the systems are split [2.1.2].

2.2 Degrees of protection

2.2.1 General

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 Sec 3, Tab 1 or, in case of ships with **MMI-STD** additional class notation assigned, the requirements of Pt E, Ch 4, Sec 5, Tab 2.

2.2.2 Rotating machines

The degree of protection of enclosures of rotating electrical machines is to be at least the one required by IP 23 (see Sec 3).

The degree of protection of terminals is to be at least IP44.

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.

2.2.3 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, see [8.1].

2.2.4 Switchgear, controlgear assemblies and convertors

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 convertors installed in spaces accessible to unqualified personnel, a degree of protection of at least IP4X is required.

2.3 Insulation

2.3.1 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 Tab 1.

Intermediate values may be accepted for nominal voltages provided that the next highest air clearance is observed.

In the case of smaller distances, an appropriate voltage impulse test is to be applied.

Table 1 : Minimum clearances

Rated voltage, in kV	Minimum clearance, in mm
3 - 3,3	55
6 - 6,6	90
10 - 11	120
15	160

2.3.2 Creepage distances between live parts and between live parts and earthed metal parts for standard components are to be in accordance with relevant IEC Publications for the nominal voltage of the system, the nature of the insulation material and the transient overvoltage developed by switch and fault conditions.

For non-standardised parts within the busbar section of a switchgear assembly, the minimum creepage distance is to be at least 25 mm/kV and behind current limiting devices, 16mm/kV.

2.4 Protection

2.4.1 Faults on the generator side of the circuit breaker

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 devices are to trip the generator circuit breaker and to automatically de-excite the generator.

In distribution systems with a neutral earthed, phase to earth faults are also to be treated as above.

2.4.2 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 automatically disconnect the faulty circuits. In high impedance earthed systems, where outgoing feeders will not be isolated in case of an earth fault, the insulation of the equipment is to be designed for the phase to phase voltage.

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.

Note 1: 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 $1/3^{1/2}$ and 1.

2.4.3 Power transformers

Power transformers are to be provided with overload and short circuit protection.

When transformers are connected in parallel, tripping of the protective devices on the primary side is to automatically trip the switch connected on the secondary side.

2.4.4 Voltage transformers for control and instrumentation

Voltage transformers are to be provided with overload and short circuit protection on the secondary side.

2.4.5 Fuses

Fuses are not to be used for overload protection.

2.4.6 Low voltage systems

Lower voltage systems supplied through transformers from high voltage systems are to be protected against overvoltages. This may be achieved by:

a) direct earthing of the lower voltage system

b) appropriate neutral voltage limiters

c) earthed screen between the primary and secondary windings of transformers.

3 Rotating machinery

3.1 Stator windings of generators

3.1.1 Generator stator windings are to have all phase ends brought out for the installation of the differential protection.

3.2 Temperature detectors

3.2.1 Rotating machinery is to be provided with temperature detectors in its stator windings to actuate a visual and audible alarm in a normally attended position whenever the temperature exceeds the permissible limit.

If embedded temperature detectors are used, means are to be provided to protect the circuit against overvoltage.

3.3 Tests

3.3.1 In addition to the tests normally required for rotating machinery, a high frequency high voltage test in accordance with IEC 60034-15 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.

4 Power Transformers

4.1 General

4.1.1 Transformers are to be of dry type according to IEC 60726.

5 Cables

5.1 General

5.1.1 Cables are to be constructed in accordance with IEC 60092-353 and 60092-354 or other equivalent Standard.

6 Fuses

6.1 General

6.1.1 *(1/1/2017)*

Fuses are to be constructed in accordance with IEC Publication 60282-1 or other equivalent Standard.

7 Switchgear and controlgear assemblies

7.1 General

7.1.1 Switchgear and controlgear assemblies are to be constructed according to IEC Publication 62271-200 and the following additional requirements.

7.2 Construction

7.2.1 Mechanical construction

Switchgear is to be of metal - enclosed type in accordance with IEC 62271-200 or of the insulation - enclosed type in accordance with IEC 60466.

7.2.2 Locking facilities

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.

7.2.3 Shutters

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.

7.2.4 Earthing and short-circuiting

For maintenance purposes an adequate number of earthing and short-circuiting devices is to be provided to enable circuits to be worked on in safety.

7.3 Auxiliary systems

7.3.1 Source of supply

If electrical energy and/or physical energy is required for the operation of circuit breakers and switches, a store supply of such energy is to be provided for at least two operations of all the components.

However, the tripping due to overload or short-circuit, and under-voltage is to be independent of any stored electrical energy sources. This does not preclude shunt tripping provided that alarms are activated upon lack of continuity in the release circuits and power supply failures.

7.3.2 Number of supply sources

At least two independent sources of supply for auxiliary circuits of each independent section of the system (see [2.1.1]) are to be provided. Where necessary one source of supply is to be from the emergency source of electrical power for the start up from dead ship condition.

7.4 High voltage test

7.4.1 A power-frequency voltage test is to be carried out on any switchgear and controlgear assemblies. The test procedure and voltages are to be according to IEC 62271-200.

8 Installation

8.1 Electrical equipment

8.1.1 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.

At the entrance to spaces where high-voltage electrical equipment is installed, a suitable marking is to be placed indicating danger of high-voltage. As regards high-voltage electrical equipment installed outside the aforementioned spaces, similar marking is to be provided.

8.2 Cables

8.2.1 Runs of cables

In accommodation spaces, high voltage cables are to be run in enclosed cable transit systems.

8.2.2 Segregation

High voltage cables are to be segregated from cables operating at different voltage ratings; in particular, they are not to be run in the same cable bunch, 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 in [2.3.1]. However, high voltage cables are not to be installed on the same cable tray for cables operating at the nominal system voltage of 1 kV and less.

8.2.3 Installation arrangements

High voltage cables are generally to be installed on carrier plating 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.

8.2.4 Terminations

Terminations in all conductors of high voltage cables are, as far as practicable, to be 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).

8.2.5 Marking

High voltage cables are to be readily identifiable by suitable marking.

8.2.6 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 completed cable and its accessories.

The test is to be carried out after an insulation resistance test.

When a d.c. voltage withstand test is carried out, the voltage is to be not less than:

- 1.6 (2.5 Uo + 2kV) for cables of rated voltage (Uo) up to and including 3,6 kV, or
- 4.2 Uo for higher rated voltages

where Uo is the rated power frequency voltage between conductor and earth or metallic screen, for which the cable is designed.

The test voltage is to be maintained for a minimum of 15 minutes.

After completion of the test the conductors are to be connected to earth for a sufficient period in order to remove any trapped electric charge.

An insultation resistance test is then repeated.

Alternatively, an a.c. voltage withstand test may be carried out on the advice of the high voltage cable manufacturer at a voltage not less than the normal operating voltage of the cable, to be maintained for a minimum of 24 hours.

Note 1: Tests specified in IEC 60502 will be considered adequate.

SECTION 14 ELECTRIC PROPULSION PLANT

1 General

1.1 Applicable requirements

1.1.1 The following requirements apply to ships for which the main propulsion plants are provided by at least one electric propulsion motor and its electrical supply. All electrical components of the propulsion plants are to comply with these requirements.

1.1.2 Prime movers are to comply with the requirements of Ch 1, Sec 2.

1.1.3 For the torsional vibration characteristics of the electric propulsion plant, the provisions of Ch 1, Sec 9 apply.

1.1.4 Cooling and lubricating oil systems are to comply with the requirements of Ch 1, Sec 10.

1.1.5 Monitoring and control systems are to comply with the requirements of Chapter 3.

1.1.6 Installations assigned an additional notation for automation are to comply with the requirements of Part E, Chapter 2.

1.2 Operating conditions

1.2.1 The normal torque available on the electric propulsion motors for manoeuvring is to be such as to enable the vessel to be stopped or reversed when sailing at its maximum service speed.

1.2.2 Adequate torque margin is to be provided for three-phase synchronous motors to avoid the motor pulling out of synchronism during rough weather and when turning.

1.2.3 When an electric generating plant has a continuous rating greater than the electric propulsion motor rating, means are to be provided to limit the continuous input to the motor. This value is not to exceed the continuous full load torque for which motor and shafts are designed.

1.2.4 The plant as a whole is to have sufficient overload capacity to provide the torque, power and reactive power needed during starting and manoeuvring conditions.

Locked rotor torque which may be required in relation to the operation of the vessel (e.g. for navigation in ice) is to be considered.

1.2.5 The electric motors and shaftline are to be constructed and installed so that, at any speed reached in service, all the moving components are suitably balanced.

2 Design of the propulsion plant

2.1 General

2.1.1 The electrical power for the propulsion system may be supplied from generating sets, dedicated to the propulsion system, or from a central power generation plant, which supplies the ship's services and electric propulsion.

The minimum configuration of an electric propulsion plant consists of one prime mover, one generator and one electric motor. When the electrical production used for propulsion is independent of the shipboard production, the diesel engines driving the electric generators are to be considered as main engines.

2.1.2 For plants having only one propulsion motor controlled via a static convertor, a standby convertor which it is easy to switch over to is to be provided. Double stator windings with one convertor for each winding are considered as an alternative solution.

2.1.3 In electric propulsion plants having two or more constant voltage propulsion generating sets, the electrical power for the ship's auxiliary services may be derived from this source. Additional ship's generators for auxiliary services need not be fitted provided that effective propulsion and the services mentioned in Sec 3, [2.2.3] are maintained with any one generating set out of service.

Where transformers are used to supply the ship's auxiliary services, see Sec 5.

2.1.4 Plants having two or more propulsion generators, two or more static convertors or two or more motors on one propeller shaft are to be so arranged that any unit may be taken out of service and disconnected electrically, without affecting the operation of the others.

2.2 Power supply

2.2.1 Where the plant is intended exclusively for electric propulsion, voltage variations and maximum voltage are to be maintained within the limits required in Sec 2.

2.2.2 In special conditions (e.g. during crash-stop manoeuvres), frequency variations may exceed the limits stipulated in Sec 2 provided that other equipment operating on the same network is not unduly affected.

2.2.3 The electric plant is to be so designed as to prevent the harmful effects of electromagnetic interference generated by semiconductor convertors, in accordance with Sec 2.

2.3 Auxiliary machinery

2.3.1 Propeller/thruster auxiliary plants are to be supplied directly from the main switchboard or from the main distribution board or from a distribution board reserved for such circuits, at the auxiliary rated voltage.

2.3.2 When the installation has one or more lubrication systems, devices are to be provided to ensure the monitoring of the lubricating oil return temperature.

2.3.3 Propelling machinery installations with a forced lubrication system are to be provided with alarm devices which will operate in the event of oil pressure loss.

2.4 Electrical Protection

2.4.1 Automatic disconnections of electric propulsion plants which adversely affect the manoeuvrability of the ship are to be restricted to faults liable to cause severe damage to the equipment.

2.4.2 The following protection of convertors is to be provided:

- protection against overvoltage in the supply systems to which convertors are connected
- protection against overcurrents in semiconductor elements during normal operation
- short-circuit protection.

2.4.3 Overcurrent protective devices in the main circuits are to be set sufficiently high so that there is no possibility of activation due to the overcurrents caused in the course of normal operation, e.g. during manoeuvring or in heavy seas.

2.4.4 Overcurrent protection may be replaced by automatic control systems ensuring that overcurrents do not reach values which may endanger the plant, e.g. by selective tripping or rapid reduction of the magnetic fluxes of the generators and motors.

2.4.5 In the case of propulsion plants supplied by generators in parallel, suitable controls are to ensure that, if one or more generators are disconnected, those remaining are not overloaded by the propulsion motors.

2.4.6 In three-phase systems, phase-balance protective devices are to be provided for the motor circuit which de-excite the generators and motors or disconnect the circuit concerned.

2.5 Excitation of electric propulsion motor

2.5.1 Each propulsion motor is to have its own exciter.

2.5.2 For plants where only one generator or only one motor is foreseen, each machine is to be provided with a standby exciter, which it is easy to switch over to.

2.5.3 In the case of multi-propeller propulsion ships, one standby exciter which it is easy to switch over to is to be provided.

2.5.4 For the protection of field windings and cables, means are to be provided for limiting the induced voltage when the field circuits are opened. Alternatively, the induced voltage when the field circuits are opened is to be maintained at the nominal design voltage.

2.5.5 In excitation circuits, there is to be no overload protection causing the opening of the circuit, except for excitation circuits with semiconductor convertors.

3 Construction of rotating machines and semiconductor convertors

3.1 Ventilation

3.1.1 Where electrical machines are fitted with an integrated fan and are to be operated at speeds below the rated speed with full load torque, full load current, full load excitation or the like, the design temperature rise is not to be exceeded.

3.1.2 Where electrical machines or convertors are force-ventilated, at least two fans, or other suitable arrangements, are to be provided so that limited operation is possible in the event of one fan failing.

3.2 Protection against moisture and condensate

3.2.1 Machines and equipment which may be subject to the accumulation of moisture and condensate are to be provided with effective means of heating. The latter is to be provided for motors above 500 kW, in order to maintain the temperature inside the machine at about 3°C above the ambient temperature.

3.2.2 Provision is to be made to prevent the accumulation of bilge water, which is likely to enter inside the machine.

3.3 Rotating machines

3.3.1 Electrical machines are to be able to withstand the excess speed which may occur during operation of the ship.

3.3.2 The design of rotating machines supplied by static convertors is to consider the effects of harmonics.

3.3.3 The winding insulation of electrical machines is to be capable of withstanding the overvoltage which may occur in manoeuvring conditions.

3.3.4 The design of a.c. machines is to be such that they can withstand without damage a sudden short-circuit at their terminals under rated operating conditions.

3.3.5 The obtainable current and voltage of exciters and their supply are to be suitable for the output required during manoeuvring and overcurrent conditions, including short-circuit in the transient period.

3.4 Semiconductor convertors

3.4.1 The following limiting repetitive peak voltages U_{RM} are to be used as a base for each semiconductor valve:

- when connected to a supply specifically for propeller drives:
  $U_{RM} = 1,5\ U_P$
- when connected to a common main supply:
  $U_{RM} = 1,8\ U_P$
  where
  U_P : is the peak value of the rated voltage at the input of the semiconductor convertor.

3.4.2 For semiconductor convertor elements connected in series, the values in [3.4.1] are to be increased by 10%. Equal voltage distribution is to be ensured.

3.4.3 For parallel-connected convertor elements, an equal current distribution is to be ensured.

3.4.4 Means are to be provided, where necessary, to limit the effects of the rate of harmonics to the system and to other semiconductor convertors. Suitable filters are to be installed to keep the current and voltage within the limits given in Sec 2.

4 Control and monitoring

4.1 General

4.1.1 The control and monitoring systems, including computer based systems, are to be type approved, according to Ch 3, Sec 6.

4.2 Power plant control systems

4.2.1 The power plant control systems are to ensure that adequate propulsion power is available, by means of automatic control systems and/or manual remote control systems.

4.2.2 The automatic control systems are to be such that, in the event of a fault, the propeller speed and direction of thrust do not undergo substantial variations.

4.2.3 Failure of the power plant control system is not to cause complete loss of generated power (i.e. blackout) or loss of propulsion.

4.2.4 The loss of power plant control systems is not to cause variations in the available power; i.e. starting or stopping of generating sets is not to occur as a result.

4.2.5 Where power-aided control (for example with electrical, pneumatic or hydraulic aid) is used for manual operation, failure of such aid is not to result in interruption of power to the propeller, any such device is to be capable of purely manual operation.

4.2.6 The control system is to include the following main functions:

- monitoring of the alarms: any event critical for the proper operation of an essential auxiliary or a main element of the installation requiring immediate action to avoid a breakdown is to activate an alarm
- speed or pitch control of the propeller
- shutdown or slow down when necessary.

4.2.7 Where the electric propulsion system is supplied by the main switchboard together with the ship's services, load shedding of the non-essential services and /or power limitation of the electric propulsion is to be provided. An alarm is to be triggered in the event of power limitation or load shedding.

4.2.8 The risk of blackout due to electric propulsion operation is to be eliminated. At the request of the Society, a failure mode and effects analysis is to be carried out to demonstrate the reliability of the system.

4.3 Indicating instruments

4.3.1 In addition to the provisions of Chapter 3 of the Rules, instruments indicating consumed power and power available for propulsion are to be provided at each propulsion remote control position.

4.3.2 The instruments specified in [4.3.3]and [4.3.4] in relation to the type of plant are to be provided on the power control board or in another appropriate position.

4.3.3 The following instruments are required for each propulsion alternator:

- an ammeter on each phase, or with a selector switch to all phases
- a voltmeter with a selector switch to all phases
- a wattmeter
- a tachometer or frequency meter
- a power factor meter or a var-meter or a field ammeter for each alternator operating in parallel
- a temperature indicator for direct reading of the temperature of the stator windings, for each alternator rated above 500 kW.

4.3.4 The following instruments are required for each a.c. propulsion motor:

- an ammeter on the main circuit
- an embedded sensor for direct reading of the temperature of the stator windings, for motors rated above 500 kW
- an ammeter on the excitation circuit for each synchronous motor
- a voltmeter for the measurement of the voltage between phases of each motor supplied through a semiconductor frequency convertor.

4.3.5 Where a speed measuring system is used for control and indication, the system is to be duplicated with separate sensor circuits and separate power supply.

4.3.6 An ammeter is to be provided on the supply circuit for each propulsion semiconductor bridge.

4.4 Alarm system

4.4.1 An alarm system is to be provided, in accordance with the requirements of Chapter 3. The system is to give an indication at the control positions when the parameters specified in [4.4] assume abnormal values or any event occurs which can affect the electric propulsion.

4.4.2 Where an alarm system is provided for other essential equipment or installations, the alarms in [4.4.1] may be connected to such system.

4.4.3 Critical alarms for propulsion are to be indicated to the bridge separately.

4.4.4 The following alarms are to be provided, where applicable:

- high temperature of the cooling air of machines and semiconductor convertors provided with forced ventilation (see Note 1)
- reduced flow of primary and secondary coolants of machines and semiconductor convertors having a closed cooling system with a heat exchanger
- leakage of coolant inside the enclosure of machines and semiconductor convertors with liquid-air heat exchangers
- high winding temperature of generators and propulsion motors, where required (see [4.3])
- low lubricating oil pressure of bearings for machines with forced oil lubrication
- tripping of protective devices against overvoltages in semiconductor convertors (critical alarm)
- tripping of protection on filter circuits to limit the disturbances due to semiconductor convertors
- tripping of protective devices against overcurrents up to and including short-circuit in semiconductor convertors (critical alarm)
- voltage unbalance of three-phase a.c. systems supplied by semiconductor frequency convertors
- earth fault for the main propulsion circuit (see Note 2)
- earth fault for excitation circuits of propulsion machines (see Note 3).

Note 1: As an alternative to the air temperature of convertors or to the airflow, the supply of electrical energy to the ventilator or the temperature of the semiconductors may be monitored.

Note 2: In the case of star connected a.c. generators and motors with neutral points earthed, this device may not detect an earth fault in the entire winding of the machine.

Note 3: This may be omitted in brushless excitation systems and in the excitation circuits of machines rated up to 500 kW. In such cases, lamps, voltmeters or other means are to be provided to detect the insulation status under operating conditions.

4.5 Reduction of power

4.5.1 Power is to be automatically reduced in the following cases:

- low lubricating oil pressure of bearings of propulsion generators and motors
- high winding temperature of propulsion generators and motors
- fan failure in machines and convertors provided with forced ventilation, or failure of cooling system
- lack of coolant in machines and semiconductor convertors
- load limitation of generators or inadequate available power.

4.5.2 When power is reduced automatically, this is to be indicated at the propulsion control position (critical alarm).

4.5.3 Switching-off of the semiconductors in the event of abnormal service operation is to be provided in accordance with the manufacturer's specification.

5 Installation

5.1 Ventilation of spaces

5.1.1 Loss of ventilation to spaces with forced air cooling is not to cause loss of propulsion. To this end, two sets of ventilation fans are to be provided, one acting as a standby unit for the other. Equivalent arrangements using several independently supplied fans may be considered.

5.2 Cable runs

5.2.1 Instrumentation and control cables are to comply with the requirements of Ch 3, Sec 5 of the Rules.

5.2.2 Where there is more than one propulsion motor, all cables for any one machine are to be run as far as is practicable away from the cables of other machines.

5.2.3 Cables which are connected to the sliprings of synchronous motors are to be suitably insulated for the voltage to which they are subjected during manoeuvring.

6 Tests

6.1 Test of rotating machines

6.1.1 The test requirements are to comply with Sec 4.

6.1.2 For rotating machines, such as synchronous generators and synchronous electric motors, of a power of more than 3 MW, a test program is to be submitted to the Society for approval.

6.1.3

In relation to the evaluation of the temperature rise, it is necessary to consider the supplementary thermal losses induced by harmonic currents in the stator winding. To this end, two methods may be used:

- direct test method, when the electric propulsion motor is being supplied by its own frequency convertor, and/or back to back arrangement according to the supplier's facility
- indirect test method as defined in App 1; in this case, a validation of the estimation of the temperature excess due to harmonics is to be documented. A justification based on a computer program calculation may be taken into consideration, provided that validation of such program is demonstrated by previous experience.

7 Specific requirements for PODs

7.1 General

7.1.1 The requirements for the structural part of a POD are specified in Pt B, Ch 9, Sec 1, [11] .

7.1.2 When used as steering manoeuvring system, the POD is to comply with the requirements of Ch 1, Sec 11.

7.2 Rotating commutators

7.2.1 As far as the electrical installation is concerned, the electric motor is supplied by a rotating commutator which rotates with the POD. The fixed part of the power transmission is connected to the ship supply, which uses the same components as a conventional propulsion system. Sliding contacts with a suitable support are used between the fixed and rotating parts.

7.2.2

Type tests are to be carried out, unless the manufacturer can produce evidence based on previous experience indicating the satisfactory performance of such equipment on board ships.

7.2.3 A test program is to be submitted to the Society for approval. It is to be to demonstrated that the power transmission and transmission of low level signals are not affected by the environmental and operational conditions prevailing on board. To this end, the following checks and tests are to be considered:

- check of the protection index (I.P.), in accordance with the location of the rotating commutator
- check of the clearances and creepage distances
- check of insulation material (according to the test procedure described in IEC Publication 60112)
- endurance test:

  After the contact pressure and rated current are set, the commutator is subjected to a rotation test. The number of rotations is evaluated taking into consideration the ship operation and speed rotation control system. The possibility of turning the POD 180° to proceed astern and 360° to return to the original position is to be considered. The commutator may be submitted to cycles comprising full or partial rotation in relation to the use of the POD as steering gear. The voltage drops and current are to be recorded.

  An overload test is to be carried out in accordance with Sec 4 (minimum 150%, 15 seconds)
- check of the behaviour of the sliprings when subjected to the vibration defined in Ch 3, Sec 6
- check of the behaviour of the sliprings, after damp heat test, as defined in Chapter 3, and possible corrosion of the moving parts and contacts

  After the damp heat test, the following are to be carried out:
- Insulation measurement resistance test. The minimum resistance is to be in accordance with Sec 4, Tab 2.
- Dielectric strength test as defined in Sec 4.

7.3 Electric motors

7.3.1 The thermal losses are dissipated by the liquid cooling of the bulb and by the internal ventilation of the POD. The justification for the evaluation of the heating balance between the sea water and air cooling is to be submitted to the Society.

Note 1: The calculation method used for the evaluation of the cooling system (mainly based on computer programs) is to be documented. The calculation method is to be justified based on the experience of the designer of the system. The results of scale model tests or other methods may be taken into consideration.

7.3.2 Means to adjust the air cooler characteristics are to be provided on board, in order to obtain an acceptable temperature rise of the windings. Such means are to be set following the dock and sea trials.

7.4 Instrumentation and associated devices

7.4.1 Means are to be provided to transmit the low level signals connected to the sensors located in the POD.

7.5 Additional tests

7.5.1 Tests of electric propulsion motors are to be carried out in accordance with Sec 4, and other tests in accordance with Ch 1, Sec 15.

7.5.2 Tests are to be performed to check the validation of the temperature rise calculation.

SECTION 15 TESTING

1 General

1.1 Rule application

1.1.1 Before a new installation, or any alteration or addition to an existing installation, is put into service, the electrical equipment is to be tested in accordance with [3], [4] and [5] to the satisfaction of the Surveyor in charge.

1.2 Insulation-testing instruments

1.2.1 Insulation resistance may be measured with an instrument applying a voltage of at least 500 V. The measurement will be taken when the deviation of the measuring device is stabilised.

Note 1: Any electronic devices present in the installation are to be disconnected prior to the test in order to prevent damage.

2 Type approved components

2.1

2.1.1 *(1/1/2017)*

The following components are to be type tested or type approved according to the requirements in the present Chapter 2 and, excluding cables, transformers, rotating machines and converters (but not the relevant electronic control equipment), according to the tests listed in Chapter 3, Sec 6, Tab 1, as far as applicable, or in accordance with [2.1.2]:

- electrical cables (internal wiring of equipment excluded)
- transformers
- electric motors
- electrical convertors
- circuit-breakers, contactors, fuses and fuse-combination units used in power and lighting distribution systems, motor and transformer circuits, and overcurrent protective devices
- sensors, alarm panels, electronic protective devices, automatic and remote control equipment, actuators, safety devices for installations intended for essential services (steering, controllable pitch propellers, propulsion machinery, etc.), electronic speed regulators for main or auxiliary engines, electronic devices for alarm, safety and control of electrical convertors for primary essential services and emergency services as defined in Chapter 2, Sec 3, [3.6.3]
- computers used for tasks essential to safety
- programmable electronic systems intended for functions which are subject to classification requirements.

2.1.2 Case by case approval based on submission of adequate documentation and execution of tests may also be granted at the discretion of the Society.

3 Insulation resistance

3.1 Lighting and power circuits

3.1.1 The insulation resistance between all insulated poles (or phases) and earth and, where practicable, between poles (or phases), is to be at least 1 MΩ in ordinary conditions.

The installation may be subdivided to any desired extent and appliances may be disconnected if initial tests give results less than that indicated above.

3.2 Internal communication circuits

3.2.1 Circuits operating at a voltage of 50 V and above are to have an insulation resistance between conductors and between each conductor and earth of at least 1 MΩ.

3.2.2 Circuits operating at voltages below 50 V are to have an insulation resistance between conductors and between each conductor and earth of at least 0,33 MΩ.

3.2.3 If necessary, any or all appliances connected to the circuit may be disconnected while the test is being conducted.

3.3 Switchboards

3.3.1 The insulation resistance between each busbar and earth and between each insulated busbar and the busbar connected to the other poles (or phases) of each main switchboard, emergency switchboard, section board, etc. is to be not less than 1 MΩ.

3.3.2 The test is to be performed before the switchboard is put into service with all circuit-breakers and switches open, all fuse-links for pilot lamps, earth fault-indicating lamps, voltmeters, etc. removed and voltage coils temporarily disconnected where otherwise damage may result.

3.4 Generators and motors

3.4.1 The insulation resistance of generators and motors, in normal working condition and with all parts in place, is to be measured and recorded.

3.4.2 The test is to be carried out with the machine hot immediately after running with normal load.

3.4.3 The insulation resistance of generator and motor connection cables, field windings and starters is to be at least 1 MΩ.

4 Earth

4.1 Electrical constructions

4.1.1 Tests are to be carried out, by visual inspection or by means of a tester, to verify that all earth-continuity conductors and earthing leads are connected to the frames of apparatus and to the hull, and that in socket-outlets having earthing contacts, these are connected to earth.

4.2 Metal-sheathed cables, metal pipes or conduits

4.2.1 Tests are to be performed, by visual inspection or by means of a tester, to verify that the metal coverings of cables and associated metal pipes, conduits, trunking and casings are electrically continuous and effectively earthed.

5 Operational tests

5.1 Generating sets and their protective devices

5.1.1 Generating sets are to be run at full rated load to verify that the following are satisfactory:

- electrical characteristics
- commutation (if any)
- lubrication
- ventilation
- noise and vibration level.

5.1.2 Suitable load variations are to be applied to verify the satisfactory operation under steady state and transient conditions (see Sec 4, [2]) of:

- voltage regulators
- speed governors.

5.1.3 Generating sets intended to operate in parallel are to be tested over a range of loading up to full load to verify that the following are satisfactory:

- parallel operation
- sharing of the active load
- sharing of the reactive load (for a.c. generators).

Synchronising devices are also to be tested.

5.1.4 The satisfactory operation of the following protective devices is to be verified:

- overspeed protection
- overcurrent protection (see Note 1)
- load-shedding devices
- any other safety devices.

For sets intended to operate in parallel, the correct operation of the following is also to be verified:

- reverse-power protection for a.c. installations (or reverse-current protection for d.c. installations)
- minimum voltage protection.

Note 1: Simulated tests may be used to carry out this check where appropriate.

5.1.5 The satisfactory operation of the emergency source of power and of the transitional source of power, when required, is to be tested. In particular, the automatic starting and the automatic connection to the emergency switchboard, in case of failure of the main source of electrical power, are to be tested.

5.2 Switchgear

5.2.1 All switchgear is to be loaded and, when found necessary by the attending Surveyor, the operation of overcurrent protective devices is to be verified (see Note 1).

Note 1: The workshop test is generally considered sufficient to ensure that such apparatus will perform as required while in operation.

5.2.2 Short-circuit tests may also be required at the discretion of the Society in order to verify the selectivity characteristics of the installation.

5.3 Consuming devices

5.3.1 Electrical equipment is to be operated under normal service conditions (though not necessarily at full load or simultaneously) to verify that it is suitable and satisfactory for its purpose.

5.3.2 Motors and their starters are to be tested under normal operating conditions to verify that the following are satisfactory:

- power
- operating characteristics
- commutation (if any)
- speed
- direction of rotation
- alignment.

5.3.3 The remote stops foreseen are to be tested.

5.3.4 Lighting fittings, heating appliances etc. are to be tested under operating conditions to verify that they are suitable and satisfactory for their purposes (with particular regard to the operation of emergency lighting).

5.4 Communication systems

5.4.1 Communication systems, order transmitters and mechanical engine-order telegraphs are to be tested to verify their suitability.

5.5 Installations in areas with a risk of explosion

5.5.1 Installations and the relevant safety certification are to be examined to ensure that they are of a type permitted in the various areas and that the integrity of the protection concept has not been impaired.

5.6 Voltage drop

5.6.1 Where it is deemed necessary by the attending Surveyor, the voltage drop is to be measured to verify that the permissible limits are not exceeded (see Sec 3, [9.11.4]).

APPENDIX 1 INDIRECT TEST METHOD FOR SYNCHRONOUS MACHINES

1 General

1.1 Test method

1.1.1

The machine is to subjected to the three separate running tests specified below (see Fig 1) when it is completed (with covers, heat exchangers, all control devices and sensors), the exciter circuit is connected to its normal supply or to a separate supply having the same characteristics, and the supply is fitted with the necessary measuring instruments:

- Test N° 1: No load test at rated voltage and current on rotor, stator winding in open circuit. The temperature rise of the stator winding depends, in such case, on the magnetic circuit losses and mechanical losses due to ventilation, where:
  - Δt_{s1} is the stator temperature rise
  - Δt_{r1} is the rotor temperature rise
- Test N° 2: Rated stator winding current with the terminals short-circuited. The temperature of the stator winding depends on the thermal Joule losses and mechanical losses, as above, where:
  - Δt_{s2} is the stator temperature rise
  - Δt_{r2} is the rotor temperature rise, which for test N° 2 is negligible
- Test N° 3: Zero excitation. The temperature of all windings depends on the mechanical losses due to friction and ventilation, where:
  - Δt_{s3} is the stator temperature rise
  - Δt_{r3} is the rotor temperature rise

Note 1: The synchronous electric motor is supplied at its rated speed by a driving motor. The temperature balance will be considered as being obtained, when the temperature rise does not vary by more than 1°C per hour.

1.1.2

Temperature measurements of the stator winding can be based on the use of embedded temperature sensors or measurement of winding resistance. When using the resistance method for calculation of the temperature rise, the resistance measurement is to be carried out as soon as the machine is shut down.

The rotor temperature rise is obtained by calculation of rotor resistance, $R_{rotor} = (U/I)_r$, where U and I are the voltage and current in the magnetic field winding.

The following parameters are recorded, every 1/2 hour:

- temperature sensors as well as the stator current and voltage
- the main field voltage and current
- the bearing temperatures (embedded sensor or thermometer), and the condition of cooling of the bearings, which are to be compared to those expected on board.

1.1.3

The tests described above allow the determination of the final temperature rise of stator and rotor windings with an acceptable degree of accuracy.

- The temperature rise of the stator winding is estimated as follows:

  $\Delta t_{stator} = \Delta t_{s1} + \Delta t_{s2} - \Delta t_{s3}$

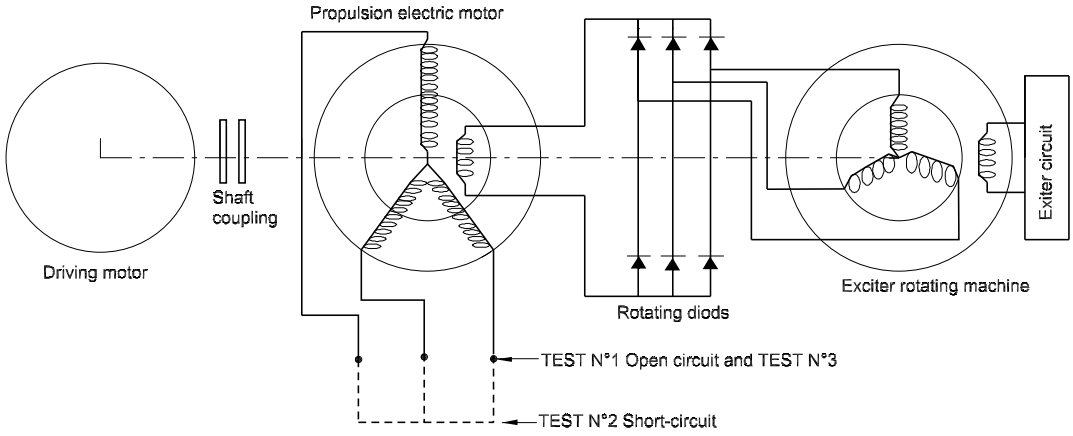
  Δt_{stator} stator winding is to be corrected by the supplementary temperature rise due to current harmonics evaluated by the manufacturer
- Considering that in test N° 1 the magnetic field winding current Irt is different from the manufacturer's estimated value Ir (due to the fact that the cos j in operation is not equal to 1), the temperature rise of the rotor is to be corrected as follows:

  $\Delta t_{rotor} = (\Delta t_{r1} - \Delta t_{r3})$ x ((rated loading conditions Ir/ test loading conditions Irt)^2 - Δt_{r3}

1.1.4

In the indirect method, a possible mutual influence of the temperature rise between the stator and the Amendments to Part C of the Rules for the classification of Naval Ships Page 50 of 100 rotor is not taken into consideration. The test results may be representative of the temperature rise on board ship, but a margin of 10 to 15°C is advisable compared with the permitted temperature of the Rules and the measure obtained during tests.

Figure 1 : Schematic diagram used for the test



Part C
Machinery, Systems and Fire Protection

Chapter 3
AUTOMATION

SECTION 1 GENERAL REQUIREMENTS

1 General

1.1 Field of application

1.1.1 The following requirements apply to automation systems, installed on all ships, intended for essential services as defined in Ch 2, Sec 1. They also apply to systems required in Chapter 1 and Chapter 2, installed on all ships.

1.1.2 This chapter is intended to avoid that failures or malfunctions of automation systems associated with essential and non-essential services cause danger to other essential services.

1.1.3 Requirements for qualified automation systems and for additional notations are specified in Part E, Chapter 2.

1.2 Regulations and standards

1.2.1 The regulations and standards applicable are those defined in Ch 2, Sec 1.

1.3 Definitions

1.3.1 Unless otherwise stated, the terms used in this chapter have the definitions laid down in Ch 2, Sec 1 or in the IEC standards. The following definitions also apply:

- Alarm indicator is an indicator which gives a visible and/or audible warning upon the appearance of one or more faults to advise the operator that his attention is required.
- Alarm system is a system intended to give a signal in the event of abnormal running condition.
- Application software is a software performing tasks specific to the actual configuration of the computer based system and supported by the basic software.
- Automatic control is the control of an operation without direct or indirect human intervention, in response to the occurrence of predetermined conditions.
- Automation systems are systems including control systems and monitoring systems.
- Basic software is the minimum software, which includes firmware and middleware, required to support the application software.
- Cold standby system is a duplicated system with a manual commutation or manual replacement of cards which are live and non-operational. The duplicated system is to be able to achieve the operation of the main system with identical performance, and be operational within 10 minutes.
- Computer based system is a system of one or more computers, associated software, peripherals and interfaces, and the computer network with its protocol.
- Control station is a group of control and monitoring devices by means of which an operator can control and verify the performance of equipment.
- Control system is a system by which an intentional action is exerted on an apparatus to attain given purposes.
- Expert system is an intelligent knowledge-based system that is designed to solve a problem with information that has been compiled using some form of human expertise.
- Fail safe is a design property of an item in which the specified failure mode is predominantly in a safe direction with regard to the safety of the ship, as a primary concern.
- Full redundant is used to describe an automation system comprising two (identical or non-identical) independent systems which perform the same function and operate simultaneously.
- Hot standby system is used to describe an automation system comprising two (identical or non-identical) independent systems which perform the same function, one of which is in operation while the other is on standby with an automatic change-over switch.
- Instrumentation is a sensor or monitoring element.
- Integrated system is a system consisting of two or more subsystems having independent functions connected by a data transmission network and operated from one or more workstations.
- Local control is control of an operation at a point on or adjacent to the controlled switching device.
- Manual control is control of an operation acting on final control devices either directly or indirectly with the aid of electrical, hydraulic or mechanical power.
- Monitoring system is a system designed to observe the correct operation of the equipment by detecting incorrect functioning (measure of variables compared with specified value).
- Safety system is a system intended to limit the consequence of failure and is activated automatically when an abnormal condition appears.
- Software is the program, procedures and associated documentation pertaining to the operation of the computer system.
- Redundancy is the existence of more than one means for performing a required function.
- Remote control is the control from a distance of apparatus by means of an electrical or other link.

1.4 General

1.4.1 The automation systems and components, as indicated in Ch 2, Sec 15, [2], are to be chosen among the list of type approved products.

They are to be approved on the basis of the applicable requirements of these Rules and in particular those stated in this Chapter.

Case by case approval may also be granted at the discretion of the Society, based on submission of adequate documentation and subject to the satisfactory outcome of any required tests.

1.4.2 Main and auxiliary machinery essential for the propulsion, control and safety of the ship shall be provided with effective means for its operation and control.

1.4.3 Control, alarm and safety systems are to be based on the fail-to-safety principle.

1.4.4 Failure of automation systems is to generate an alarm.

1.4.5 Detailed indication, alarm and safety requirements regarding automation systems for individual machinery and installations are to be found in Chapter 1.

2 Documentation

2.1 General

2.1.1 Before the actual construction is commenced, the Manufacturer, Designer or Shipbuilder is to submit to the Society the documents (plans, diagrams, specifications and calculations) requested in this Section.

The list of documents requested is to be intended as guidance for the complete set of information to be submitted, rather than an actual list of titles.

The Society 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.

Plans are to include all the data necessary for their interpretation, verification and approval.

Unless otherwise agreed with the Society, documents for approval are to be sent in triplicate if submitted by the Shipyard and in four copies if submitted by the equipment supplier. Documents requested for information are to be sent in duplicate.

In any case, the Society reserves the rights to require additional copies, when deemed necessary.

2.2 Documents to be submitted

2.2.1 The documents listed in Tab 1 are to be submitted.

Table 1 : Documentation to be submitted

N°	I/A **(1)**	Documentation
1	A	The general specification for the automation of the ship
2	A	The detailed specification of the essential service systems
3	A	The list of components used in the automation circuits, and references (Manufacturer, type, etc.)
4	I	Test procedures for control, alarm and safety systems
5	A	A general diagram showing the monitoring and/or control positions for the various installations, with an indication of the means of access and the means of communication between the positions as well as with the engineers
6	A	The diagrams of the supply circuits of automation systems, identifying the power source
7	A	The list of monitored parameters for alarm/monitoring and safety systems
(1) A = to be submitted for approval; I = to be submitted for information.		

Table 2 : Documentation to be submitted

N°	I/A **(1)**	Documentation
1	I	System description, computer software [2.3.2]
2	A	System description, computer hardware [2.3.3]
3	I	System reliability analysis [2.3.4]
4	I	User interface description [2.3.5]
5	I	Test programs [2.3.6]
(1) A = to be submitted for approval; I = to be submitted for information.		

2.3 Documents for computer based system

2.3.1 General

For computer based systems, the documents listed in Tab 2 are to be submitted.

2.3.2 System description, computer software

This documentation is to contain:

- a list of all main software modules installed per hardware unit with names and version numbers
- a description of all main software which is to include at least:
  - a description of basic software installed per hardware unit, including communication software, when applicable
  - a description of application software.

2.3.3 Description of computer hardware

The documentation to be submitted is to include:

- hardware information of importance for the application and a list of documents that apply to the system.
- the supply circuit diagram
- a description of hardware and software tools for equipment configuration
- the information to activate the system
- general information for trouble shooting and repair when the system is in operation.

2.3.4 System reliability analysis

The documentation to be submitted is to demonstrate the reliability of the system by means of appropriate analysis such as:

- a failure mode analysis describing the effects due to failures leading to the destruction of the automation system. In addition, this documentation is to show the consequences on other systems, if any. This analysis is appraised in accordance with the IEC 60812, or a recognised standard
- test report /life test
- MTBF calculation (Mean Time Between Failure)
- any other documentation demonstrating the reliability of the system.

2.3.5 User interface description

The documentation is to contain:

- a description of the functions allocated to each operator interface (keyboard/screen or equivalent)
- a description of individual screen views (schematics, colour photos, etc.)
- a description of how menus are operated (tree presentation)
- an operator manual providing necessary information for installation and use.

2.3.6 Test programs

The following test programs are to be submitted:

- software module/unit test
- software integration test
- system validation test
- on-board test.

Each test program is to include:

- a description of each test item
- a description of the acceptance criteria for each test.

2.4 Documents for type approval of equipment

2.4.1 Documents to be submitted for type approval of equipment are listed hereafter:

- a request for type approval from the manufacturer or his authorized representative
- the technical specification and drawings depicting the system, its components, characteristics, working principle, installation and conditions of use and, when there is a computer based system, the documents listed in Tab 2
- any test reports previously prepared by specialised laboratories.

3 Environmental and supply conditions

3.1 General

3.1.1 General

The automation system is to operate correctly when the power supply is within the range specified in Sec 2.

3.1.2 Environmental conditions

The automation system is to be designed to operate satisfactorily in the environment in which it is located. The environmental conditions are described in Ch 2, Sec 2.

3.1.3 Failure behavior

The automation system is to have non-critical behaviour in the event of power supply failure, faults or restoration of operating condition following a fault. If a redundant power supply is used, it must be taken from an independent source.

3.2 Power supply conditions

3.2.1 Electrical power supply

The conditions of power supply to be considered are defined in Ch 2, Sec 2.

3.2.2 Pneumatic power supply

For pneumatic equipment, the operational characteristics are to be maintained under permanent supply pressure variations of ± 20% of the rated pressure.

Detailed requirements are given in Ch 1, Sec 10.

3.2.3 Hydraulic power supply

For hydraulic equipment, the operational characteristics are to be maintained under permanent supply pressure variations of ± 20% of the rated pressure.

Detailed requirements are given in Ch 1, Sec 10.

4 Materials and construction

4.1 General

4.1.1 The choice of materials and components construction is to be made according to the environmental, shock and operating conditions in order to maintain the required function of the equipment.

4.1.2 The design location and installation of the automation system is to take into account the environmental, shock and operating conditions in order to maintain the required function of the equipment.

4.2 Type approved components

4.2.1 See Ch 2, Sec 15.

SECTION 2 DESIGN REQUIREMENTS

1 General

1.1

1.1.1 All control systems essential for the propulsion, control and safety of the ship shall be independent or designed such that failure of one system does not degrade the performance of another system.

1.1.2 Remote controlled systems are to have manual operation by local interfaces.

Failure of any part of remote control systems is not to prevent the use of the manual override.

1.1.3 Safety functions are to be independent of control and monitoring systems. As far as practicable, control and monitoring systems are also to be independent or adequately redundant.

1.1.4 Control, monitoring and safety systems are to have self-check facilities. In the event of failure, an alarm is to be activated.

In particular, failure of the power supply of the automation system is to generate an alarm.

1.1.5 When a computer based system is used for control, alarm or safety systems, it is to comply with the requirements of Sec 3.

2 Power supply of automation systems

2.1 General

2.1.1 Loss of power supplies to the automation system is to generate an alarm.

2.2 Electrical power supply

2.2.1 The power supply is to be protected against short circuit and overload for each independent automation system.

The power supply is to be isolated.

2.2.2 The capacity of the batteries ensuring continuity of power supply is to be sufficient to allow the normal operation of the alarm, control and safety system for at least half an hour.

2.2.3 Automation systems are to be continuously powered.

2.2.4 Their power sources are to be duplicated.

2.2.5 Batteries are not to be considered as power sources in respect of article [2].

3 Control systems

3.1 General

3.1.1 As far as practicable, in the case of failure, the control systems used for essential services are to remain in their last position they had before the failure or to fail in a safe condition.

3.2 Local control

3.2.1 Each system is to be able to be operated manually from a position located so as to enable visual control of operation. For detailed instrumentation for each system, refer to Chapter 1and Chapter 2.

It shall also be possible to control the auxiliary machinery, essential for the propulsion and safety of the ship, at or near the machinery concerned.

3.3 Remote control systems

3.3.1 When several control stations are provided, control of machinery is to be possible at one station at a time and a hierarchy is to be defined.

3.3.2 At each location there shall be an indicator showing which location is in control of the propulsion machinery.

3.3.3 Remote control is to be provided with the necessary instrumentation, in each control station, to allow effective control (correct function of the system, indication of control station in operation, alarm display).

3.3.4 When transferring the control location, no significant alteration of the controlled equipment is to occur. Transfer of control of the propulsion machinery and of workstation is to be protected by an audible warning and acknowledged by the receiving control location. The main control location is to be able to take control without acknowledgement.

3.4 Automatic control systems

3.4.1 Automatic starting, operational and control systems have to include provisions for manually overriding the automatic controls.

3.4.2 Automatic control is to be stable in the range of the controller in normal working conditions.

3.4.3 Automatic control is to have instrumentation to verify the correct function of the system.

4 Control of propulsion machinery

4.1 Remote control

4.1.1 The requirements mentioned in [3] are to be applied for propulsion machinery.

The highest priority of propulsion control is to be assigned to the central position nearer to the principal machinery.

4.1.2 The design of the remote control system is to be such that in case of its failure an alarm will be given.

4.1.3 Supply failure (voltage, fluid pressure, etc.) in propulsion plant remote control is to activate an alarm at the control position. In the event of remote control system failure and unless the Society considers it impracticable, the preset speed and direction of thrust are to be maintained until local control is in operation. This applies in particular in the case of loss of electric, pneumatic or hydraulic supply to the system.

4.1.4 Propulsion machinery orders from the navigation bridge are to be indicated in the main machinery control room, and at the manoeuvring platform.

4.1.5 The control are to 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. Where multiple propellers are designed to operate simultaneously, they must be controlled by one control device.

4.1.6 Indicators are to be fitted on the navigation bridge, in the main machinery control room and at the manoeuvring platform, for:

propeller speed and direction of rotation in the case of fixed pitch propellers; and

propeller speed and pitch position in the case of controllable pitch propellers.

4.1.7 The main propulsion machinery is to be provided with an emergency stopping device on the navigation bridge which is to be independent of the navigation bridge control system.

4.2 Remote control from navigating bridge

4.2.1 Where propulsion machinery is controlled from the navigating bridge, the remote control is to include an automatic device such that the number of operations to be carried out is reduced and their nature is simplified and such that control is possible in both the ahead and astern directions. Where necessary, means for preventing overload and running in critical speed ranges of the propulsion machinery is to be provided.

4.2.2 Each local control position, including partial control (e.g. local control of controllable pitch propellers or clutches) is to be provided with means of communication with each remote control position.

4.2.3 At the navigating bridge, the control of the routine manoeuvres for one line of shafting is to be performed by a single control device: a lever, a handwheel or a push-button board. However each mechanism contributing directly to the propulsion, such as the engine, clutch, automatic brake or controllable pitch propeller, is to be able to be individually controlled, either locally or at a central monitoring and control position.

4.2.4 Remote starting of the propulsion machinery is to be automatically inhibited if a condition exists which may damage the machinery, e.g. shaft turning gear engaged, drop of lubrication oil pressure or brake engaged.

4.3 Automatic control

4.3.1 The requirements in [3] are applicable. In addition, the following requirements are to be considered, if relevant.

4.3.2 Main turbine propulsion machinery and, where applicable, main internal combustion propulsion machinery and auxiliary machinery are to be provided with automatic shutoff arrangements in the case of failures such as lubricating oil supply failure which could lead rapidly to complete breakdown, serious damage or explosion.

4.3.3 The automatic control system is to be designed on a fail safe basis, and, in the event of failure, the system is to be adjusted automatically to a predetermined safe state.

4.3.4 When the remote control system of the propulsion machinery includes automatic starting, the number of automatic consecutive attempts is to be limited at a preset value of the starting air pressure permitting 3 attempts, and an alarm is to be provided, on the navigation bridge and in the machinery space.

4.3.5 Operations following any setting of the bridge control device (including reversing from the maximum ahead service speed in case of emergency) are to take place in an automatic sequence and with acceptable time intervals , as prescribed by the manufacturer.

4.3.6 For steam turbines, a slow turning device is to be provided which operates automatically if the turbine is stopped longer than admissible. Discontinuation of this automatic turning from the bridge is to be possible.

4.4 Automatic control of propulsion and manoeuvring units

4.4.1 When the power source actuating the automatic control of propelling units fails, an alarm is to be triggered. In such case, the preset direction of thrust is to be maintained long enough to allow the intervention of engineers. Failing this, minimum arrangements, such as stopping of the shaft line, are to be provided to prevent any unexpected reverse of the thrust. Such stopping may be automatic or ordered by the operator, following an appropriate indication.

4.5 Clutches

4.5.1 Where the clutch of a propulsion engine is operated electrically, pneumatically or hydraulically, an alarm is to be given at the control station in the event of loss of energy; as far as practicable, this alarm is to be triggered while it is still possible to operate the equipment.

4.5.2 Clutch control is to be fail-set.

4.6 Brakes

4.6.1 Automatic or remote controlled braking is to be possible only if:

- propulsion power has been shut off
- the turning gear is disconnected
- the shaftline speed (r.p.m.) is below the threshold stated by the builder.

5 Remote control of valves

5.1

5.1.1 The following requirements are applicable to valves whose failure could impair essential services.

5.1.2 Failure of the power supply is not to permit a valve to move to an unsafe condition.

5.1.3 An indication is to be provided at the remote control station showing the actual position of the valve or whether the valve is fully open or fully closed.

5.1.4 In case of failure of manually operated or automatic remote control systems, the local control of valves is to be possible.

5.1.5 Equipment located in places which may be flooded is to be capable of operation even if submerged.

6 Alarm system

6.1 General requirements

6.1.1 Alarms are to be visual and audible and are to be clearly distinguishable, in the ambient noise and lighting in the normal position of the personnel, from any other signals.

6.1.2 Sufficient information is to be provided for proper handling of alarms.

6.1.3 The alarm system is to be of the self-check type; failure within the alarm system, including the outside connection, is to activate an alarm. The alarm circuits are to be independent from each other. All alarm circuits are to be protected so as not to endanger each other.

6.2 Alarm functions

6.2.1 Alarm activation

Alarms are to be activated when abnormal conditions appear in the machinery, which need the intervention of personnel on duty, and on the automatic change-over, when standby machines are installed.

An existing alarm is not to prevent the indication of any further fault.

6.2.2 Acknowledgement of alarm

The acknowledgment of an alarm consists in manually silencing the audible signal and additional visual signals (e.g. rotating light signals) while leaving the visual signal on the active control station. Acknowledged alarms are to be clearly distinguishable from unacknowledged alarms. Acknowledgement should not prevent the audible signal to operate for new alarm.

Alarms are to be maintained until they are accepted and visual indications of individual alarms have to remain until the fault has been corrected, when the alarm system has to automatically reset to the normal operating condition.

Acknowledgement of alarms is only to be possible at the active control station.

Alarms, including the detection of transient faults, are to be maintained until acknowledgement of the visual indication.

Acknowledgement of visual signals is to be separate for each signal or common to a limited group of signals. Acknowledgement is only to be possible when the user has visual information on the alarm condition for the signal or all signals in a group.

6.2.3 Locking of alarms

Manual locking of separate alarms may be accepted when this is clearly indicated.

Locking of alarm and safety functions in certain operating modes (e.g. during start-up or trimming) is to be automatically disabled in other modes.

6.2.4 Time delay of alarms

It is to be possible to delay alarm activation in order to avoid false alarms due to normal transient conditions (e.g. during start-up or trimming).

6.2.5 Transfer of responsibility

Where several alarm control stations located in different spaces are provided, responsibility for alarms is not to be transferred before being acknowledged by the receiving location. Transfer of responsibility is to give an audible warning. At each control station it is to be indicated which location is in charge.

6.2.6 Alarm systems with limited number of monitored positions

For alarms with a limited number of monitored positions, relaxation to the requirements of [6.2] may be granted at judgement of the Society

7 Safety system

7.1 Design

7.1.1 System failures

A safety system is to be designed so as to limit the consequence of failures. It is to be constructed on the fail-to-safety principle.

The safety system is to be of the self-check type; as a rule, failure within the safety system, including the outside connection, is to activate an alarm.

7.2 Function

7.2.1 Safety activation

The safety system is to be activated automatically in the event of identified conditions which could lead to damage of associated machinery or systems, such that:

- normal operating conditions are restored (e.g. by the starting of the standby unit), or
- the operation of the machinery is temporarily adjusted to the prevailing abnormal conditions (e.g. by reducing the output of the associated machinery), or
- the machinery is protected, as far as possible, from critical conditions by shutting off the fuel or power supply, thereby stopping the machinery (shutdown), or appropriate shutdown.

7.2.2 Safety indication

When the safety system has been activated, it is to be possible to trace the cause of the safety action. This is to be accomplished by means of a central or local indication.

When a safety system is made inoperative by a manual override, this is to be clearly indicated at corresponding control stations.

Automatic safety actions are to activate an alarm at predefined control stations.

7.3 Shutdown

7.3.1 For shutdown systems of machinery, the following requirements are to be applied:

- when the system has stopped a machine, the latter is not to be restarted automatically before a manual reset of the safety system has been carried out
- the shutdown of the propulsion system is to be limited to those cases which could lead to serious damage, complete breakdown or explosion.

7.4 Standby systems

7.4.1 For the automatic starting system of the standby units, the following requirements are to be applied:

- faults in the electrical or mechanical system of the running machinery are not to prevent the standby machinery from being automatically started
- when a machine is on standby, ready to be automatically started, this is to be clearly indicated at its control position
- the change-over to the standby unit is to be indicated by a visual and audible alarm
- means are to be provided close to the machine, to prevent undesired automatic or remote starting (e.g. when the machine is being repaired)
- automatic starting is to be prevented as far as practicable when conditions are present which could endanger the standby machine.

7.5 Testing

7.5.1 The safety systems are to be tested in accordance with the requirements in Sec 6.

SECTION 3 PROGRAMMABLE ELECTRONIC SYSTEMS

1 Scope

1.1 General

1.1.1 *(1/1/2017)*

These Requirements apply to the use of programmable electronic systems that provide control, alarm, monitoring or safety functions which are subject to classification requirements.

Aids to navigation and loading instruments are excluded.

Note 1: For loading instrument / stability computer, IACS Rec. No. 48 may be considered.

2 Requirements applicable to programmable electronic systems

2.1 General

2.1.1 *(1/1/2017)*

Programmable electronic systems are to fulfil the requirements of the system under control for all normally anticipated operating conditions, taking into account danger to persons, environmental impact, damage to the ship as well as equipment, usability of programmable electronic systems and operability of non-computer devices and systems etc.

2.1.2 *(1/1/2017)*

When an alternative design or arrangement deviating from these requirements is proposed, an engineering analysis is required to be carried out in accordance with a relevant international or national standard acceptable to the Society; see also SOLAS Ch II-1/F, Reg. 55.

Note 1: As a failure of a category III system may lead to an accident with catastrophic severity, the use of unconventional technology for such applications will only be permitted exceptionally in cases where evidence is presented that demonstrates acceptable and reliable system performance to the satisfaction of the Society.

2.2 System categories

2.2.1 *(1/1/2017)*

Programmable electronic systems are to be assigned into three system categories as shown in Tab 1 according to the possible extent of the damage caused by a single failure within the programmable electronic systems.

Consideration is to be given to the extent of the damage directly caused by a failure, but not to any consequential damage.

Identical redundancy will not be taken into account for the assignment of a system category.

2.2.2 *(1/1/2017)*

The assignment of a programmable electronic system to the appropriate system category is to be made according to the greatest likely extent of direct damage. For examples, see Tab 2.

Note 1: Where independent effective backup or other means of averting danger is provided, system category III may be decreased by one category.

Table 1 : System categories *(1/1/2017)*

Category	Effects	System functionality
I	Those systems, failure of which will not lead to dangerous situations for human safety, safety of the vessel and/or a threat to the environment.	Monitoring function for informational / administrative tasks
II	Those systems, failure of which could eventually lead to dangerous situations for human safety, safety of the vessel and/or a threat to the environment.	• Alarm and monitoring functions • Control functions which are necessary to maintain the ship in its normal operational and habitable conditions
III	Those systems, failure of which could immediately lead to dangerous situations for human safety, safety of the vessel and/or a threat to the environment.	• Control functions for maintaining the vessel's propulsion and steering • Safety functions

Table 2 : Examples of assignment to system categories *(1/1/2017)*

Category	Examples
I	Maintenance support systems, Information and diagnostic systems
II	Alarm and monitoring equipment, Tank capacity measuring equipment, Control systems for auxiliary machinery, Main propulsion remote control systems, Fire detection systems, Fire-extinguishing systems, Bilge systems, Governors
III	Machinery protection systems/equipment, Burner control systems, Electronic fuel injection for diesel engines, Control systems for propulsion and steering, Synchronising units for switchboards
Note 1: The examples listed are not exhaustive.	

2.3 Data communication links

2.3.1 *(1/1/2017)*

These requirements apply to system categories II and III using shared data communication links to transfer data between distributed programmable electronic equipment or systems.

2.3.2 *(1/1/2017)*

Where a single component failure results in loss of data communication, means are to be provided to automatically restore data communication.

2.3.3 *(1/1/2017)*

Loss of a data communication link is not to affect the ability to operate essential services by alternative means.

2.3.4 *(1/1/2017)*

Means are to be provided to protect the integrity of data and provide timely recovery of corrupted or invalid data.

2.3.5 *(1/1/2017)*

The data communication link is to be self-checking, detecting failures on the link itself and data communication failures on nodes connected to the link. Detected failures are to initiate an alarm.

2.3.6 *(1/1/2017)*

System self-checking capabilities shall be arranged to initiate transition to the least hazardous state for the complete installation in the event of data communication failure.

2.3.7 *(1/1/2017)*

The characteristics of the data communication link shall be such as to transmit all necessary information in adequate time and such that overloading is prevented.

2.4 Additional requirements for wireless data links

2.4.1 *(1/1/2017)*

These requirements are in addition to the requirements of [2.3.1] to [2.3.7] and apply to system category II using wireless data communication links to transfer data between distributed programmable electronic equipment or systems. For system category III, the use of wireless data communication links is to be in accordance with [2.1.2].

2.4.2 *(1/1/2017)*

Functions that are required to operate continuously to provide essential services dependant on wireless data communication links shall have an alternative means of control that can be brought into action within an acceptable period of time.

2.4.3 *(1/1/2017)*

Wireless data communication is to employ recognised international wireless communication system protocols that incorporate the following:

a) Message integrity. Fault prevention, detection, diagnosis and correction so that the received message is not corrupted or altered when compared to the transmitted message;

b) Configuration and device authentication. It is only to permit connection of devices that are included in the system design;

c) Message encryption. Protection of the confidentiality and/or criticality of the data content;

d) Security management. Protection of network assets and prevention of unauthorised access to network assets.

2.4.4 *(1/1/2017)*

The wireless system is to comply with the radio frequency and power level requirements of International Telecommunications Union and flag State requirements.

Note 1: Consideration should be given to system operation in the event of Port State and local regulations that pertain to the use of radio-frequency transmission prohibiting the operation of a wireless data communication link due to frequency and power level restrictions.

2.5 Protection against modification

2.5.1 *(1/1/2017)*

Programmable electronic systems of categories II and III are to be protected against program modification by the user.

2.5.2 *(1/1/2017)*

For systems of category III, modifications of parameters by the Manufacturer are to be approved by the Society.

2.5.3 *(1/1/2017)*

Any modifications made after performance of the tests witnessed by the Society as per item 6 in Table 3 are to be documented and traceable.

3 Documentation

3.1 Documents to be submitted

3.1.1 *(1/1/2017)*

For the evaluation of programmable electronic systems of categories II and III, documents according to IEC 60092-504 paragraph 10.11 are to be submitted (see Sec 1, Tab 2).

3.1.2 *(1/1/2017)*

When an alternative design or arrangement is intended to be used, an engineering analysis is to be submitted in addition.

3.1.3 *(1/1/2017)*

For all tests required in accordance with the system category, a test plan is to be submitted and the tests are to be documented.

3.1.4 *(1/1/2017)*

Additional documentation may be required for systems of category III. The documentation is to include a description of the test methods and the required test results.

3.1.5 *(1/1/2017)*

For wireless data communication equipment, the following additional information is to be submitted:

a) Details of Manufacturer's recommended installation and maintenance practices;

b) Network plan with arrangement and type of antennas and identification of location;

c) Specification of wireless communication system protocols and management functions; see [2.4.3];

d) Details of radio frequency and power levels;

e) Evidence of type testing in accordance with Sec 6;

f) On-board test schedule; see [5.7.3].

3.1.6 *(1/1/2017)*

Documents for the evaluation of programmable electronic systems of category I are to be submitted if requested.

3.1.7 *(1/1/2017)*

Modifications are to be documented by the Manufacturer. Subsequent significant modifications to the software and hardware for system categories II and III are to be submitted for approval.

Note 1: A significant modification is a modification which influences the functionality and/or safety of the system.

4 Tests and Evidence

4.1

4.1.1 *(1/1/2017)*

Tests and evidence are to be in accordance with Tab 3. Definitions and notes relating to Tab 3 are given in item [5].

5 Definitions and notes relating to Tab 3, tests and evidence

5.1 Evidence of quality system

5.1.1 Quality plan for software *(1/1/2017)*

A plan for software lifecycle activities is to be produced which defines relevant procedures, responsibilities and system documentation, including configuration management.

5.1.2 Inspection of components (hardware only) from sub-suppliers *(1/1/2017)*

Proof that components and/or sub-assemblies conform to specification.

5.1.3 Quality control in production *(1/1/2017)*

Evidence of quality assurance measures on production.

5.1.4 Final test reports *(1/1/2017)*

Reports from testing of the finished product and documentation of the test results.

5.1.5 Traceability of software *(1/1/2017)*

Modification of program contents and data, as well as change of version is to be carried out in accordance with a procedure and is to be documented.

5.2 Hardware and software description

5.2.1 Software description *(1/1/2017)*

Software is to be described, e.g.

- Description of the basic and communication software installed in each hardware unit
- Description of application software (not program listings)
- Description of functions, performance, constraints and dependencies between modules or other components.

5.2.2 Hardware description *(1/1/2017)*

Hardware is to be described, e.g.

- System block diagram, showing the arrangement, input and output devices and interconnections
- Connection diagrams
- Details of input and output devices
- Details of power supplies.

5.2.3 Failure analysis for safety related functions only (e.g. FMEA) *(1/1/2017)*

The analysis is to be carried out using appropriate means, e.g.

- Fault tree analysis
- Risk analysis
- FMEA or FMECA

The purpose is to demonstrate that, for single failures, systems will fail to safety and that systems in operation will not be lost or degraded beyond acceptable performance criteria when specified by the Society.

Table 3 : Tests and evidence according to the system category *(1/1/2017)*

No.	Tests and evidence	System Category		
		I	II	III
1	Evidence of quality system			
	Quality plan for software		M	M
	Inspection of components (hardware only) from sub-suppliers		M	M
	Quality control in production		M	M
	Final test reports	M	M	S
	Traceability of software	M	M	S
2	Hardware and software description			
	Software description		M	S
	Hardware description		M	S
	Failure analysis for safety related functions only			S
3	Evidence of software testing			
	Evidence of software testing according to quality plan		M	S
	Analysis regarding existence and fulfilment of programming procedures for safety related functions			S
4	Hardware tests			
	Tests according to Sec 6		W	W
5	Software tests			
	Module tests		M	S
	Subsystem tests		M	S
	System test		M	S
6	Performance tests			
	Integration test		M	W
	Fault simulation		W	W
	Factory Acceptance Test (FAT)	M	W	W
7	On board test			
	Complete system test	M	W	W
	Integration test		W	W
	Operation of wireless equipment to demonstrate electromagnetic compatibility		W	W **(1)**
8	Modifications			
	Tests after modifications	M	S/W	S/W

Note 1: M = Evidence kept by the Manufacturer and submitted on request
S = Evidence checked by the Society
W = To be witnessed by the Society
(1) the level of witnessing will be determined during the assessment required by [2.1.2]

5.3 Evidence of software testing

5.3.1 Evidence of software testing according to quality plan *(1/1/2017)*

Procedures for verification and validation activities are to be established, e.g.

- Methods of testing
- Production of test programs
- Simulation.

5.3.2 Analysis regarding existence and fulfilment of programming procedures for safety related functions *(1/1/2017)*

Specific assurance methods are to be planned for verification and validation of fulfilment of requirements, e.g.

- Diverse programs
- Program analysis and testing to detect formal errors and discrepancies in the description
- Simple structure.

5.4 Hardware tests

5.4.1 *(1/1/2017)*

Testing according to Sec 6 will normally be a type approval test.

Special consideration may be given to tests witnessed and approved by another QSCS Classification Society (see Pt A, Ch 1, Sec 1, [1.2.1]).

5.5 Software tests

5.5.1 Module tests *(1/1/2017)*

Software module tests are to provide evidence that each module performs its intended function and does not perform unintended functions.

5.5.2 Subsystem tests *(1/1/2017)*

Subsystem testing is to verify that modules interact correctly to perform the intended functions and do not perform unintended functions.

5.5.3 System tests *(1/1/2017)*

System testing is to verify that subsystems interact correctly to perform the functions in accordance with specified requirements and do not perform unintended functions.

5.6 Performance tests

5.6.1 Integration tests *(1/1/2017)*

Programmable electronic system integration testing is to be carried out using satisfactorily tested system software, and as far as practicable intended system components.

5.6.2 Fault simulation *(1/1/2017)*

Faults are to be simulated as realistically as possible to demonstrate appropriate system fault detection and system response. The results of any required failure analysis are to be observed.

5.6.3 Factory Acceptance Test (FAT) *(1/1/2017)*

Factory acceptance testing is be carried out in accordance with a test program accepted by the Society. Testing is to be based on demonstrating that the system fulfils the requirements specified by the Society.

5.7 On board tests

5.7.1 Complete system test *(1/1/2017)*

Testing is to be performed on the completed system comprising actual hardware components with the final application software, in accordance with an approved test program.

5.7.2 Integration tests *(1/1/2017)*

On board testing is to verify that correct functionality has been achieved with all systems integrated.

5.7.3 Tests on radio-frequency transmission *(1/1/2017)*

For wireless data communication equipment, tests during harbour and sea trials are to be conducted to demonstrate that radio-frequency transmission does not cause failure of any equipment and does not itsself fail as a result of electromagnetic interference during expected operating conditions.

Note 1: Where electromagnetic interference caused by wireless data communication equipment is found to be causing failure of equipment required for category II or III systems, the layout and/or equipment shall be changed to prevent further failures occurring.

5.8 Modifications

5.8.1 Tests after modifications *(1/1/2017)*

Modifications to approved systems are to be announced in advance and carried out to the Society's satisfaction; see item [3.1.7].

SECTION 4 CONSTRUCTIONAL REQUIREMENTS

1 General

1.1 General

1.1.1 Automation systems are to be so constructed as:

- to withstand the environmental conditions the environmental conditions, as defined in Ch 2, Sec 2, [1], in which they operate
- to have necessary facilities for maintenance work.

1.2 Materials

1.2.1 Materials are generally to be of the flame-retardant type.

1.2.2 Connectors are to be able to withstand standard vibrations, mechanical constraints and corrosion conditions as given in Sec 6.

1.3 Component design

1.3.1 Automation components are to be designed to simplify maintenance operations. They are to be so constructed as to have:

- easy identification of failures
- easy access to replaceable parts
- easy installation and safe handling in the event of replacement of parts (plug and play principle) without impairing the operational capability of the system, as far as practicable
- facility for adjustment of set points or calibration
- test point facilities, to verify the proper operation of components.

1.3.2 Sensors fitted to tanks for flammable oil having flash point higher than 60 °C or similar installation are to be suitable for use in Zone 1.

1.4 Environmental and supply conditions

1.4.1 The environmental and supply conditions are specified in Sec 1. Specific environmental conditions are to be considered for air temperature and humidity, vibrations, corrosion from chemicals and mechanical or biological attacks.

2 Electrical and/or electronic systems

2.1 General

2.1.1 Electrical and electronic equipment is to comply with the requirements of Chapter 2 and Chapter 3.

2.1.2 A separation is to be done between any electrical components and liquids, if they are in a same enclosure. Necessary drainage will be provided where liquids are likely to leak.

2.1.3 When plug-in connectors or plug-in elements are used, their contacts are not to be exposed to excessive mechanical loads. They are to be provided with a locking device.

2.1.4 All replaceable parts are to be so arranged that it is not possible to connect them incorrectly or to use incorrect replacements. Where this not practicable, the replacement parts as well as the associated connecting devices are to be clearly identified. In particular, all connection terminals are to be properly tagged. When replacement cannot be carried out with the system on, a warning sign is to be provided.

2.1.5 Where forced cooling is installed, an alarm is to be provided in the event of failure of the cooling system.

2.1.6 The interface connection is to be so designed to receive the cables required. The cables are to be chosen according to Ch 2, Sec 3.

2.2 Electronic system

2.2.1 Printed circuit boards are to be so designed that they are properly protected against the normal aggression expected in their environment.

2.2.2 Electronic systems are to be constructed taking account of electromagnetic interferences.

Special precautions are to be taken for:

- measuring elements such as the analogue amplifier or analog/digital converter; and
- connecting different systems having different ground references.

2.2.3 The components of electronic systems (printed circuit board, electronic components) are to be clearly identifiable with reference to the relevant documentation.

2.2.4 Where adjustable set points are available, they are to be readily identifiable and suitable means are to be provided to protect them against changes due to vibrations and uncontrolled access.

2.2.5 All stages of fabrication of printed circuit boards are to be subjected to quality control. Evidence of this control is to be documented.

2.2.6 Burn-in tests or equivalent tests are to be performed.

2.2.7 The programmable components are to be clearly tagged with the program date and reference.

Components are to be protected against outside alteration when loaded.

2.3 Electrical system

2.3.1 Cables and insulated conductors used for internal wiring are to be at least of the flame-retardant type, and are to comply with the requirements in Chapter 2.

2.3.2 If specific products (e.g. oil) are likely to come into contact with wire insulation, the latter is to be resistant to such products or properly shielded from them, and to comply with the requirements in Chapter 2.

3 Automation consoles

3.1 General

3.1.1 Automation consoles are to be designed on ergonomic principles. Handrails are to be fitted for safe operation of the console.

3.2 Indicating instruments

3.2.1 The operator is to receive feed back information on the effects of his orders.

3.2.2 Indicating instruments and controls are to be arranged according to the logic of the system in control. In addition, the operating movement and the resulting movement of the indicating instrument are to be consistent with each other.

3.2.3 The instruments are to be clearly labelled. When installed in the wheelhouse, all lighted instruments of consoles are to be dimmable, where necessary.

3.3 VDU's and keyboards

3.3.1 VDU's in consoles are to be located so as to be easily readable from the normal position of the operator. The environmental lighting is not to create any reflection which makes reading difficult.

3.3.2 The keyboard is to be located to give easy access from the normal position of the operator. Special precautions are to be taken to avoid inadvertent operation of the keyboard.

SECTION 5 INSTALLATION REQUIREMENTS

1 General

1.1

1.1.1 Automation systems are to be installed taking into account:

- the maintenance requirements (test and replacement of systems or components)
- the influence of EMI. The IEC 60533 standard is to be taken as guidance
- the environmental conditions corresponding to the location in accordance with Ch 2, Sec 1 and Ch 2, Sec 3, [6].

1.1.2 Control stations are to be arranged for the convenience of the operator.

1.1.3 Automation components are to be properly fitted. Screws and nuts are to be locked, where necessary.

2 Sensors and components

2.1 General

2.1.1 The location and selection of the sensor is to be done so as to measure the actual value of the parameter. Choosing the location of the sensor, temperature, vibration, shock and EMI levels are to be taken into account. When this is not possible, the sensor is to be designed to withstand the local environment.

2.1.2 The enclosure of the sensor and the cable entry are to be appropriate to the space in which they are located.

2.1.3 Means are to be provided for testing, calibration and replacement of automation components. Such means are to be designed, as far as practicable, so as to avoid perturbation of the normal operation of the system.

2.1.4 When replacement of automation components is not possible, duplication of these components is required.

2.1.5 A tag number is to identify automation components and is to be clearly marked and attached to the component. These tag numbers are to be collected on the instrument list mentioned in Sec 1, Tab 1.

2.1.6 Electrical connections are to be arranged for easy replacement and testing of sensors and components. They are to be clearly marked.

2.1.7 Low level signal sensors are to be avoided. When installed they are to be located as close as possible to amplifiers, so as to avoid external influences. Failing this, the wiring is to be provided with suitable EMI protection and temperature correction.

2.2 Temperature elements

2.2.1 Temperature sensors, thermostats or thermometers used in fluid manifolds are to be installed in a thermowell of suitable material, to permit easy replacement and functional testing. The thermowell is not to significantly modify the response time of the whole element.

2.3 Pressure elements

2.3.1 Three-way valves or other suitable arrangements are to be installed to permit functional testing of pressure elements, such as pressure sensors, pressure switches or pressure gauges, without stopping the installation.

2.3.2 In specific applications, where high pulsations of pressure are likely to occur, a damping element, such as a capillary tube or equivalent, is to be installed.

3 Cables

3.1 Installation

3.1.1 Cables are to be installed according to the requirements in Ch 2, Sec 12, [7].

3.1.2 Suitable installation features such as screening and/or twisted pairs and/or separation between signal and other cables are to be provided in order to avoid possible interference on control and instrumentation cables.

3.1.3 Specific transmission cables (coaxial cables, twisted pairs, etc.) are to be routed in specific cable-ways and mechanically protected to avoid loss of any transmitted data. Where there is a high risk of mechanical damage, the cables are to be protected with pipes or equivalent.

3.1.4 The cable bend radius is to be in accordance with the requirements of Ch 2, Sec 12, [7.2].

For coaxial cables or fibre optic cables, whose characteristics may be modified, special precautions are to be taken according to the manufacturer's instructions.

3.2 Cable terminations

3.2.1 Cable terminations are to be arranged according to the requirements in Chapter 2. Particular attention is to be paid to the connections of cable shields. Shields are to be connected only at the sensor end when the sensor is earthed, and only at the processor end when the sensor is floating.

3.2.2 Cable terminations are to be able to withstand the identified environmental conditions (shocks, vibrations, salt mist, humidity, etc.).

3.2.3 Terminations of all special cables such as coaxial cables or fibre optic cables are to be arranged according to the manufacturer's instructions.

4 Pipes

4.1

4.1.1 For installation of piping circuits used for automation purposes, see the requirements in Ch 1, Sec 10.

4.1.2 As far as practicable, piping containing liquids is not to be installed in or adjacent to electrical enclosures (see Sec 4, [2.1.2]).

4.1.3 Hydraulic and pneumatic piping for automation systems is to be marked to indicate its function.

5 Automation consoles

5.1 General

5.1.1 Consoles or control panels are to be located so as to enable a good view of the process under control, as far as practicable. Instruments are to be clearly readable in the ambient lighting.

5.1.2 The location is to be such as to allow easy access for maintenance operations.

SECTION 6 TESTING

1 General

1.1 General

1.1.1 Automation systems are to be tested for type approval, acceptance or commissioning, when required. Tests are to be carried out under the supervision of a Surveyor of the Society.

1.1.2 The type testing conditions for electrical, control and instrumentation equipment, computers and peripherals are described in [2].

1.1.3 Automation systems are to be inspected at works, according to the requirements of [3], in order to check that the construction complies with the Rules.

1.1.4 Automation systems are to be commissioned when installed on board and prior to sea trials, to verify their performance and adaptation on site, according to [4].

2 Type approval

2.1 General

2.1.1 *(1/1/2017)*

This test specification for type approval is applicable, but not confined, to electrical, electronic and programmable Equipment intended for:

- control, monitoring, alarm and protection systems for use in ships.
- internal communication.

Note 1:

- These test requirements are harmonised with IEC 60092-504 "Electrical Installations in Ships -Part 504: Special features - Control and Instrumentation" and IEC 60533 "Electrical and electronic installations in ships - Electromagnetic compatibility". Electrical and electronic equipment on board ships, required neither by the Rules nor by International Conventions, liable to cause eletromagnetic disturbance are to be of type which fulfill the test requirements of test specification items 19 and 20 of Tab 1
- Functional test, as used in Tab 1, is a simplified test sufficient to verify that the equipment under test (EUT) has not suffered any deterioration caused by the individual environmental tests and not a complete performance test as required in item 2 of Tab 1.

2.1.2 The necessary documents to be submitted, prior to type testing, are listed in Sec 1, [2.4.1]. The type approval of automation systems refers to hardware type approval or software type approval, as applicable.

2.2 Hardware type approval

2.2.1 These tests are to demonstrate the ability of the equipment to function as intended under the specified testing conditions.

The extent of the testing, i.e. the selection and sequence of tests and the number of pieces to be tested is to be determined upon examination and evaluation of the equipment or component subject to testing giving due regard to its intended use according to the Owner spcification in agreement with the Society.

Equipment is to be tested in its normal position unless otherwise specified in the test specification.

The relevant tests are listed in Tab 1.

2.2.2 The following additional tests may be required, depending on particular manufacturing or operational conditions:

- mechanical endurance test
- temperature shock test (e.g. 12 shocks on exhaust gas temperature sensors from 20°C ± 5°C to maximum temperature of the range)
- immersion test
- oil resistance test
- shock test.

The test procedure is to be defined with the Society in each case.

Table 1 : Type tests *(1/1/2017)*

No.	Test	Procedure **(1)**	Test parameters	Other information
1	Visual inspection			• conformance to drawings, design data.
2	Performance test	Manufacturer performance test programme based upon specification and relevant Rule requirements. When the EUT is required to comply with an international performance standard, e.g. protection relays, verification of requirements in the standard are to be part of the performance testing required in this initial test and subsequent performance tests after environmental testing where required in this Tab 1.	• standard atmosphere condition • temperature: 25°C ± 10°C • relative humidity: 60% ± 30% • air pressure: 96 KPa ±10 KPa	• confirmation that operation is in accordance with the requirements specified for particular system or equipment • checking of self-monitoring features • checking of specified protection against an access to the memory • checking against effect an erroneous use of control elements in the case of computer systems
3	External power supply failure		• 3 interruptions during 5 minutes • switching- off time 30 s each case	• The time of 5 minutes may be exceeded if the equipment under test needs a longer time for start up, e.g. booting sequence • For equipment which requires booting, one additional power supply interruption during booting to be performed Verification of: • equipment behaviour upon loss and restoration of supply; • possible corruption of programme or data held in programmable electronic systems, where applicable.

<table>
<tr><th>No.</th><th>Test</th><th>Procedure (1)</th><th>Test parameters</th><th>Other information</th></tr>
<tr><td rowspan="3">4</td><td colspan="2" rowspan="2">Power supply variations
a) Electric</td><td>AC SUPPLY
<table><tr><th>Combination</th><th>Voltage variation permanent</th><th>Frequency variation permanent</th></tr><tr><td>1</td><td>+ 6%</td><td>+ 5%</td></tr><tr><td>2</td><td>+ 6%</td><td>– 5%</td></tr><tr><td>3</td><td>– 10%</td><td>– 5%</td></tr><tr><td>4</td><td>– 10%</td><td>+ 5%</td></tr><tr><td></td><td>voltage transient
1,5 s
%</td><td>frequency transient
5 s
%</td></tr><tr><td>5</td><td>+ 20%</td><td>+ 10%</td></tr><tr><td>6</td><td>– 20%</td><td>– 10%</td></tr></table></td><td rowspan="3"></td></tr>
<tr><td>DC SUPPLY
Voltage tolerance continuous: ± 10%
Voltage cyclic variation: 5%
Voltage ripple: 10%

Electric battery supply:
• +30% to –25% for equipment connected to charging battery or as determined by the charging/discharging characteristics, including ripple voltage from the charging device;
• +20% to –25% for equipment not connected to the battery during charging</td></tr>
<tr><td colspan="2">b) Pneumatic and hydraulic</td><td>Pressure: ± 20%
Duration: 15 minutes</td></tr>
<tr><td>5</td><td>Dry heat</td><td>IEC 60068-2-2</td><td>• Temperature: 55°C ± 2°C
Duration: 16 hours, or
• Temperature: 70°C ± 2°C
Duration: 16 hours (see (2))</td><td>• equipment operating during conditioning and testing
• functional test (see [2.1.1] Note 1b)) during the last hour at the test temperature
• for equipment specified for increased temperature the dry heat test is to be conducted at the agreed test temperature and duration.</td></tr>
</table>

No.	Test	Procedure **(1)**	Test parameters	Other information
6	Damp heat	IEC 60068-2-30 Test D_b	Temperature: 55°C Humidity: 95% Duration: 2 cycles 2 x (12 + 12 hours)	• measurement of insulation resistance before test • the test is to start with 25°C ± 3°C and at least 95% humidity • equipment operating during the complete first cycle and switched off during second cycle except for functional test • functional test during the first 2 hours of the first cycle at the test temperature and during the last 2 hours of the second cycle at the test temperature; duration of the second cycle can be extended due to more convenient management of the functional test • recovery at standard atmosphere conditions • insulation resistance measurements and performance test
7	Vibration	IEC 60068-2-6 Test F_c	• 2 Hz ± 3/0 Hz to 13,2 Hz – amplitude: ± 1mm • 13,2 Hz to 100 Hz – acceleration: ± 0,7 g For severe vibration conditions such as, e. g., on diesel engines, air compressors, etc.: • 2,0 Hz to 25 Hz – amplitude: ± 1,6 mm • 25 Hz to 100 Hz – acceleration: ± 4,0 g Note: More severe conditions may exist for example on exhaust manifolds or fuel oil injection systems of diesel engines. For equipment specified for increased vibration levels the vibration test is to be conducted at the agreed vibration level, frequency range and duration. Values may be required to be in these cases 40 Hz to 2000 Hz - acceleration: ± 10,0 g at 600°C,duration 90 min.	• duration in case of no resonance condition 90 minutes at 30 Hz; • duration at each resonance frequency at which Q ≥ 2 is recorded - 90 minutes; • during the vibration test, functional tests are to be carried out; • tests to be carried out in three mutually perpendicular planes; • it is recommended as a guidance that Q does not exceed 5. • where sweep test is to be carried out instead of the discrete frequency test and a number of resonant frequencies are detected close to each other, duration of the test is to be 120 min. Sweep over a restricted frequency range between 0,8 and 1,2 times the critical frequencies can be used where appropriate. Note: Critical frequency is a frequency at which the equipment being tested may exhibit: • malfunction and/or performance deterioration • mechanical resonances and/or other response effects occur, e.g. chatter

No.	Test	Procedure **(1)**	Test parameters	Other information
8	Inclination	IEC 60092-504	Static 22,5°	a) inclined to the vertical at an angle of at least 22,5° b) inclined to at least 22,5° on the other side of the vertical and in the same plane as in (a) c) inclined to the vertical at an angle of at least 22,5° in plane at right angles to that used in (a) d) inclined to at least 22,5° on the other side of the vertical and in the same plane as in (c). Note: The period of testing in each position should be sufficient to fully evaluate the behaviour of the equipment.
			Dynamic 22,5°	Using the directions defined in a) to d) above, the equipment is to be rolled to an angle of 22,5° each side of the vertical with a period of 10 seconds. The test in each direction is to be carried out for not less than 15 minutes. On ships for the carriage of liquified gases and chemicals, the emergency power supply is to remain operational with the ship flooded up to a maximum final athwart ship inclination of 30°. Note: These inclination tests are normally not required for equipment with no moving parts
9	Insulation resistance	Rated supply voltage voltage U_n(V) (V) $U_n \leq 65$ $U_n > 65$ Test voltage D.C. 2 x U_n min. 24 500	Minimum insulation resistance before test: 10 MΩ; 100 MΩ after test: 1,0 MΩ; 10 MΩ	For high voltage equipment, reference is made to Ch 2, Sec 13. • insulation resistance test is to be carried out before and after: damp heat test, cold test and salt mist test, high voltage test; • between all circuits and earth; and where appropriate • between the phases. Note: Certain components e.g. for EMC protection may be required to be disconnected for this test.

No.	Test	Procedure **(1)**	Test parameters	Other information
10	High voltage	Rated voltage U_n (V) Up to 65 66 to 250 251 to 500 501 to 690	Test voltage (V) (A.C. voltage 50 or 60Hz) 2 x U_n + 500 1500 2000 2500	For high voltage equipment, reference is made to Ch 2, Sec 13. • separate circuits are to be tested against each other and all circuits connected with each other tested against earth; • printed circuits with electronic components may be removed during the test; • period of application of the test voltage: 1 minute
11	Cold	IEC 60068-2-1	• Temperature: +5°C ± 3°C Duration: 2 hours, or • Temperature: –25°C ± 3°C Duration: 2 hours (see **(3)**)	• initial measurement of insulation resistance; • equipment not operating during conditioning and testing except for operational test; • operational test during the last hour at the test temperature; • insulation resistance measurement and the operational test after recovery
12	Salt mist	IEC 60068-2-52 Test Kb	Four spraying periods with a storage of seven days after each.	• initial measurement of insulation resistance and initial functional test • equipment not operating during conditioning • functional test on the 7th day of each storage period • insulation resistance measurement and performance test 4 to 6h after recovery (see **(4)**) • on completion of exposure, the equipment shall be examined to verify that deterioration or corrosion (if any) is superficial in nature
13	Electrostatic discharge	IEC 61000-4-2	Contact discharge: 6 kV Air discharge: 2kV, 4kV, 8 kV Interval between single discharges: 1 s. No. of pulses: 10 per polarity According to test level 3	• to simulate electrostatic discharge as may occur when persons touch the appliance • the test is to be confined to the points and surfaces that can normally be reached by the operator • performance Criterion B (see **(5)**)
14	Electromagnetic field	IEC 61000-4-3	Frequency range: 80 MHz - 2 GHz Modulation**: 80% AM at 1000Hz Field strength: 10V/m Frequency sweep rate: ≤ $1{,}5.10^{-3}$ decades/s (or 1% / 3 s) According to test level 3	• to simulate electromagnetic fields radiated by different transmitters • the test is to be confined to the appliances exposed to direct radiation by transmitters at their place of installation • performance criterion A (see **(6)**). ** If, for tests of equipment, an input signal with a modulation frequency of 1000 Hz is necessary, a modulation frequency of 400 Hz may be chosen

No.	Test	Procedure **(1)**	Test parameters	Other information
15	Conducted low frequency		A.C.: • Frequency range: rated frequency to 200th harmonic • Test voltage (rms): 10% of supply to 15th harmonic reducing to 1% at 100th harmonic and maintain this level to the 200th harmonic, min 3 V rms Max 2 W D.C.: • Frequency range: 50 Hz - 10 kHz • Test voltage (rms) :10% of supply max. 2 W	• to simulate distortions in the power supply system generated for instance, by electronic consumers and coupled in as harmonics • performance criterion A (see **(6)**) • See Figure in Notes in this Table • to keep max. 2W, the voltage of the test signal may be lower.
16	Conducted Radio Frequency	IEC 61000-4-6	AC, DC, I/O ports and signal/control lines: Frequency range: 150 kHz - 80 MHz Amplitude: 3 V rms (see **(7)**) Modulation***: 80% AM at 1000 Hz Frequency sweep range: $\leq 1{,}5.10^{-3}$ decades/s (or 1% / 3sec.) According to test level 2	• Equipment design and the choice of materials is to simulate electromagnetic fields coupled as high frequency into the test specimen via the connecting lines • performance criterion A (see **(6)**). *** If, for tests of equipment, an input signal with a modulation frequency of 1000 Hz is necessary, a modulation frequency of 400 Hz may be chosen
17	Electrical Fast Transients / Burst	IEC 61000-4-4	Single pulse time: 5ns (between 10% and 90% value) Single pulse width: 50 ns (50% value) Amplitude (peak): 2 kV line on power supply port/earth; 1 kV on I/O data control and communication ports (coupling clamp) Pulse period: 300 ms Burst duration: 15 ms Duration/polarity: 5 min According to test level 3	• arcs generated when actuating electrical contacts • interface effect occurring on the power supply, as well as at the external wiring of the test specimen • performance criterion B (see **(5)**)
18	Surge	IEC 61000-4-5	Test applicable to AC and DC power ports Open-circuit voltage: Pulse rise time: 1,2 µs ((front time) Pulse width: 50 µs (time to half value) Amplitude (peak) : 1 kV line/earth; 0,5 kV line/line Short-circuit current: Pulse rise time: 8 µs (front time) Pulse width: 20 µs (time to half value) Repetition rate: $\geq$ 1 pulse/min No of pulses: 5 per polarity Application: continuous According to test level 2	• interference generated for instance, by switching “ON” or “OFF” high power inductive consumers • test procedure in accordance with figure 10 of the standard for equipment where power and signal lines are identical • performance criterion B (see **(5)**)

No.	Test	Procedure **(1)**	Test parameters	Other information
19	Radiated Emission	CISPR 16-2-3	For equipment installed in the bridge and deck zone: Frequency range: — Quasi peak limits: 0,15 - 0,30 MHz — 80 - 52 dBµV/m 0,30 - 30 MHz — 52 - 34 dBµV/m 30 - 2000 MHz — 54 dBµV/m except for: 156 - 165 MHz — 24 dBµV/m For equipment installed in the general power distribution zone: Frequency range: — Quasi peak limits: 0,15 - 30 MHz — 80 - 50 dBµV/m 30 - 100 MHz — 60 - 54 dBµV/m 100 - 2000 MHz — 54 dBµV/m except for: 156 - 165 MHz — 24 dBµV/m	• procedure in accordance with the standard but distance 3 m between equipment and antenna • alternatively the radiation limit at a distance of 3 m from the enclosure port over the frequency 156 MHz to 165 MHz is to be 30 dB micro-V/m peak
20	Conducted Emission	CISPR 16-2-1	Test applicable to AC and DC power ports For equipment installed in the bridge and deck zone: Frequency range: — Limits: 10 - 150 kHz — 96 - 50 dBµV 150 - 350 kHz — 60 - 50 dBµV 0,35 - 30 MHz — 50 dBµV For equipment installed in the general power distribution zone: Frequency range: — Limits: 10 - 150 kHz — 120 - 69 dBµV 150 - 500 kHz — 79 dBµV 0,5 - 30 MHz — 73 dBµV	

No.	Test	Procedure **(1)**	Test parameters	Other information
21	Flame retardant	IEC 60092-101 or IEC 60695-11-5	Flame application: 5 times 15 s each Interval between each application: 15 s or one time 30 s. Test criteria based upon application. The test is performed with the EUT or housing of the EUT applying needle-flame test method.	• the burnt out or damaged part of the specimen by not more than 60mm long • no flame, no incandescence or in the event of a flame or incandescence being present, it is to extinguish itself within 30 s of the removal of the needle flame without full combustion of the test specimen • any dripping material is to extinguish itself in such a way as not to ignite a wrapping tissue. The drip height is 200 mm ± 5 mm.

(1) Column 3 indicates the testing procedure which is normally to be applied. However, equivalent testing procedure may be accepted by the Society provided that what required in the other columns is fulfilled. The latest edition of the normative reference applies.

(2) Equipment to be mounted in consoles, housing etc. together with heat dissipating power equipment are to be tested with 70°C.

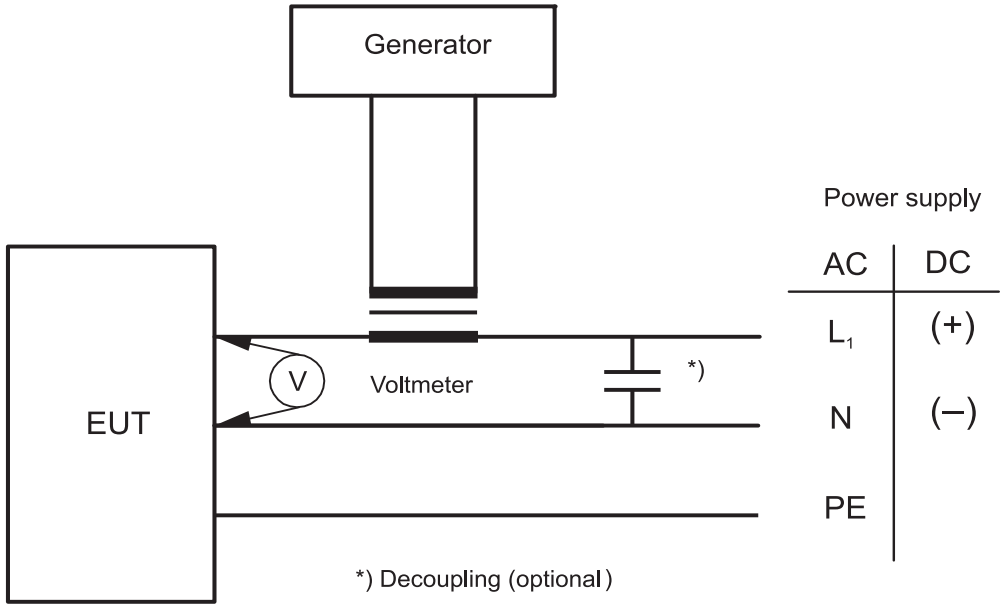
(3) For equipment installed in non-weather protected locations or cold locations test is to be carried out at –25°C.

(4) Salt mist test is to be carried out for equipment installed in weather exposed areas.

(5) Performance Criterion B: (for transient phenomena): the EUT is to continue to operate as intended after the tests. No degradation of performance or loss of function is allowed as defined in the technical specification published by the Manufacturer. During the test, degradation or loss of function or performance which is self recoverable is however allowed but no change of actual operating state or stored data is allowed.

(6) Performance Criterion A (for continuous phenomena): the Equipment Under Test is to continue to operate as intended during and after the test. No degradation of performance or loss is allowed as defined in relevant equipment standard and the technical specification published by the Manufacturer.

(7) For equipment installed on the bridge and deck zone, the test levels are to be increased to 10V rms for spot frequencies in accordance with IEC 60945 at 2; 3; 4; 6.2; 8.2; 12.6; 16.5; 18.8; 22; 25 MHz.



2.3 Software type approval

2.3.1 Software type approval consists of evaluation of the development quality and verification of test results.

Documents in accordance with Sec 1, Tab 2 are required to demonstrate the development quality.

Repetition of unit tests, integration tests or validation tests is required to verify the consistency of test results.

Certificate may be issued at the request of the manufacturer when approval is granted.

2.3.2 For computer based systems, as a guidance, the documents to be submitted for information are listed in Tab 2.

2.3.3 The software type approval applies only to basic software of the computer based system.

The basic software approval is carried out in the following phases:

- Examination of the documents as required in Sec 1, [2.3.2],
- Verification that all the development work has been carried out according to the quality procedure. The complementary documents required in Tab 2 prove the quality of the development work.

Note 1: Particular attention will be given to the test results collected on unit testing file, integration test file and validation test file

- Repetition of tests of the essential function of the software. Comparison with documentation containing the test results of previous tests is to be carried out.

2.3.4 The application software is to be approved on a case by case basis, according to [3.3.2].

Table 2 : Basic software development documents

N°	I/A **(2)**	DOCUMENT
1	I	Follow-up of developed software: identification, safeguard, storage
2	I	Document showing the capability and training of the development team
3	I	Production of a specification file
4	I	Production of a preliminary design file
5	I	Production of a detailed design file
6	I	Production of a coding file
7	I	Production of a unit testing file **(1)**
8	I	Production of an integration test file **(1)**
9	I	Production of a validation test file **(1)**
10	I	Production of a maintenance facility file
11	I	Production of a quality plan
12	I	Follow-up of the quality plan: checks, audits, inspections, reviews
(1) Complementary test carried out, at random, at the request of the Surveyor **(2)** A : to be submitted for approval; I : to be submitted for information.		

2.4 Loading instruments

2.4.1 Loading instruments approval consists of:

- approval of hardware according to [2.2], unless to computers are available on board for loading calculations only
- approval of basic software according to [2.3]
- approval of application software, consisting in data verification which results in the Endorsed Test Condition according to Part B
- installation testing according to [4].

3 Acceptance testing

3.1 General

3.1.1 Acceptance tests are generally to be carried out at the manufacturer's facilities before the shipment of the equipment.

Acceptance tests refer to hardware and software tests as applicable.

3.2 Hardware testing

3.2.1 Hardware acceptance tests include, where applicable:

- visual inspection
- operational tests and, in particular:
  - tests of all alarm and safety functions
  - verification of the required performance (range, calibration, repeatability, etc.) for analogue sensors
  - verification of the required performance (range, set points, etc.) for on/off sensors
  - verification of the required performance (range, response time, etc.) for actuators
  - verification of the required performance (full scale, etc.) for indicating instruments
- high voltage test
- hydrostatic tests.

Additional tests may be required by the Society.

3.2.2 Final acceptance will be granted subject to:

- the results of the tests listed in [3.2.1]
- the type test report or type approval certificate.

3.3 Software testing

3.3.1 Software acceptance tests of computer based systems are to be carried out to verify their adaptation to their use on board, and concern mainly the application software.

3.3.2 The software modules of the application software are to be tested individually and subsequently subjected to an integration test. The test results are to be documented and to be part of the final file. It is to be checked that:

- the development work has been carried out in accordance with the plan
- the documentation includes the proposed tests, the acceptance criteria and the result.

Repetition tests may be required to verify the consistency of test results.

3.3.3 Software acceptance will be granted subject to:

- examination of the available documentation
- a functional test of the whole system.

The Society may ask for additional tests of systems which are part of safety systems or which integrate several functions.

4 Commissioning

4.1 General

4.1.1 Commissioning tests are to be carried out on automation systems associated with essential services to verify their compliance with the Rules, by means of visual inspection and the performance and functionality according to Tab 3.

Table 3 : Commissioning tests

Equipment	Nature of tests
Electronic equipment	Main hardware functionality
Analogue sensors	Signal calibration, trip set point adjustment
On/off sensors	Simulation of parameter to verify and record the set points
Actuators	Checking of operation in whole range and performance (response time, pumping)
Reading instruments	Checking of calibration, full scale and standard reference value

When completed, automation systems are to be such that a single failure, for example loss of power supply, is not to result in a major degradation of essential function. In addition, a blackout test is to be carried out to show that automation systems are continuously supplied.

Upon completion of commissioning tests, test reports are to be made available to the Surveyor.

Part C
Machinery, Systems and Fire Protection

Chapter 4
FIRE PROTECTION, DETECTION AND EXTINCTION

SECTION 1 GENERAL

1 Application

1.1 General

1.1.1 The requirements of this Chapter apply to naval surface ships. Fire protection of naval ships shall be achieved by provisions of passive and active fire protection systems for each space and by provisions of the subdivision of the ship spaces into main vertical zones and into safety zones.

1.1.2 The probability of mission prosecution following an event implying fire spread to spaces or compartments essential for the ship's operability can be assessed by qualitative risk analysis. The purpose being, as deemed appropriate by the Naval Authority, the identification of:

- the necessary redundancy, and
- the number and location of ship's safety zones.

1.2 Exemptions

1.2.1 The Society may, upon acceptance of the Naval Authority, if the position of spaces and/or of rooms is such as to render the application of any specific requirement of this Chapter unreasonable or unnecessary, exempt from those requirements individual ships.

1.3 Naval Authority Rules and Approval

1.3.1 When the Naval Authority has issued specific rules covering fire protection, the Society may accept such rules for classification purposes in lieu of those given in this Chapter.

1.3.2 Evidence of approval of the fire protection by the Naval Authority may be accepted for the purpose of classification.

1.3.3 In cases of application of the requirements of [1.3.1] or [1.3.2] an appropriate entry is made in the classification files of the ship.

1.4 Documentation to be submitted

1.4.1 The interested party is to submit to the Society the documents listed in Tab 1.

1.5 Type approved products

1.5.1 The following materials, equipment, systems or products in general used for fire protection are to be type approved by the Society, except for special cases for which the acceptance may be given for individual ships on the basis of suitable documentation or ad hoc tests:

a) Fire-resisting and fire-retarding divisions (bulkheads or decks) and associated doors

b) Upholstered furniture, excluding the frame

c) Materials for pipes penetrating A or B class divisions (where they are not of steel or other equivalent material)

d) Materials for oil or fuel oil pipes (where they are not of steel or copper and its alloys)

e) Bulkhead or deck penetrations for electrical cables passing through A or B class divisions

f) Materials with low flame spread characteristic including paints, varnishes and similar, when they are required to have such characteristic

g) Non-combustible materials

h) Textile and non-textile materials suspended vertically, for example curtains

i) Non-readily igniting materials for primary deck coverings

j) Fixed foam fire-extinguishing systems and associated foam-forming liquids

k) Fixed powder fire-extinguishing systems, including the powder

l) Fixed or mobile fire extinguishing systems with two combined extinguishing agents e.g. foam and powder for aircraft decks.

m) Portable foam applicators.

n) Flexible pipes and expansion bellows of non-coventional material for any type of fluid.

o) Sprinkler heads for sprinkler systems

p) Nozzles for fixed pressure water-spraying fire-extinguishing systems for machinery spaces, boiler rooms, ammunitions spaces, and spaces intended for the car-

riage of vehicles tyred or crawled or aircraft and for hangars.

q) Sensing heads for automatic fire alarm and fire detection systems.

r) Fixed fire detection and fire alarm systems

s) Explosive mixture detecting systems

t) Portable explosive mixture detecting apparatus

u) Emergency escape breathing devices

v) Portable fire-extinguishers

w) Large capacity fire-extinguishers

x) Extinguishing media substitute for the foam in fire extinguishers

y) Fire protective overalls

z) Breathing apparatus

aa) Electric safety lamps

ab) Lifelines

ac) Fire hoses

ad) Water fog applicators and nozzles, including dual purpose nozzles, for fire hoses

ae) Bedding components

af) Fixed watermist fire extinguishing systems with or without additives

ag) Fixed gas extinguishing systems

ah) Fixed water based local applications fire fighting systems

ai) Fire dampers.

The Society may request type approval for other materials, equipment, systems or products required by the applicable provisions for ships or installations of special types.

The Naval Authority may not allow some of th listed products to be installed as well as may request that other products (such as upholstery materials for furniture, resilient materials for mattres, material for smoke curtains, etc.) used on ships are approved by the Society on the basis of specified standards.

2 Definitions

2.1 Accommodation spaces

2.1.1 Accommodation spaces are those spaces used for public spaces, corridors, stairs, lavatories, cabins, offices, hospitals, secretarias, meeting rooms, parlours, shops, pantries containing no cooking appliances and similar spaces.

2.1.2 Pantries (including isolated pantries) containing no cooking appliances may contain:

- coffee automats, toasters, dishwashers, microwave ovens, water boilers and similar appliances, each with a maximum power of 5 kW
- electrically heated cooking plates and hot plates for keeping food warm, each with a maximum power of 2kW and a surface temperature not greater than 150°C.

A dining room containing such appliances is not regarded as a pantry.

2.2 A class divisions

2.2.1 A class divisions are those divisions formed by bulkheads and decks which comply with the following:

a) they shall be constructed of steel or other equivalent material;

b) they shall be suitably stiffened;

c) they shall be so constructed as to be capable of preventing the passage of smoke and flame to the end of the one-hour standard fire test;

d) they shall be insulated with approved non-combustible materials such that the average temperature of the unexposed side will not rise more than 140°C above the original temperature, nor will the temperature, at any one point, including any joint, rise more than 180°C above the original temperature, within the time listed below:

  – class "A-60" .....60 minutes
  – class "A-30" .....30 minutes
  – class "A-15".....15 minutes
  – class "A-0".....0 minutes

e) the Society shall require a test of a prototype bulkhead or deck in accordance with the "Fire Test Procedures Code" (see [2.15]) to ensure that it meets the above requirements for integrity or temperature rise.

2.2.2

The products indicated in Tab 2 may be installed without testing or approval. Lower thickness or scantlings than indicated in Tab 2 may be accepted on a case by case basis.

Table 1 : Documentation to be submitted

No	I/A **(1)**	Document **(2)**
1	A	Structural fire protection showing the purpose of the various spaces of the ships, the fire rating of bulkheads and decks, means of closings of openings in A and B class divisions, draught stops, and completed with the indication of material of other bulkhead and of ceilings and lining
2	A	Natural and mechanical ventilation systems showing the penetrations on A class divisions, location of dampers, means of closing, arrangements of air conditioning rooms
3	A	Means of escape and access to spaces and low location lightning arrangement
4	A	Automatic fire detection systems and manually operated call points
5	A	Fire pumps and fire main including pumps head and capacity, hydrant and hose locations **(2)**
6	A	Arrangement of fixed fire-extinguishing systems **(2)**
7	A	Arrangement of sprinkler or sprinkler equivalent systems **(2)**
8	A	Fire-fighting equipment and firemen's outfits
9	A	Electrical diagram of the fixed gas fire-extinguishing systems , fixed fire detection systems, fire alarm and emergency lighting
10	A	Electrical diagram of the sprinkler systems
11	A	Electrical diagram of power control and position indication circuits for fire devices
12	I	General arrangement plan
13	I	Safety zone plan
14	A	Fire control plan

(1) A : to be submitted for approval
I : to be submitted for information.

(2) Plans are to be schematic and functional and to contain all information necessary for their correct interpretation and verification such as:

- service pressures
- capacity and head of pumps and compressors, if any
- materials and dimensions of piping and associated fittings
- volumes of protected spaces, for gas and foam fire-extinguishing systems
- surface areas of protected zones for sprinkler and pressure water-spraying, low expansion foam and powder fire-extinguishing systems
- capacity, in volume and/or in mass, of vessels or bottles containing the extinguishing media or propelling gases, for gas, sprinkler, foam and powder fire-extinguishing systems
- type, number and location of nozzles of extinguishing media for gas, sprinkler, pressure water-spraying, foam and powder fire-extinguishing systems.

All or part of the information may be provided, instead of on the above plans, in suitable operation manuals or in specifications of the systems.

Table 2

Classification	Product description
class A-0 bulkhead	A steel bulkhead with dimensions not less than the minimum dimensions given below: • thickness of plating: 4 mm • stiffeners 60 x 60 x 5 mm spaced at 600 mm or structural equivalent
class A-0 deck	A steel bulkhead with dimensions not less than the minimum dimensions given below: • thickness of plating: 4 mm • stiffeners 95 x 65 x 7 mm spaced at 600 mm or structural equivalent
class B-0 division	Division with plating thickness not less than 3 mm when constructed of steel, and not less than 4 mm when constructed of light alloy, and suitably stiffened

2.3 Aircraft deck

2.3.1 Aircraft deck is a purpose-built aircraft landing and take-off deck located on a ship including all structure, fire-figthing appliances and other equipment necessary for the safe operation of aircrafts.

2.4 Ammunitions spaces

2.4.1

Ammunition spaces are the spaces (integral magazines, independent magazines, small magazines, magazines lockers, magazines boxes and pyrotechnics lockers) used for the storage of ammunitions (missiles, shells, mines, demolition stores, etc. charged whit explosives, propellant, pyrotechnics, initiating compositions or nuclear, biological or chemical material) for use in conjunction with offensive, defensive, training or non operating purposes, including those parts of the weapons systems containing explosives.

Special consideration will be given by the Society to handling and lifting spaces of ammunitions.

2.5 B class divisions

2.5.1 B class divisions are those formed by bulkheads, decks, ceilings or linings which comply with the following:

a) they shall be so constructed as to be capable of preventing the passage of flame to the end of the first half hour of the standard fire test;

b) they shall have an insulation value such that the average temperature of the unexposed side will not rise more than 140°C above the original temperature, nor will the temperature at any one point, including any joint, rise more than 225°C above the original temperature, within the time listed below:

- class "B-15" .....15 minutes
- class "B-0" .....0 minutes

c) they shall be constructed of approved non-combustible materials and all materials entering into the construction and erection of B class divisions shall be non-combustible, with the exception that combustible veneers may be permitted provided they meet the other relevant requirements of this Chapter;

d) the Society shall require a test of a prototype bulkhead or deck in accordance with the Fire Test Procedures Code (see [2.15]) to ensure that it meets the above requirements for integrity or temperature rise.

2.6 Bulkhead decks

2.6.1 The bulkhead deck is the uppermost deck up to which the transverse watertight bulkheads are carried.

2.7 Cargo spaces

2.7.1 Cargo spaces are all spaces used for cargo (including cargo oil tanks) and trunks to such spaces.

2.8 Central damage control station

2.8.1 The central damage control station is a continuously manned control station (see [2.13]) in which are centralized the control and indicator of functions and operations for fire, flooding, alarms, essential machineries, NBC protection, public address etc. as indicated in the Rules and as it may be deemed necessary by the Naval Authority.

2.9 C class divisions

2.9.1 C class divisions are constructed of approved non-combustible materials. They need meet neither requirements relative to the passage of smoke and flame nor limitations relative to the temperature rise. Combustible veneers are permitted provided they meet the other relevant requirements of this Chapter.

2.10 Closed ro-ro cargo spaces

2.10.1 Closed ro-ro cargo spaces are those which are neither open ro-ro cargo spaces nor weather decks.

2.11 Closed vehicle spaces

2.11.1 Closed vehicle spaces are vehicle spaces which are neither open vehicle spaces nor weather decks.

2.12 Continuous B class ceilings and linings

2.12.1 Continuous B class ceilings and linings are those B class ceilings and linings which terminate only at an A or B class division.

2.13 Control stations

2.13.1 Control stations are those spaces in which the ship's radio or main navigating equipment or main naval detection, defence, combat operating equipment, or the emergency source of power is located or where the fire recording or fire control equipment is centralized.

2.14 Fire Safety Systems Code

2.14.1 Fire Safety Systems Code means the International Code for Fire Safety Systems as adopted by the Maritime Safety Committee of the IMO by Resolution MSC.98(73).

2.15 Fire Test Procedures Code

2.15.1 "Fire Test Procedures Code" means the "International Code for Application of Fire Test Procedures", as adopted by the Maritime Safety Committee of the IMO by Resolution MSC.61 (67).

2.16 Flashpoint

2.16.1 Flashpoint is the temperature in degrees Celsius (closed cup test) at which the product will give off enough flammable vapour to be ignited, as determined by an approved flashpoint apparatus.

2.17 Fuel oil unit

2.17.1 The fuel oil unit is the equipment used for the preparation of fuel oil for delivery to an oil fired boiler or equipment used for the preparation for delivery of heated oil to an internal combustion engine and includes any oil pressure pumps, filters and heaters dealing with oil at a pressure of more than 0,18 MPa.

2.17.2 "Fuel oil unit" includes any equipment used for the preparation and delivery of fuel oil, whether or not heater, to boilers (including inert gas generators, fired heat exchangers and incinerators) and engines (including gas turbines) at a pressure of more than 0,18 MPa.

2.18 Furniture and furnishings of restricted fire risk

2.18.1

Furniture and furnishings of restricted fire risk are furniture and furnishing are to comply with the following:

a) all case furniture such as desks, wardrobes, dressing tables, bureaux, dressers, is constructed entirely of approved non-combustible materials, except that a combustible veneer not exceeding 2 mm may be used on the working surface of such articles

b) all free-standing furniture such as chairs, sofas, tables, is constructed with frames of non-combustible materials

c) all draperies, curtains and other suspended textile materials have, to the satisfaction of the Society, qualities of resistance to the propagation of flame not inferior to those of wool of mass 0,8 kg/m^2 , this being determined in accordance with the Fire Test Procedures Code (see [2.15])

d) all floor coverings have low flame spread characteristics

e) all exposed surfaces of bulkheads, linings and ceilings have low flame-spread characteristics

f) all upholstered furniture has qualities of resistance to the ignition and propagation of flame, this being determined in accordance with the Fire Test Procedures Code (see [2.15]), and

g) all bedding components have qualities of resistance to the ignition and propagation of flame, this being determined in accordance with the Fire Test Procedures Code (see [2.15]).

2.19 Low flame spread

2.19.1 A low flame spread means the surface thus described will adequately restrict the spread of flame, this being determined in accordance with the "Fire Test Procedures Code (see [2.15])".

2.19.2 Non-combustible materials are considered as low flame spread. However, due consideration will be given by the Society to the method of application and fixing.

2.20 Machinery spaces

2.20.1 Machinery spaces are all machinery spaces of category A and all other spaces containing propulsion machinery, boilers, fuel cells systems, fuel oil units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air conditioning machinery, and similar spaces, and trunks to such spaces.

2.21 Machinery spaces of category A

2.21.1 Machinery spaces of category A are those spaces and trunks to such spaces which contain:

a) internal combustion machinery used for main propulsion, or

b) internal combustion machinery used for purposes other than main propulsion where such machinery has in the aggregate a total power output of not less than 375 kW, or

c) any oil fired boiler or fuel oil unit, or

d) gas turbines.

2.21.2 Spaces which contain oil fired equipment other than boilers, such as inert gas generators, incinerators, etc., are to be considered as machinery spaces of category A.

2.22 Main vertical zones

2.22.1 Main vertical zones are those sections into which the hull, superstructure and deckhouses are divided by A class divisions, the mean length and width of which on any deck does not in general exceed 40 m which may be extended up to no more than 50 m to bring the ends of such zones to coincide with watertight subdivision bulkheads below the bulkhead deck and/or to accommodate large spaces above the bulkhead deck.

2.23 NBC

2.23.1 NBC means the fixed and mobile systems and/or arrangements provided for detection, protection and decontamination against nuclear, bacteriological and chemical environment.

2.24 Non-combustible material

2.24.1 Non-combustible material is a material which neither burns nor gives off flammable vapours in sufficient quantity for self-ignition when heated to approximately 750°C, this being determined in accordance with the "Fire Test Procedures Code (see [2.15]). Any other material is a combustible material.

2.24.2 In general, products made only of glass, concrete, ceramic products, natural stone, masonry units, common metals and metal alloys are considered as being non-combustible and may be installed without testing and approval.

2.25 Open ro-ro cargo spaces

2.25.1

Open ro-ro cargo spaces are either open at both ends, or open at one end and provided with adequate natural ventilation effective over their entire length through permanent openings distributed in the side plating or deckhead or from above, having a total area of at least 10% of the total area of the space's sides.

2.26 Open vehicle spaces

2.26.1

Open vehicle spaces are those vehicle spaces either open at both ends, or have an opening at one end and provided with adequate natural ventilation effective over their entire length through permanent openings distributed in the side plating or deckhead or from above, having a total area of at least 10% of the total area of the space sides.

2.27 Public spaces

2.27.1 Public spaces are those portions of the accommodation which are used for halls, dining rooms, lounges recreational areas, ward rooms, brief rooms, print rooms and similar permanently enclosed spaces.

2.28 Prescriptive requirements and alternative design and arrangements

2.28.1 Prescriptive requirements means the construction characteristics, limiting dimensions or fire safety systems specified in this chapter other than Sec 11.

2.28.2 Alternative design and arrangements means a ship design and arrangements or part thereof in accordance with the procedure given in Sec 11 in alternative to the prescriptive requirements.

2.29 Ro-ro cargo spaces

2.29.1 Ro-ro cargo spaces are spaces not normally subdivided in any way and extending to either a substantial length or the entire length of the ship in which goods packaged or in bulk, in or on rail or road cars, vehicles (including road or rail tankers), trailers, containers, pallets, demountable tanks or in or on similar stowage units or other receptacles can be loaded and unloaded normally in a horizontal direction.

2.30 Safety zones

2.30.1 Safety zones are compartment(s), space(s) or groups thereof, determined by the qualitative risk analysis [1.1.2] which are deemed necessary by the Naval Authority for controlling the spread of damage following external offence(s) by providing each zone with own damage control measures.

2.30.2

Number and positions of Safety Zones is to be stated in the "Regulatory Framework" of the ship (see Pt A, Ch 2, App 1).

2.30.3

For the purpose of this chapter, when a ship is not subdivided in Safety Zones the ship is to be regarded as having one Safety Zone.

2.31 Service spaces

2.31.1 Service spaces are those spaces used for galleys, pantries containing cooking appliances, lockers, mail and specie rooms, storerooms, laundries, waste compactors, ironing rooms, laboratories, oven, workshops other than those forming part of the machinery spaces, and similar spaces and trunks to such spaces.

2.31.2

a) Main pantries and pantries containing cooking appliances may contain:
   1) coffee automats, toasters, dishwashers, microwave ovens, water boilers and similar appliances, each with a power of more than 5 kW
   2) electrically heated cooking plates and hot plates for keeping food warm, each with a maximum power of 5 kW.

b) Spaces containing any electrically heated cooking plate or hot plate for keeping food warm with a power of more than 5 kW are to be regarded, for the purpose of Sec 5, as galleys.

2.32 Steel or other equivalent material

2.32.1 Where the words "steel or other equivalent material" occur, "equivalent material" means any non-combustible material which, by itself or due to insulation provided, had structural and integrity properties equivalent to steel at the end of the applicable exposure to the standard fire test (e.g. aluminium alloy without magnesium and with appropriate insulation).

2.33 Special category spaces

2.33.1

Special category spaces are those enclosed spaces into and from which vehicles can be driven, boats can be docked/housed, aircraft parked and to which crew and non-crew have access. Special category spaces may be accommodated on more than one deck provided that the total overall clear height for vehicles does not exceed 10 metres.

2.34 Standard fire test

2.34.1 The standard fire test is one in which the specimens of the relevant bulkheads and decks are exposed in a test furnace to temperatures corresponding approximately to the standard time-temperature curve. The test methods shall be in accordance with the Fire Test Procedures Code (see [2.15]).

2.35 Vehicle spaces

2.35.1 Vehicle spaces are cargo spaces intended for the carriage of tyred or crawled motor vehicles or aircraft with fuel in their tanks for their own propulsion.

SECTION 2 PREVENTION OF FIRE AND EXPLOSION

1 Probability of ignition

1.1 Arrangements for fuel oil, lubrication oil, JP5-NATO(F44) and other flammable oils

1.1.1 Limitation in the use of oils as fuel

See Ch 1, Sec 1, [2.9].

1.2 Arrangements for fuel oil and JP5-NATO (F44)

1.2.1 See Ch 1, Sec 10 and Pt D, Ch 1, Sec 4.

1.3 Arrangements for lubricating oil

1.3.1 See Ch 1, Sec 10.

1.4 Arrangements for other flammable oils

1.4.1 See Ch 1, Sec 10.

1.5 Use of gaseous fuel for domestic purpose

1.5.1 The use of gaseous fuel for domestic purpose is not allowed.

1.6 Miscellaneus items of ignition sources and ignitability

1.6.1 Electric radiators

Electric radiators, if used, shall be fixed in position and so constructed as to reduce fire risks to a minimum. No such radiators shall be fitted with an element so exposed that clothing, curtains, or other similar materials can be scorched or set on fire by heat from the element.

1.6.2 Waste receptacles

All waste receptacles shall be constructed of non-combustible materials with no openings in the sides or bottom.

1.6.3 Insulation surfaces against oil penetration

a) In spaces where penetration of oil products is possible, the surface of insulation shall be impervious to oil or oil vapours.

b) Materials used in machinery spaces are not normally to have properties increasing the fire potential of these rooms. Neither combustible nor oil-absorbing materials are to be used as flooring, bulkhead lining, ceiling or deck in the control room, machinery spaces, shaft tunnel or rooms where oil tanks are located.

1.6.4 Primary deck coverings

Primary deck coverings, if applied within accommodation and service spaces and control stations, shall be of approved material which will not readily ignite, this being determined in accordance with the Fire Test Procedures Code (see Sec 1, [2.15]).

1.7 Non-sparking fans

1.7.1 General

Where non-sparking fans are required by the Rules, the provisions of the following [1.7.2] and [1.7.3]are also to be complied with.

1.7.2 Design criteria

a) The air gap between the impeller and the casing is to be not less than 1/10 of the shaft diameter in way of the impeller bearing and in any case not less than 2 mm, but need not exceed 13 mm.

b) Protective screens with square mesh of not more than 13 mm are to be fitted to the inlet and outlet of ventilation ducts to prevent objects entering the fan housing.

1.7.3 Materials

a) Except as indicated in the fourth bullet of item c) below, the impeller and the housing in way of the impeller are to be made of spark-proof materials which are recognised as such by means of an appropriate test to the satisfaction of the Society.

b) Electrostatic charges, both in the rotating body and the casing, are to be prevented by the use of antistatic materials. Furthermore, the installation on board of ventilation units is to be such as to ensure their safe bonding to the hull

c) 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 of non-ferrous material is fitted in way of the impeller
- any combination of ferrous (including austenitic stainless steel) impellers and housings with not less than 13 mm design tip clearance.

d) The following impeller and housing combinations are considered as sparking and therefore are not permitted:
   - impellers of an aluminium alloy or a magnesium alloy and a ferrous housing, regardless of tip clearance
   - housings 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.

e) Complete fans are to be tested in accordance either with the Society's requirements or national or international standards accepted by the Society.

2 Fire growth potential

2.1 Control of air supply and flammable liquid to the space

2.1.1 Application

The devices and means in items [2.1.2] and [2.1.3] in addition to be operable as stated therein, shall be operable from central damage control station.

2.1.2 Closing appliances and stopping devices of ventilation

a) The main inlets and outlets of all ventilation systems shall be capable of being closed from outside the spaces being ventilated.

   The controls are to be easily accessible as well as prominently and permanently marked and are to indicate whether the shut-off is open or closed.

   Ventilation inlets and oulets located at outside boundaries are to be fitted with closing appliances as required above and need not comply with Sec 5, [6.3.2].

b) Power ventilation of accommodation spaces, service spaces, vehicle spaces, ro-ro vehicle spaces, hangars, control stations and machinery spaces shall be capable of being stopped from an easily accessible position outside the space being served. This position should not be readily cut off in the event of a fire in the spaces served.

c) All power ventilation, except for ventilation of machinery space and vehicle spaces, ro-ro vehicle spaces, hangars and any alternative system which may be required under Sec 4, [1.1.1], shall be fitted with controls so grouped that all fans may be stopped from either of two separate positions which shall be situated as far apart as practicable. Fans serving power ventilation systems to vehicle spaces, ro-ro vehicle spaces or hangars shall be capable of being stopped from a safe position outside such spaces.

2.1.3 Means of control in machinery spaces

a) Means of control shall be provided for closure of openings in funnels which normally allow exhaust ventilation, and closure of ventilator dampers.

b) Means of control shall be provided for stopping ventilating fans. Controls provided for the power ventilation serving machinery spaces shall also be grouped so as to be operable from two positions, one of which shall be outside such spaces. The means provided for stopping the power ventilation of the machinery spaces shall be entirely separate from the means provided for stopping ventilation of other spaces.

c) Means of control shall be provided for stopping forced and induced draught fans, fuel oil transfer pumps, fuel oil unit pumps and other similar fuel pumps.

   This applies also to lubricating oil pumps and oil separators (purifiers) except oily water separators.

d) The controls required in a) to c) above shall be located outside the space concerned, where they will not be cut off in the event of fire in the space they serve.

   In machinery spaces of category A, controls to close off ventilation ducts and pipes are to be installed with due regard to the hot gases produced by a fire in the space concerned.

e) The controls required in the above items a) to d) and in Sec 4, [1.2.2] and in Sec 5, [4.2.2] and the controls for any required fire-extinguishing system shall be situated at one control position or grouped in as few positions as possible to the satisfaction of the Society.

   Means for stopping the fuel oil transfer pumps required in item c) are also to be capable of being operated from the inside of the space in which the pumps are situated.

2.2 Fire protection materials

2.2.1 Use of non-combustible materials

a) Insulating materials

   Except in refrigerated compartments, insulating materials shall be non-combustible. Vapour barriers and adhesives used in conjunction with insulation, as well as insulation of pipe fittings, for cold service systems need not be non-combustible, but they shall be kept to the minimum quantity practicable and their exposed surfaces shall have low flame spread characteristics.

   Cold service means refrigeration systems and chilled water piping for air conditioning systems.

b) Ceilings and linings

   Except in refrigerated compartments, all linings, grounds, draught stops, ceilings shall be of non combustible materials. Partial bulkheads or decks used to subdivide a space for utility shall also be of non-combustible material. The floor plating of normal passageways in machinery spaces of category A is to be made of steel.

2.2.2 Use of combustible materials

a) General

   "A", "B" or "C" class divisions, which are faced with combustible materials and combustible facing, moulding, decorations and veneers, may be used in accommodation and service spaces in accordance with the provisions of b) to d) below.

b) Maximum calorific value of combustible materials

   Materials used on surfaces, and covered by the requirement of item a), shall not have a calorific value exceeding 45 MJ/m^2 of the area for the thickness used.

   This requirement does not apply to the surfaces of furniture fixed to the linings and the walls.

c) Total volume of combustible materials

When combustible materials are used as permitted in the previous item a), the total volume of combustible components (facings, mouldings, decorations and veneers in any accommodation and service space) shall not exceed a volume equivalent to 2,5 mm veneer on the combined area of the walls and ceiling linings.

Furniture fixed to linings and walls or decks need not be included in the calculation of the maximum calorific values and volume of combustible material.

d) Low flame spread characteristics of surfaces

The following surfaces shall have low flame spread characteristics in accordance with the Fire Test Procedures Code or with more stringent standards (i.e. STANAG 4602) indicated by the Naval Authority:

1) exposed surfaces (deck, ceilings and bulkheads) of all spaces of a ship,

2) surfaces including grounds in concealed or inaccessible spaces in all spaces of a ship.

The evaluation of the flame-spread characteristic of the boundary linings of the ships has to be performed for the layers combinations forming the coating.

2.2.3 Furniture

Furniture in corridors and in stairway enclosure are not allowed.

3 Smoke generation potential and toxicity

3.1 General

3.1.1

The following equipment/materials shall not be capable of producing excessive quantities of smoke and toxic products, this being determined in accordance with the Fire Test Procedures Code or with more stringent standards (i.e. STANAG 4602) indicated by the Naval Authority:

- deck covering
- facings, mouldings, decorations and veneers
- ceiling facings
- furniture, upholstered furniture, textiles and curtains of restricted fire risk
- paints, varnishes and other finishes.

In general, non-combustible materials are considered to comply with the requirements for smoke generation potential and toxicity without further testing.

3.2 Primary deck coverings

3.2.1

Primary deck coverings, if applied within accommodation and service spaces and control stations, shall be of approved material which will not give rise to toxic or explosive hazards at elevated temperatures, this being determined in accordance with the Fire Test Procedures Code or by more stringent standards (i.e. STANAG 4602) indicated by the Naval Authority.

SECTION 3 SUPPRESSION OF FIRE AND EXPLOSION DETECTION AND ALARM

1 General

1.1 Minimum number of detectors

1.1.1 Where a fixed fire detection and fire alarm system is required for the protection of spaces other than those specified in [4.1.1], at least one detector complying with the requirements given in Sec 13 shall be installed in each such space.

2 Initial and periodical test

2.1 General

2.1.1

The function of the fire detection system required in the relevant sections of this chapter shall be tested under varying conditions of ventilation after installation.

2.1.2

The function of fixed fire detection and alarm system shall be periodically tested to the satisfaction of the Society by means of equipment producing hot air at the appropiate temperature, or smoke or aerosol particles having the appropriate range of density or particle size, or other phenomena associated with incipient fires to which the detector is designed to respond.

3 Protection of machinery spaces

3.1 Installation

3.1.1 A fixed fire detection and fire alarm system complying with the relevant provisions given in Sec 13 shall be installed in any machinery space (see Sec 1, [2.20.1]).

For fire detecting system for unattended machinery spaces of Category A, see also Part E, Chapter 2.

3.2 Design

3.2.1 The fire detection system required in [3.1.1] shall 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 recesses and in spaces of restricted height and where their use is specially appropriate, detection systems using only thermal detectors are not 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 on the navigating bridge and in central damage control station (see Sec 1, [2.8.1]) by a responsible member of the crew.

4 Protection of accommodation, service spaces and control stations

4.1 Smoke detectors in stairways, corridors and escape routes

4.1.1 Smoke detectors shall be installed in all stairways, corridors and escape routes within accommodation spaces. Consideration shall be given to the installation of special purpose smoke detectors within ventilation ducting.

4.2 Requirements for accommodation spaces

4.2.1 A fixed fire detection and fire alarm system shall be installed and arranged as to provide smoke detection in service spaces, control stations and accommodation spaces, including corridors and stairways. Smoke detectors need not be fitted in private bathrooms. Heat detectors in lieu of smoke detectors may be installed in galleys.

5 Protection of ammunitions magazines and lockers

5.1 Application and general requirements

5.1.1

The ammunitions magazines and lockers are to be provided with a fixed fire detection system capable of smoke and heat detection and alarm system capable of smoke and heat detection and complying with the requirements of Sec 13.

Unless otherwise stated by the Naval Authority, heat detector shall be set to operate at a temperature close to 54°C and when the temperature is raised to 45°C at a rate exceeding 3°C per minute. Furthermore, thermal inertia of heat detection (ability to detect and respond to extremely steep temperature/time gradients) is to be such that the detector is capable of responding to temperature gradients of at least 25°C per second.

Temperature inside ammunition magazines is to be monitored at the Damage Control Station(s).

Spaces which are not used as tanks for liquids and bounding ammunition magazines are to be provided with fixed fire detection system and alarm system capable of smoke or heat detection and complying with the requirements of Sec 13.

6 Manually operated call point

6.1 General requirements

6.1.1

Manually operated call points complying with the the requirements of Sec 13 shall be installed throughout the accommodation spaces, service spaces and control stations.

One manually operated call point shall be located at each exit of escape routes. Manually operated call points shall be readily accessible in the corridors of each deck so that no part of the corridor is more than 20 m from a manual call point.

The system of call points is to be separated from the automatic fire dtection and fire alarm system unless it is provided with remotely and individually identifiable call points; in such a case, the manually operated call points may be included in a loop covering sections of fire detectors in control stations, accommodation and service spaces in the concerned area.

7 Inspection hatches and radiotelephone apparatus

7.1 Inspection hatches

7.1.1 The construction of ceiling and bulkheading shall be such that it will be possible, without impairing the efficiency of the fire protection, for the fire patrols to detect any smoke originating in concealed and inaccessible places.

7.2 Radiotelephone apparatus

7.2.1 Each member of the fire patrol shall be provided with a two-way portable radiotelephone apparatus.

7.2.2 Two-way portable telephone apparatuses are to be audible from most parts of the vessel. As a minimum, they are to be audible in areas where the fire patrol make their rounds such as key box locations and the routes specified on fire patrol check lists. If necessary, extra antennas are to be fitted to obtain effective communication.

8 Receiving systems of fire alarm

8.1 Control panel

8.1.1 The control panel of a fixed fire detection and fire alarm system shall be designed on the fail-safe principle, e.g. an open detector circuit shall cause an alarm condition.

8.2 Position of detection alarms, remote control and control panels

8.2.1 Ships shall have the detection alarms for the systems required by this Section centralized in a continuously manned central control station. In addition, controls for remote closing of the fire doors and shutting down the ventilation fans shall be centralized in the same location. The ventilation fans shall be capable of reactivation by the crew at the continuously manned central damage control station. The control panels in the central damage control station shall be capable of indicating open or closed positions of fire doors, if any, closed or off status of the detectors, alarms and fans. The control panel shall be continuously powered and should have an automatic change-over to standby power supply in the event of loss of normal supply. The control panel shall be powered from at least two electrical switchboards which cannot be put out of service at the same time by any event. The speratated feeders shall be so arranged as to avoid galleys, machinery spaces, ammunitions spaces and other high fire risk spaces except in so far as it is necessary to reach the appropriate switchboards.

SECTION 4 SUPPRESSION OF FIRE AND EXPLOSION CONTROL OF SMOKE SPREAD

1 Protection of control stations outside machinery spaces

1.1 General

1.1.1

Practicable measures shall be taken, for manned control stations outside machinery spaces in order to ensure that ventilation, visibility and freedom from smoke are maintained, so that in the event of fire the machinery and equipment contained therein may be supervised and continue to function effectively. Alternative and separate means of air supply shall be provided; air inlets of the two sources of supply shall be so disposed that the risk of both inlets drawing in smoke simultaneously is minimised.

For such purpose, at least one of the means of air supply serving the control station(s) shall be a dedicated air supply system.

1.1.2 Equally effective local closing arrangements means that in the case of ventilators these are to be fitted with fire dampers or smoke dampers which are to be easily closed within the control station in order to maintain the absence of smoke in the event of fire.

1.2 Release of smoke from machinery spaces

1.2.1

Suitable arrangements shall be made to permit the release of smoke in the event of fire, from the space to be protected.

The normal ventilation systems may be acceptable for this purpose.

1.2.2 Means of control shall be provided for permitting the release of smoke and the controls shall be located outside the space concerned, where they will not be cut off in the event of fire in the space they serve.

1.2.3 The controls of item [1.2.2] shall be situated at one control position or grouped in as few positions as possible to the satisfaction of the Society. Furthermore controls of item [1.2.2] shall be also situated in the central damage control station.

1.3 Draught stops

1.3.1 Air spaces enclosed behind ceilings, panelling or linings shall be suitably divided by close-fitting draught stops not more than 14 m apart. In the vertical direction, such enclosed air spaces, including those behind linings of stairways, trunks, etc., shall be closed at each deck.

1.4 Portable smoke exhaust fans and relevant ducts

1.4.1

Each main vertical zone shall be provided with a portable smoke exhaust actuated by means of compressed air or sea water systems.

1.4.2

The fan shall be sized such that the entire volume of the largest accommodation, service space or control station of the main vertical zone can be exhausted in 10 minutes or less.

1.4.3 Portable smoke exhaust fans and their flexible exhaust ducts shall be suitable for smoke temperature greater than 300°C . They shall be easy to be use and shall have features as not to interfere with handling of safety equipment.

SECTION 5 SUPPRESSION OF FIRE AND EXPLOSION CONTAINMENT OF FIRE

1 Thermal and structural boundaries

1.1 Thermal and structural division

1.1.1 The ship shall be subdivided into spaces by thermal and structural divisions having regard to the fire risk of the space.

1.2 Main vertical zones, horizontal zones and safety zones

1.2.1

a) The hull, superstructure and deckhouses shall be divided (see Sec 1, [2]) into main vertical zones and, if stated in the "Regulatory Framework" of the ship (see Pt A, Ch 2, App 1), in safety zones by A-60 fire class divisions. Steps and recesses shall be kept to a minimum but, where they are necessary, they shall also be A-60 class divisions. Where tanks are on both sides of the division the standard may be reduced to "A-0".

b) As far as practicable, the bulkheads forming the boundaries of the main vertical zones above the bulkhead deck shall be in line with watertight subdivision bulkheads situated immediately below the bulkhead deck. The Society may allow to extend the length of the main vertical zones up to 50 m as it may be necessary in order to bring the ends of the main vertical zones to coincide with watertight subdivision bulkheads or in order to accommodate a large space above the bulkhead deck.

Furthermore in special cases and provided that each main vertical bulkhead is extended to the hull, superstructure and deckhouses pertaining to the main vertical zone, the Society may agree to proposal of Naval Authority to extend the length of main vertical zone(s) up to 60 m to bring the bulkhead(s) of main vertical zone(s) to coincide with bulkhead(s) of safety zone(s).

The length of a main vertical zones is the maximum distance between the furthermost points of the bulkheads bounding it.

c) Such bulkheads shall extend from deck to deck and to the shell or other boundaries.

d) On spaces designed for special purpose, such as vehicle spaces, ro-ro vehicle spaces or hangar(s), etc. where the provisions of main vertical zone bulkheads would defeat the purpose for which such spaces are intended, equivalent means for controlling and limiting a fire shall be substituted and specifically approved by the Society.

However, in a ship with vehicle spaces, ro-ro vehicle spaces, or aircraft hangar(s) such spaces shall comply with the applicable requirements of this section and Sec 12 and, in so far as, such compliance would be inconsistent with compliance with other requirements of this Chapter, the requirements of this section and of Sec 12 shall prevail.

1.2.2 Bulkheads within a main vertical zone

a) All bulkheads which are not required to be A class divisions shall be at least B class or C class divisions as prescribed in:

- Tab 1 and Tab 2 for **front line ships** and other ships capable of carrying more than 240 persons including the crew;
- Tab 3 and Tab 4 for **second line ships** and **auxiliary ships** not capable of carrying more than 240 persons including the crew;

b) The following requirements shall govern application of Tab 1 to Tab 4:

- Tab 1 and Tab 3 shall apply to bulkheads not bounding either main vertical zones or horizontal zones.
- Tab 2 and shall apply to decks not forming steps in main vertical zones nor bounding horizontal zones.

c) All bulkheads required to be B class divisions shall extend from deck to deck and to the shell or other boundaries unless the continuous B class ceilings or linings fitted on both sides of the bulkheads are at least of the same fire resistance as the bulkhead, in which case the bulkhead may terminate at the continuous ceiling or lining.

d) For determining the appropriate fire integrity standards to be applied to boundaries between adjacent spaces, such spaces are classified according to their fire risk as shown in categories (1) to (15) below. Where the contents and use of a space are such that there is a doubt as to its classification for the purpose of this Sec 5, it shall be treated as a space within the relevant category having the most stringent boundary requirements. The title of each category is intended to be typical rather than restrictive. The number in parentheses preceding each category refers to the applicable column or row in the tables.

- (1) Control stations

  Central damage control stations

  Space containing naval systems for detection, command, defence, offence, communication, combat (e.g. COC) or weapon control /operation

  Bridge for command, defence, operation or planning rooms. Spaces containing centralised ship's operation equipment (e.g. COP)

  Spaces containing emergency sources of power and lighting

  Wheelhouse and chartroom

Spaces containing the ship's radio equipment

Fire-extinguishing rooms, fire control rooms and fire recording stations

Control room for propulsion machinery when located outside the propulsion machinery space

Spaces containing centralized fire alarm equipment

Spaces containing centralized emergency public address system stations and equipment.

- (2) Stairways

  Interior stairways, lifts, totally enclosed emergency escape trunks and escalators (other than those wholly contained within the machinery spaces, storage or vehicle spaces, ro-ro vehicle spaces or hangars and trunks thereto, which are to be considered as part thereof) and enclosures thereto.

  In this connection a stairway which is enclosed at only one level shall be regarded as part of the space from which it is not separated by a fire door.

- (3) Corridors

  Corridors and lobbies.

- (4) Evacuation stations and external escape routes

  Survival craft stowage area

  Open deck spaces and passageway forming lifeboat and liferaft embarkation and lowering stations

  Muster stations, internal and external

  External stairs and open decks used for escape routes.

  The ship's side to the waterline in the lightest seagoing condition, superstructure and deckhouse sides situated below and adjacent to the liferaft and evacuation slide embarkation areas

- (5) Open deck spaces

  Open deck spaces and passageway clear of survival craft stowage area and their embarkation and lowering stations

  Air spaces (the space outside superstructures and deckhouses)

- (6) Accommodation spaces of minor fire risk

  Cabins and berthing spaces having a deck area of less than 50 m^2, containing furniture and furnishings of restricted fire risk

  Offices and dispensaries containing furniture and furnishings of restricted fire risk

  Public spaces containing furniture and furnishings of restricted fire risk and having a deck area of less than 50 m^2 .

- (7) Accommodation spaces of moderate fire risk

  Spaces as in category (6) above but containing furniture and furnishings of other than restricted fire risk

  Public spaces and berthing spaces containing furniture and furnishings of restricted fire risk and having a deck area of 50 m^2 or more

  Isolated lockers and small storerooms in accommodation spaces having deck area less than 4 m^2 (in which flammable liquids are not stowed)

  Cleaning gear lockers (in which flammable liquids are not stowed)

  Laboratories and lockers for medicines (in which flammable liquids are not stowed)

  Pharmacies

  Small drying rooms (having a deck area of 4 m^2 or less)

  Specie rooms

  Operating rooms and other rooms for such purpose.

- (8) Accommodation spaces of greater fire risk

  Public and berthing spaces containing furniture and furnishings of other than restricted fire risk and having a deck area of 50 m^2 or more

- (9) Sanitary and similar spaces

  Communal sanitary facilities, showers, baths, water closets, etc.

  Small laundry rooms

  Isolated pantries containing no cooking appliances in accommodation spaces

  Private sanitary facilities shall be considered a portion of the space in which they are located.

- (10) Tanks, voids and auxiliary machinery spaces having little or no fire risk

  Water tanks forming part of the ship's structure

  Voids and cofferdams

  Auxiliary machinery spaces which do not contain machinery having a pressure lubrication system and where storage of combustibles is prohibited, such as:

  – ventilation and air-conditioning rooms

  – windlass room

  – steering gear room

  – stabiliser equipment room

  – electric propulsion motor room

  – rooms containing section switchboards and purely electrical equipment other than oil-filled electrical transformers (above 10 kVA)

  – shaft alleys and pipe tunnels

  – spaces for pumps and refrigeration machinery (not handling or using flammable liquids)

  Closed trunks serving the spaces listed above

  Other closed trunks such as pipe and cable trunks

- (11) Auxiliary machinery spaces, cargo spaces other than ro-ro vehicle spaces and other than insensitive label ammunition spaces, cargo and other oil tanks and other similar spaces of moderate fire risk

  Cargo oil tanks

  Cargo holds, trunkways and hatchways

  Refrigerated chambers

  Fuel oil tanks (where installed in a separate space with no machinery)

  Shaft alleys and pipe tunnels allowing storage of combustibles

  Auxiliary machinery spaces as in category (10) which contain machinery having a pressure lubrication system or where storage of combustibles is permitted

  Fuel oil filling stations

Spaces containing oil-filled electrical transformers (above 10 kVA)

Spaces containing turbine and reciprocating steam engine driven auxiliary generators and small internal combustion engines of power output up to 110 kW driving generators, sprinkler, drencher or fire pumps, bilge pumps, etc.

Closed trunks serving the spaces listed above

- (12) Machinery spaces and main galleys

  Main propulsion machinery rooms (other than electric propulsion motor rooms) and boiler rooms

  Auxiliary machinery spaces other than those in categories (10) and (11) which contain internal combustion machinery or other oil-burning, heating or pumping units

  Main galleys and annexes

  Fuel oil, JP5-NATO (F44) and lubricating oil pump rooms

  Trunks and casings to the spaces listed above
- (13) Store-rooms, workshops, pantries, etc.

  Main pantries not annexed to galley

  Main laundries

  Large drying rooms having a deck area greater than 4 m^2

  Miscellaneous stores

  Mail and baggage rooms

  Garbage rooms

  Workshops (not part of machinery spaces, ro-ro spaces, hangars, galleys, etc.)

  Lockers and storerooms having areas greater than 4 m^2, other than those spaces that have provisions for the storage of flammable liquids.
- (14) Explosion risk spaces and other spaces in which flammable liquids are stowed

  Ammunitions spaces

  Refuelling stations other than those located inside hangars

  Spaces for non-detonating ammunitions and weapons (insensitive label required)

  Paint lockers

  Store-rooms containing flammable liquids (including dyes, medicines, etc.)

  Laboratories (in which flammable liquids are stowed).
- (15) Special purpose spaces

  Aircraft or helicopter hangars

  Vehicle spaces and boat spaces (including unmanned vehicles)

  Ro-ro cargo spaces

  Aircraft or helicopter decks.

  RAS station

e) Notwithstanding the provisions of [1.2.2] there are no special requirements for material or integrity of boundaries where only a dash appears in the tables.

f) The Society shall determine in respect of category (5) spaces whether the insulation values in Tab 1 and Tab 3 shall apply to ends of deckhouses and superstructures, and whether the insulation values in Tab 2 and Tab 4 shall apply to weather decks. In no case shall the requirements of category (5) necessitate enclosure of spaces which in the opinion of the Society need not be enclosed.

g) Continuous B class ceilings or linings, in association with the relevant decks or bulkheads, may be accepted as contributing, wholly or in part, to the required insulation and integrity of a division.

h) In approving structural fire protection details, the Society will give special regard to the risk of heat transmission at intersections and terminal points of required thermal barriers. The insulation of a deck or bulkhead shall be carried past the penetration, intersection or terminal point for a distance of at least 450 mm in the case of steel and aluminium structures. If a space is divided with a deck or a bulkhead of "A" class standard having insulation of different values, the insulation with the higher value shall continue on the deck or bulkhead with the insulation of the lesser value for a distance of at least 450 mm.

1.2.3 Fire integrity of bulkheads and decks for front line ships and other ships capable of carrying more than 240 persons including the crew

The minimum fire integrity of all bulkheads and decks for front line ships and other ships capable of carrying more than 240 persons including the crew shall be as prescribed in Tab 1 and Tab 2. Where, due to any particular structural arrangements in the ship, difficulty is experienced in determining from the Tables the minimum fire integrity value of any divisions, such values shall be determined to the satisfaction of the Society.

Table 1 : Bulkheads not bounding either vertical zones or horizontal zones for front line ships and other ships capable of carrying more than 240 persons including the crew

SPACES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Control stations (1)	B-0 [a]	A-0	A-0	A-0	A-0	A-60	A-60	A-60	A-0	A-0	A-60	A-60	A-60	A-60	A-60
Stairways (2)		A-0 [a]	A-0	A-0	A-0	A-0	A-15 [c]	A-15	A-0	A-0	A-15	A-30	A-15	A-30	A-30
Corridors (3)			B-0	A-60	A-0	B-0	B-0	B-0	B-0	A-0	A-15	A-30	A-0	A-30	A-30
Evacuation stations and external escape routes (4)				-	A-0	A-60 [b]	A-60 [b]	A-60 [b]	A-60 [b]	A-0	A-0	A-60 [b]	A-60 [b]	A-60 [b]	A-60 [b]
Open deck spaces (5)					-	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Accommodation spaces of minor fire risk (6)						B-0	B-0	B-0	C	A-0	A-0	A-30	A-0	A-30	A-30
Accommodation spaces of moderate fire risk (7)							B-0	B-0	C	A-0	A-15 [c]	A-60	A-15	A-30	A-60
Accommodation spaces of greater fire risk (8)								B-0	C	A-0	A-15	A-60	A-15	A-30	A-60
Sanitary and similar spaces (9)									C	A-0	A-0	A-0	A-0	A-0	A-0
Tanks, voids and auxiliary machinery spaces having little or no fire risk (10)										A-0 [a]	A-0	A-0	A-0	A-0	A-0
Auxiliary machinery spaces and other spaces of moderate fire risk (11)											A-0 [a]	A-0	A-0	A-30	A-30
Machinery spaces and main galleys (12)												A-30 [a]	A-0	A-60	A-60
Storerooms, workshops, pantries, etc. (13)													A-0 [a]	A-30	A-30
Explosion risk spaces and other spaces in which flammable liquids are stowed (14)														A-30	A-60
Special purpose spaces (15)															A-30 [a]

Note 1:

[a] Where adjacent spaces are in the same numerical category and letter "a" appears, a bulkhead or deck between such spaces need not be fitted if deemed unnecessary by the Naval Administration. For example, in category (12) a bulkhead need not be required between a galley and its annexed pantries provided the pantry bulkheads and decks maintain the integrity of the galley boundaries. A bulkhead is, however, required between a galley and a machinery space, or between two different machinery spaces, e.g. main propulsion room and Diesel Generator room or oil pump room, even though both spaces are in category (12)

[b] The ship's side, to the waterline in the lightest seagoing condition, superstructure and deckhouse sides situated below and adjacent to the liferaft and evacuation slide embarkation areas may be reduced to A-30.

[c] When furniture and furnishings of restricted fire risk are used in category 7 spaces, may be reduced to A-0

[d] For spaces containing naval systems for detection, command, defence, offence, combat or weapon/control operation and command, defence operation or planning rooms (e.g. hangar control station, dock control station, etc) and spaces containing electrical distribution equipment if located outside power generation machinery spaces may be reduced to A-0

Table 2 : Decks not forming steps in main vertical zones nor bounding horizontal zones for front line ships and other ships capable of carrying more than 240 persons including the crew

SPACE below	SPACE above														
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Control stations (1)	A-30 [d]	A-30 [d]	A-15 [d]	A-0	A-0	A-0	A-15 [c]	A-30	A-0	A-0	A-0	A-60	A-15	A-30	A-30
Stairways (2)	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-30	A-0	A-30	A-30
Corridors (3)	A-15 [d]	A-0	A-0	A-60	A-0	A-0	A-15 [c]	A-15	A-0	A-0	A-0	A-30	A-0	A-30	A-30
Evacuation stations and external escape routes (4)	A-0	A-0	A-0	A-0	-	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Open deck spaces (5)	A-0	A-0	A-0	A-0	-	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Accommodation spaces of minor fire risk (6)	A-60	A-0	A-0	A-60	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-15
Accommodation spaces of moderate fire risk (7)	A-60	A-0	A-0	A-0	A-0	A-0	A-15 [c]	A-15 [c]	A-0	A-0	A-0	A-0	A-0	A-30	A-30
Accommodation spaces of greater fire risk (8)	A-60	A-15 [c]	A-15 [c]	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-60
Sanitary and similar spaces (9)	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Tanks, voids and auxiliary machinery spaces having little or no fire risk (10)	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0 [a]	A-0	A-0	A-0	A-0	A-0
Auxiliary machinery spaces and other spaces of moderate fire risk (11)	A-60	A-30	A-30	A-60	A-0	A-0	A-0	A-0	A-0	A-0 [a]	A-0	A-0	A-0	A-0	A-0
Machinery spaces and main galleys (12)	A-60	A-60	A-60	A-0	A-0	A-60	A-60	A-60	A-0	A-0	A-30	A-30 [a]	A-0	A-0	A-60
Storerooms, workshops, pantries, etc. (13)	A-60	A-30	A-15	A-60	A-0	A-30	A-30 [c]	A-30	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Explosion risk spaces and other spaces in which flammable liquids are stowed (14)	A-60	A-60	A-60	A-60	A-0	A-30	A-60	A-60	A-0	A-0	A-0	A-0	A-0	A-0	A-30
Special purpose spaces (15)	A-60	A-60	A-60	A-60	A-0	A-30	A-60	A-60	A-0	A-0	A-0	A-0	A30	A-30	A-0

Note 1:

[a] Where adjacent spaces are in the same numerical category and letter "a" appears, a bulkhead or deck between such spaces need not be fitted if deemed unnecessary by the Naval Administration. For example, in category (12) a bulkhead need not be required between a galley and its annexed pantries provided the pantry bulkheads and decks maintain the integrity of the galley boundaries. A bulkhead is, however, required between a galley and a machinery space, or between two different machinery spaces, e.g. main propulsion room and Diesel Generator room or oil pump room, even though both spaces are in category (12)

[b] The ship's side, to the waterline in the lightest seagoing condition, superstructure and deckhouse sides situated below and adjacent to the liferaft and evacuation slide embarkation areas may be reduced to A-30.

[c] When furniture and furnishings of restricted fire risk are used in category 7 spaces, may be reduced to A-0

[d] For spaces containing naval systems for detection, command, defence, offence, combat or weapon/control operation and command, defence operation or planning rooms (e.g. hangar control station, dock control station, etc) and spaces containing electrical distribution equipment if located outside power generation machinery spaces may be reduced to A-0

1.2.4 Fire integrity of bulkheads and decks for second line and auxiliary ships

The minimum fire integrity of all bulkheads and decks for second line and auxiliary ships not capable of carrying more than 240 persons including the crew shall be as prescribed in Tab 3 and Tab 4. Where, due to any particular structural arrangements in the ship, difficulty is experienced in determining from the Tables the minimum fire integrity value of any divisions, such values shall be determined to the satisfaction of the Society.

Table 3 : Bulkheads not bounding either vertical zones or horizontal zones for second line and auxiliary ships

SPACES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Control stations (1)	B-0 [a]	A-0	A-0	A-0	A-0	A-60	A-60	A-60	A-0	A-0	A-60	A-60	A-60	A-60	A-60
Stairways (2)		A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-15	A-30	A-15	A-30	A-30
Corridors (3)			C	A-0	A-0	B-0	B-0	B-0	B-0	A-0	A-15	A-30	A-0	A-30	A-30
Evacuation stations and external escape routes (4)				-	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-15	A-60 [b]	A-60 [b]	A-60 [b]
Open deck spaces (5)					-	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Accommodation spaces of minor fire risk (6)						C	C	C	C	A-0	A-0	A-30	A-0	A-30	A-30
Accommodation spaces of moderate fire risk (7)							C	C	C	A-0	A-15 [c]	A-60	A-15	A-30	A-60
Accommodation spaces of greater fire risk (8)								C	C	A-0	A-15	A-60	A-15	A-30	A-60
Sanitary and similar spaces (9)									C	A-0	A-0	A-0	A-0	A-0	A-0
Tanks, voids and auxiliary machinery spaces having little or no fire risk (10)										A-0 [a]	A-0	A-0	A-0	A-0	A-0
Auxiliary machinery spaces and other spaces of moderate fire risk (11)											A-0 [a]	A-0	A-0	A-30	A-30
Machinery spaces and main galleys (12)												A-0 [a]	A-0	A-60	A-60
Storerooms, workshops, pantries, etc. (13)													A-0 [a]	A-30	A-30
Explosion risk spaces and other spaces in which flammable liquids are stowed (14)														A-30	A-60
Special purpose spaces (15)															A-30 [a]

Note 1:

[a] Where adjacent spaces are in the same numerical category and letter "a" appears, a bulkhead or deck between such spaces need not be fitted if deemed unnecessary by the Naval Administration. For example, in category (12) a bulkhead need not be required between a galley and its annexed pantries provided the pantry bulkheads and decks maintain the integrity of the galley boundaries. A bulkhead is, however, required between a galley and a machinery space, or between two different machinery spaces, e.g. main propulsion room and Diesel Generator room or oil pump room, even though both spaces are in category (12)

[b] The ship's side, to the waterline in the lightest seagoing condition, superstructure and deckhouse sides situated below and adjacent to the liferaft and evacuation slide embarkation areas may be reduced to A-30.

[c] When furniture and furnishings of restricted fire risk are used in category 7 spaces, may be reduced to A-0

[d] For spaces containing naval systems for detection, command, defence, offence, combat or weapon/control operation and command, defence operation or planning rooms (e.g. hangar control station, dock control station, etc) and spaces containing electrical distribution equipment if located outside power generation machinery spaces may be reduced to A-0

Table 4 : Decks not forming steps in main vertical zones nor bounding horizontal zones for second line and auxiliary ships

SPACE below	SPACE above														
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11	(12)	(13)	(14)	(15)
Control stations (1)	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-60	A-0	A-30	A-30
Stairways (2)	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-30	A-0	A-30	A-30
Corridors (3)	A-0	A-0	A-0	A-60	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-30	A-0	A-30	A-30
Evacuation stations and external escape routes (4)	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Open deck spaces (5)	A-0	A-0	A-0	A-0	-	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Accommodation spaces of minor fire risk (6)	A-60	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-15
Accommodation spaces of moderate fire risk (7)	A-60	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-30	A-30
Accommodation spaces of greater fire risk (8)	A-60	A-15	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-30
Sanitary and similar spaces (9)	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Tanks, void and auxiliary machinery spaces having little or no fire risk (10)	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0 [a]	A-0	A-0	A-0	A-0	A-0
Auxiliary machinery spaces and other spaces of moderate fire risk (11)	A-60	A-15	A-15	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0 [a]	A-0	A-0	A-30	A-0
Machinery spaces and main galleys (12)	A-60	A-60	A-60	A-0	A-0	A-60	A-60	A-60	A-0	A-0	A-30	A-30 [a]	A-0	A-0	A-60
Storerooms, workshops, pantries, etc. (13)	A-60	A-30	A-15	A-60	A-0	A-30	A-30 [d]	A-30	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Explosion risk spaces and other spaces in which flammable liquids are stowed (14)	A-60	A-60	A-60	A-60	A-0	A-30	A-60	A-60	A-0	A-0	A-0	A-0	A-0	A-0	A-30
Special purpose spaces (15)	A-60	A-60	A-60	A-60	A-0	A-30	A-60	A-60	A-0	A-0	A-0	A-0	A30	A-30	A-0

Note 1:

[a] Where adjacent spaces are in the same numerical category and letter "a" appears, a bulkhead or deck between such spaces need not be fitted if deemed unnecessary by the Naval Administration. For example, in category (12) a bulkhead need not be required between a galley and its annexed pantries provided the pantry bulkheads and decks maintain the integrity of the galley boundaries. A bulkhead is, however, required between a galley and a machinery space, or between two different machinery spaces, e.g. main propulsion room and Diesel Generator room or oil pump room, even though both spaces are in category (12)

[b] The ship's side, to the waterline in the lightest seagoing condition, superstructure and deckhouse sides situated below and adjacent to the liferaft and evacuation slide embarkation areas may be reduced to A-30.

[c] When furniture and furnishings of restricted fire risk are used in category 7 spaces, may be reduced to A-0

[d] For spaces containing naval systems for detection, command, defence, offence, combat or weapon/control operation and command, defence operation or planning rooms (e.g. hangar control station, dock control station, etc) and spaces containing electrical distribution equipment if located outside power generation machinery spaces may be reduced to A-0

1.2.5 Protection of stairways and lifts in accommodation and service spaces

a) All stairways and ladders shall be within enclosures formed of A class divisions, in accordance with Tab 1 and with positive means of closure at all openings except that stairways connecting only two decks that need not to be enclosed, provided the integrity of the deck is maintained by proper bulkheads or doors in one 'tween-deck space. When a stairway is closed in one 'tweendeck space, the stairway enclosure shall be protected in accordance with the tables for decks in [1.2.3] or [1.2.4].

Where the above arrangement is not practicable the relevant openings on decks may be provided with horizontal enclosures formed by A class divisions in accordance with the Tab 2 or Tab 4 as appropriate.

b) Lift trunks shall be so fitted as to prevent the passage of smoke and flame from one deck to another and shall be provided with means of closing so as to permit the control of draught and smoke.

Machinery for lifts located within stairway enclosures shall be arranged in a separate room, surrounded by steel boundaries, except that small passages for lift cables are permitted. Lifts which open into spaces other than corridors, public spaces, special category spaces, stairways and external areas shall not open into stairways included in the means of escape.

2 Penetration in fire-resisting divisions

2.1 Penetrations in A class divisions

2.1.1

Where A class divisions are penetrated, such penetrations shall be tested in accordance with the Fire Test Procedures Code. In the case of ventilation ducts, [6.2.2] and [6.3.1] apply. However, where a pipe penetration is made of steel or equivalent material having a thickness of 3 mm or greater and a length of not less than 900 mm (preferably 450 mm on each side of the division), and no openings, testing is not required. Such penetrations shall be suitably insulated by extension of the insulation at the same level of the division.

2.2 Penetrations in B class divisions

2.2.1

Where B class divisions are penetrated for the passage of electrical cables, pipes, trunks, ducts, etc., or for the fitting of ventilation terminals, lighting fixtures and similar devices, arrangements shall be made to ensure that the fire resistance is not impaired, subject to the provisions of [6.3.4] . Pipes other than steel or copper that penetrate "B" class divisions shall be protected by either:

a) a fire tested penetration device, suitable for the fire resistance of the division pierced and the type of pipe used provided the penetration is installed and insulated as tested; or

b) a steel sleeve, having a thickness of not less than 1.8 mm and a length of not less than 900 mm for pipe diameters of 150 mm or more and not less than 600 mm for pipe diameters of less than 150 mm (preferably equally divided to each side of the division). The pipe shall be connected to the ends of the sleeve by flanges or couplings; or the clearance between the sleeve and the pipe shall not exceed 2.5 mm; or any clearance between pipe and sleeve shall be made tight by means of non-combustible or other suitable material.

2.3 Pipes penetrating A or B class divisions

2.3.1

Uninsulated metallic pipes penetrating "A" or "B" class divisions shall be of materials having a melting temperature which exceeds 950ºC for “A-0” and 850ºC for “B-0” class divisions.

3 Protection of openings in fire-resisting divisions

3.1 Openings in bulkheads and decks

3.1.1 Openings in A class divisions

a) Except for hatches between store and baggage spaces, and between such spaces and the weather decks, all openings shall be provided with permanently attached means of closing which shall be at least as effective for resisting fires as the divisions in which they are fitted.

b) The construction of all doors and door frames, as well as horizontal hatches and hatch coaming, in A class divisions, with the means of securing them when closed, shall provide resistance to fire as well as to the passage of smoke and flame, as far as practicable, equivalent to that of the bulkhead or deck in which the doors or hatches are situated. Such doors and door frames, as well as horizontal hatches and hatch coaming, shall be constructed of steel or other equivalent material.

   Sliding watertight doors need not be insulated.

c) It shall be possible for each door or hatch to be opened and closed from each side of bulkhead or deck, as appropriate, by one person only.

d) Fire doors in main vertical zone bulkheads, galley boundaries and stairway enclosures other than power-operated watertight doors and those which are normally locked, shall satisfy the following requirements:

   1) the doors shall be self-closing and be capable of closing against an angle of inclination of up to 3,5° opposing closure

   2) the approximate time of closure for hinged fire doors shall be no more than 40 s and no less than 10 s from the beginning of their movement with the ship in upright position. The approximate uniform rate of closure for sliding fire doors shall be of no more than 0,2 m/s and no less than 0,1 m/s with the ship in the upright position.

   3) the doors shall be capable of remote release from the continuously manned central damage control station, either simultaneously or in groups and shall be capable of release also individually from a position at both sides of the door. Release switches shall have an on-off function to prevent automatic resetting of the system.

   4) hold-back hooks not subject to central control damage station release are prohibited

   5) a door closed remotely from the central damage control station shall be capable of being re-opened at both sides of the door by local control. After such local opening, the door shall automatically close again.

6) indication shall be provided at the fire door indicator panel in the continuously manned central damage control station whether each of the remote-released doors is closed

7) the release mechanism shall be so designed that the door will automatically close in the event of disruption of the control system or central power supply

8) local power accumulators for power-operated doors shall be provided in the immediate vicinity of the doors to enable the doors to be operated after disruption of the control system or central power supply at least ten times (fully opened and closed) using the local controls

9) disruption of the control system or central power supply at one door shall not impair the safe functioning of the other doors

10) remote-released sliding or power-operated doors shall be equipped with an alarm that sounds for at least 5 s but no more than 10 s after the door is released from the central control station and before the door begins to move and continues sounding until the door is completely closed

11) a door designed to re-open upon contacting an object in its path shall re-open not more than 1 m from the point of contact

12) double-leaf doors equipped with a latch necessary to their fire integrity shall have a latch that is automatically activated by the operation of the doors when released by the control system

13) doors giving direct access to special purpose spaces which are power-operated and automatically closed need not be equipped with the alarms and remote-release mechanisms required in items 3) and 10)

14) the components of the local control system shall be accessible for maintenance and adjusting, and

15) power-operated doors shall be provided with a control system of an approved type which shall be able to operate in case of fire, this being determined in accordance with the Fire Test Procedures Code. This system shall satisfy the following requirements:

- the control system shall be able to operate the door at a temperature of at least 200°C for at least 60 min, served by the power supply
- the power supply for all other doors not subject to fire shall not be impaired, and
- at temperatures exceeding 200°C the control system shall be automatically isolated from the power supply and shall be capable of keeping the door closed up to at least 945°C.

e) In any case horizontal hatches, exterior doors and machinery spaced doors shall be provided with a system signalling their closed position in the central damage control stration.

f) The requirements for "A" class integrity of the outer boundaries of a ship shall not apply to glass partitions, windows and side scuttles, provided that there is no requirement for such boundaries to have "A" class integrity in item c) of [3.1.3].

g) Except for watertight doors, weather tight doors, doors leading to the open deck and doors which need to be reasonably gastight, all "A" class doors located in stairways, public spaces and main vertical zone bulkheads in escape routes shall be equipped with a self-closing hose port of material, construction and fire resistance which is equivalent to the door into which it is fitted, and shall be a 150 mm square clear opening with the door closed and shall be inset into the lower edge of the door, opposite the door hinges or, in the case of sliding doors, nearest the opening.

h) Where it is necessary that a ventilation duct passes through a main vertical zone division, a fail-safe automatic closing fire damper shall be fitted adjacent to the division. The damper shall also be capable of being manually closed from each side of the division. The operating position shall be readily accessible and be marked in red light-reflecting colour. The duct between the division and the damper shall be of steel or other equivalent material and, if necessary, insulated to comply with the requirements of item [2.1]. The damper shall be fitted on at least one side of the division with a visible indicator showing whether the damper is in the open position.

3.1.2 Openings in B class divisions

a) Doors and door frames in B class divisions and means of securing them shall provide a method of closure which shall have resistance to fire equivalent to that of the divisions, this being determined in accordance with the Fire Test Procedures Code, except that ventilation openings may be permitted in the lower portion of such doors. Where such opening is in or under a door, the total net area of any such opening or openings shall not exceed 0,05 m^2. When such opening is cut in a door it shall be fitted with a grill made of non-combustible material. Doors shall be non-combustible.

Cabin doors in B class divisions shall be of a self-closing type. Hold-backs are not permitted.

Alternatively, a non-combustible air balance duct arrangement between a cabin and a corridor, which is located below the sanitary unit leading through the corridor bulkhead, is permitted in order to achieve air balance of supply and exhaust air for the cabin provided that the cross-sectional area of the duct does not exceed 0,05 m^2.

b) The requirements for "B" class integrity of the outer boundaries of a ship shall not apply to glass partitions, windows and side scuttles. Similarly, the requirements for "B" class integrity shall not apply to exterior doors in superstructures and deckhouses.

3.1.3 Windows and side scuttles

a) Windows and side scuttles in bulkheads within accommodation and service spaces and control stations other than those to which the provisions of item f) of [3.1.1] and item c) of [3.1.2] apply, shall be so constructed as to preserve the integrity requirements of the type of bulkheads in which they are fitted, this being determined in accordance with the Fire Test Procedures Code.

b) Notwithstanding the requirements of Tab 1 to Tab 4, windows and side scuttles in bulkheads exposed to the weather, separating accommodation and service spaces and control stations shall be constructed with frames of steel or other suitable material. The glass shall be retained by a metal glazing bead or angle.

c) Windows facing life-saving appliances, embarkation and assembly stations, external stairs and open decks used for escape routes, and windows situated below liferaft and escape slide embarkation areas shall have fire integrity as required in Tab 1 and Tab 2, as applicable. Where automatic dedicated sprinkler heads are provided for windows, "A-0" windows may be accepted as equivalent. To be considered under this paragraph, the sprinkler heads must either be:

   1) dedicated heads located above the windows, and installed in addition to the conventional ceiling sprinklers; or

   2) conventional ceiling sprinkler heads arranged such that the window is protected by an average application rate of at least 5 l/min·m^2 and the additional window area is included in the calculation of the area of coverage.

Windows located in the ship's side below the lifeboat embarkation area shall have fire integrity at least equal to "A-0" class.

4 Protection of openings in machinery space boundaries

4.1 Application

4.1.1 The provisions of Article [4] shall apply to all machinery spaces.

4.2 Protection of openings in machinery space boundaries

4.2.1 The number of doors, ventilators, openings in funnels to permit exhaust ventilation and other openings to machinery spaces shall be reduced to a minimum consistent with the needs of ventilation and the proper and safe working of the ship.

4.2.2 Means of control shall be provided for closing power-operated doors or actuating the release mechanism on doors other than power-operated watertight doors. The control shall be located outside the space concerned, where it will not be cut off in the event of fire in the space it serves.

4.2.3 The control required in item [4.2.2] shall be situated at one control position or grouped in as few positions as possible to the satisfaction of the Society.

4.2.4 Doors other than power-operated watertight doors shall be so arranged that positive closure is assured in the event of fire in the space, by power-operated closing arrangements or by the provision of self-closing doors capable of closing against an inclination of 3,5° opposing closure and having a fail-safe hook-back facility, provided with a remotely operated release device.

4.2.5 Windows shall not be fitted in machinery space boundaries. This does not preclude the use of glass in control rooms within the machinery spaces.

5 Protection of cargo space boundaries

5.1 Application

5.1.1 The boundary bulkheads and decks of closed vehicle spaces, ro-ro vehicle spaces and aircraft hangars shall have fire integrity as required for category (14) in Tab 1 and Tab 2.

5.2 Indicators

5.2.1 Indicators shall be provided on central damage control station which shall indicate when any fire door leading to or from vehicle spaces, ro-ro vehicle spaces or aircraft hangars, is closed.

6 Ventilation systems

6.1 Duct and dampers

6.1.1 Ventilation ducts shall be of non-combustible material. Short ducts, however, not generally exceeding 2 m in length and with a cross-section not exceeding 0,02 m^2 need not be non-combustible, subject to the following conditions:

a) these ducts shall be of a material which has low flame spread characteristics

b) they may only be used at the end of the ventilation device

c) they shall not be situated less than 600 mm, measured along the duct, from an opening in an A or B class division including continuous B class ceilings.

Flexible bellows of combustible material may be used for connecting fans to the ducting in the air conditioning room.

6.1.2 The following arrangements shall be tested in accordance with the Fire Test Procedures Codes:

a) fire dampers, including relevant means of operation, and

b) duct penetrations through A class divisions. Where steel sleeves are directly joined to ventilation ducts by means of rivetted or screwed flanges or by welding, the test is not required.

6.2 Arrangements of ducts

6.2.1 Ducts provided for the ventilation of machinery spaces of category A, galleys, vehicle spaces, ro-ro vehicle spaces or aircraft hangars shall not pass through accommodation spaces, service spaces or control stations unless the ducts are either:

a) constructed of steel having a thickness of at least 2,5 mm

b) suitably supported and stiffened in relation to widths or diameters

c) fitted with manual and automatic fire dampers close to the boundaries penetrated, and

d) insulated to A-60 standard from the machinery spaces, galleys, vehicle spaces, ro-ro vehicle spaces or aircraft hangars to a point at least 5 m beyond each fire damper

or

e) constructed of steel in accordance with the above items a) and b), and

f) insulated to A-60 standard throughout the accommodation spaces, service spaces or control stations,

except that penetrations of main zone divisions shall also comply with the requirements of [6.3.1].

6.2.2 With reference to the requirements of [6.2.1] the following items a) and b) apply.

a) Galley ventilation systems are to be separated from ventilation systems serving other spaces.

b) The ventilation systems for machinery spaces of category A, vehicle spaces, ro-ro vehicle spaces, aircraft hangars and cargo spaces in general are to be separated from each other and from the ventilation systems serving other spaces.

6.2.3 Ducts provided for ventilation to accommodation spaces, service spaces or control stations shall not pass through machinery spaces of category A, galleys, vehicle spaces, ro-ro vehicle spaces or aircraft hangars unless either**:**

a) the ducts where they pass through a machinery space of category A, galley, vehicle spaces, ro-ro vehicle spaces or aircraft hangars are constructed of steel in accordance with items (a) and (b) of [6.2.1]

b) manual and automatic fire dampers are fitted close to the boundaries penetrated, and

c) the integrity of the machinery space, galley, vehicle spaces, ro-ro vehicle spaces or aircraft hangars boundaries is maintained at the penetrations

or

d) the ducts where they pass through a machinery space of category A, galley, vehicle spaces, ro-ro vehicle spaces or aircraft hangars are constructed of steel in accordance with items (a) and (b) of [6.2.1], and

e) are insulated to A-60 standard within the machinery space, galley, vehicle spaces, ro-ro vehicle spaces or aircraft hangars,

except that penetrations of main zone divisions shall also comply with the requirements of item [6.3.1].

6.2.4 Balancing openings or ducts between two enclosed spaces are prohibited except for openings as permitted by item [3.1.2].

6.3 Details of duct penetration

6.3.1 Where it is necessary that a ventilation duct passes through a main vertical zone division, a fail-safe automatic closing fire damper shall be fitted adjacent to the division. The damper shall also be capable of being manually closed from each side of the division. The operating position shall be readily accessible and be marked in red light-reflecting colour. The duct between the division and the damper shall be of steel or other equivalent material and, if necessary, insulated to comply with the requirements of item [2.1.1]. The damper shall be fitted on at least one side of the division with a visible indicator showing whether the damper is in the open position.

6.3.2 Where the ventilation ducts with a free-sectional area exceeding 0,02 m^2 pass through A class bulkheads or decks, the opening shall be lined with a steel sheet sleeve unless the ducts passing through the bulkheads or decks are of steel in the vicinity of passage through the deck or bulkhead and the ducts and sleeves shall comply with the following:

a) The sleeves shall have a thickness of at least 3 mm and a length of at least 900 mm. When passing through bulkheads, this length shall be divided preferably into 450 mm on each side of the bulkhead. These ducts, or sleeves lining such ducts, shall be provided with fire insulation. The insulation shall have at least the same fire integrity as the bulkhead or deck through which the duct passes. Equivalent penetration protection may be provided to the satisfaction of the Society.

b) Ducts with a free cross-sectional area exceeding 0,075 m^2 shall be fitted with fire dampers in addition to the requirements of the preceding item a). The fire damper shall operate automatically but shall also be capable of being closed manually from both sides of the bulkhead or deck. The dampers shall be provided with an indicator which shows whether the damper is open or closed. Fire dampers are not required, however, where ducts pass through spaces surrounded by A class divisions, without serving those spaces, provided those ducts have the same fire integrity as the divisions which they pierce.

6.3.3 With reference to the requirements of item [6.3.2], the following items a) and b) apply.

a) The term “free-sectional area” means, even in the case of a pre-insulated duct, the area calculated on the basis of the inner diameter of the duct.

b) Where a thin plated duct with a free-sectional area equal to or less than 0,02 m^2 passes through A class bulkheads or decks, the opening is to be lined with a steel sheet sleeve having a thickness of at least 3 mm and a length of at least 200 mm divided preferably into 100 mm on each side of the bulkhead or, in the case of the deck, totally laid on the lower side of the decks pierced.

6.3.4 Ventilation ducts with a free cross-sectional area exceeding 0,02 m^2 passing through B class bulkheads shall be lined with steel sheet sleeves of 900 mm in length divided preferably into 450 mm on each side of the bulkheads unless the duct is of steel for this length.

6.4 Ventilation systems

6.4.1 The ventilation fans shall be so disposed that the ducts reaching the various spaces remain within the main vertical zone.

6.4.2 Where ventilation systems penetrate decks, precautions shall be taken, in addition to those relating to the fire integrity of the deck required by item [2.1], to reduce the likelihood of smoke and hot gases passing from one deck space to another through the system. In addition to insulation requirements contained in item [6.4.3], vertical ducts shall, if necessary, be insulated as required by [1.2.3], as appropriate.

6.4.3 Except in vehicle spaces, ro-ro vehicle spaces and aircraft hangars, ventilation ducts shall be constructed of the following materials:

a) ducts not less than 0,075 m^2 in sectional area and all vertical ducts serving more than a single 'tweendeck space shall be constructed of steel or other equivalent material

b) ducts less than 0,075 m^2 in sectional area, other than the vertical ducts referred to in the preceding item a), shall be constructed of non-combustible materials. Where such ducts penetrate A or B class divisions due regard shall be given to ensuring the fire integrity of the division.

c) short lengths of duct, not in general exceeding 0,02 m^2 in sectional area nor 2 m in length, need not be non-combustible provided that all of the following conditions are met:

   1) the duct is constructed of a material of low flame spread characteristics

   2) the duct is used only at the terminal end of the ventilation system, and

   3) the duct is not located closer than 600 mm measured along its length to a penetration of an A or B class division, including continuous B class ceilings.

6.4.4 Stairway enclosures shall be ventilated and shall be served only by an independent fan and duct system which shall not serve any other spaces in the ventilation system.

6.4.5 Ventilation ducts shall be provided with suitably located hatches for inspection and cleaning.

They need to be provided only in exhaust ducts and are to be located in the vicinity of the fire dampers.

6.4.6 Ammunitions spaces ventilation systems shall be independed of other ventilation systems.

Torpedo magazines shall be provided with a dedicated ventilation system which shall be also possible to stop locally.

The ducts of systems outside the spaces, shall be sized against impacts, and shocks as indicated by the Naval Authority.

6.5 Exhaust ducts from galley ranges

6.5.1 Exhaust ducts from galley ranges in which grease or fat is likely to accumulate shall meet the requirements of items a) and b) of [6.2.2] and shall be fitted with:

a) a grease trap readily removable for cleaning unless an alternative approved grease removal system is fitted

b) a fire damper located in the lower end of the duct which is automatically and remotely operated, and in addition a remotely operated fire damper located in the upper end of the duct

c) a fixed means for extinguishing a fire within the duct

d) remote control arrangements for shutting off the exhaust fans and supply fans, for operating the fire dampers mentioned in item b) and for operating the fire-extinguishing system, which shall be placed in a position close to the entrance to the galley. Where a multi-branch system is installed, means shall be provided to close all branches exhausting through the same main duct before an extinguishing medium is released into the system; and

e) suitably located hatches for inspection and cleaning.

The requirements given in items a) to e) above apply to all exhaust ducts from galley ranges in which grease or fat is likely to accumulate from galley ranges.

With reference to the requirement of item e) above:

- one hatch is to be provided close to the exhaust fan
- in the galley exhaust duct the grease will accumulate more in the lower end. Therefore, hatches are to be fitted also in this part of the duct.

6.6 Accessibility of fire dampers

6.6.1 The fire dampers are to be easily accessible. Where they are placed behind ceilings or linings, these are to be provided with an inspection door on which a plate indicates the identification number of the fire damper. Such plate and identification number are to be placed also on any remote control required.

SECTION 6 SUPPRESSION OF FIRE AND EXPLOSION FIRE-FIGHTING

1 Water supply systems

1.1 General

1.1.1 Every ship shall be provided with fire pumps, fire mains, hydrants and hoses complying as applicable with the requirements of this Section.

1.1.2 For the purpose of this this section hydrants and fire stations have the same meaning.

1.2 Fire mains and hydrants

1.2.1 General

Materials readily rendered ineffective by heat shall not be used for fire mains and hydrants unless adequately protected. The use of diaphragm valves in which rubber membrane is fitted may be accepted providing that their efficiency would not be impaired in case of exposure to heat sources, this being demonstrated to the satisfaction of the Society.

The pipes and hydrants shall be so placed that the fire hoses may be easily coupled to them. The arrangements of pipes and hydrants shall be such as to avoid the possibility of freezing.

Suitable drainage provisions shall be provided for fire main piping. Isolation valves shall be installed for all open deck fire main branches used for purposes other than fire fighting.

Other systems supplied by fire main that are required to operate in case of fire fighting are to be clearly indicated in the fire control plan together with the relevant water demand (e.g. bilge ejectors, sprinkler systems, etc.).

1.2.2 Ready availability of water supply

The arrangements for the ready availability of water supply shall be such that at least two effective jets of water are available from any two hydrants by remote starting from a control station of at least one fire pump.

There shall be possible to start the fire pumps from a position near to their location.

1.2.3 Diameter of the fire mains

The diameter of the fire main and water service pipes shall be sufficient for the effective distribution of the maximum required discharge of water from fire pumps feeding:

a) four hydrants for front line ships and other ships capable of carrying more than 240 persons including the crew or two hydrants for second line and auxiliary ships, and

b) the most demanding fire extinguishing system and

c) other systems supplied by fire main that are required to operate in case of fire fighting.

1.2.4 Isolating valves and relief valves

a) Isolating valves to separate the section of the fire main within within the machinery space containing the main fire pump or pumps from the rest of the fire main shall be fitted in an easily accessible and tenable position outside the machinery spaces.

The fire main shall be so arranged that when the isolating valves are shut all the hydrants of the ship, except those in the machinery space referred to above, can be supplied with water by another fire pump with seawater inlet, suction and delivery pipes and isolating valves located outside the machinery space.

The isolating valves shall be controlled and operated from the central damage control station and, in case of operating energy failure, they shall remain in the previous closed or open position. Local manual operation of isolating valves from above the bulkhead deck shall be also possible.

b) Additional isolating valves are also to be provided to separate a damaged length of fire main in a main vertical zone or in a safety zone or in a horizontal zone; the undamaged parts of the fire main shall be capable of feeding all hydrants and other systems supplied by fire main that are required to operate in case of fire fighting which are located outside the damage area.

Such valves are be fitted in an easily accessible and tenable position for local manual operation.

c) A valve shall be fitted to serve each fire hydrant so that any fire hose may be removed while the fire pumps are at work.

d) Relief valves shall be provided in conjunction with all fire pumps. These valves shall be so placed and adjusted as to prevent excessive pressure in any part of the fire main system.

e) Non return check valves shall be fitted on the delivery side of fire pumps and as well as isolating valves on their suction side.

1.2.5 Number and position of hydrants

a) The number and position of hydrants shall be such that with one hose length connected to any hydrant and with two hose lengths connected to the nearby hydrant it shall be possible to reach with the free ends of such hose lengths any part of the ship normally accessible to the crew while the ship is navigating as well as any part of vehicle spaces, ro-ro vehicle spaces, and hangars.

Furthermore, hydrants, as far as it is practicable, shall be located near the accesses to the protected spaces.

For the purpose of this item [1.2.5] at least two hydrants are to be provided in machinery spaces of category A which shall be located near the escape exit of the space.

b) In addition, ships shall comply with the following:

1) In the accommodation, service, machinery spaces, vehicle spaces, ro-ro vehicle spaces and hangars the number and position of hydrants shall be such that the requirements of item a) above may be complied with when all watertight doors and all doors in safety zones bulkheads are closed.

2) Where access is provided to a machinery space of category A at a low level from an adjacent shaft tunnel, two hydrants shall be provided external to, but near the entrance of that machinery space. Where such access is provided from other spaces, in one of those spaces two hydrants shall be provided near the entrance to the machinery space of category A. Such provision need not be made where the tunnel or adjacent spaces are not part of the escape route.

3) A fire station shall be fitted nearby the doors of torpedo magazines.

1.2.6 Pressure at hydrants

With two fire pumps simultaneously delivering water through the nozzles specified in [1.4.3], with the quantity of water specified in [1.2.3], the pressure at all hydrants shall be at least 4 bar and the maximum pressure at any hydrant shall not exceed that at which the effective control of a fire hose can be demonstrated.

1.2.7 International shore connection

Ships shall be provided with at least one international shore connection, complying with Sec 13. Facilities shall be available enabling such a connection to be used on either side of the ship.

1.3 Fire pumps

1.3.1 Pumps accepted as fire pumps

Sanitary, ballast, bilge or general service pumps may be accepted as fire pumps, provided that they are not used for pumping oil.

Where fire pumps may also be used as bilge/ballast pumps, simultaneous fire and bilge/ballast pumping requirements must be accommodated.

1.3.2 Number and arrangement of fire pumps

In each safety zone below the bulkhead deck there shall be installed two fire pumps and each pump shall be fed by main and emergency source of electrical power supply or by duplicated sources of electrical power complying with Pt C, Ch 2, Sec 3, [2.3.1].

When the ship is not subdivided in safety zones, the number and location of fire pumps shall be such as to ensure the capacity required in [1.3.4] in case of fire in any one compartment and in any foreseeable case of flooding (see Pt B, Ch 3, Sec 3).

In this respect, particular attention is to be paid to fire compartment divisions, sea water connections and sources of electrical power.

1.3.3 Number and arrangement of hand-borrow pumps

Ships shall be provided with at least one hand-borrow pump for each safety zone but, in any case, not less than two pumps per ship.

In each safety zone there shall be provided arrangements in appropriate positions for the connection of hand-borrow pumps to the fire main.

In each safety zone arrangement shall be provided for sea water suction with non return valve and for the exhausted combustion gas of hand-borrow pumps.

1.3.4 Capacity of fire pumps

The fire pumps of each safety zone shall be capable of supplying the systems indicated in [1.2.3] at the pressure stated in [1.2.6].

Each of the required fire pumps shall have a capacity not less than 80% of the total required capacity divided by the minimum number of required fire pumps, but in any case not less than 25 m^3/h. Where more pumps than the minimum of required pumps are installed, such additional pumps shall have a capacity of at least 25 m^3/h.

1.4 Fire hoses and nozzles

1.4.1 Specification of hoses

a) Fire hoses shall be of non-perishable material approved by the Society or by the Naval Authority and shall be sufficient in length to project a jet of water to any of the spaces in which they may be required to be used.

Each hose shall be provided with a nozzle and the necessary couplings and, together with any necessary fittings and tools, shall be kept ready for use in conspicuous positions near the water service hydrant. Additionally, in interior locations, fire hoses shall be connected to the hydrants at all times.

Unless otherwise stated by the Naval Authority, fire hoses shall have a length of at least 10 metres, but not more than:

- 15 metres in machinery spaces;
- 20 metres in other spaces and open decks;
- 25 metres for open decks on ships with a maximum breadth in excess of 30 metres.

b) One fire hoses and one nozzle shall be provided for each hydrant of the ship.

1.4.2 Diameter of hydrants and fire stations

Hydrants diameter shall be either 45 mm or 70 mm as determined by the Naval Authority.

Fire station shall be equipped in accordance with Naval Authority standards.

1.4.3 Size and type of nozzles

a) Nozzles shall be in accordance with standards of the Naval Authority. In absence of such standards, nozzles sizes shall be 12 mm, 16 mm and 19 mm or as near thereto as possible. Larger diameter nozzles may be permitted at the discretion of the Society.

b) For accommodation and service spaces, a nozzle size greater than 12 mm need not be used.

c) For machinery spaces and exterior locations the nozzle size, not exceeding 19 mm, shall be such as to obtain the maximum discharge possible from two jets at the pressure mentioned in [1.2.6] from the smallest pump.

d) All nozzles shall be of an approved dual purpose type (i.e. spray/jet type) incorporating a shut-off.

2 Portable fire extinguishers

2.1 Type and design

2.1.1 All fire extinguishers are to comply with the requirements of Sec 13.

2.2 Arrangement of fire extinguishers

2.2.1

In enclosed spaces, near each hydrant there shall be provided two portable foam fire extinguishers or equivalent. Furthermore:

- In the proximity of any electric switchboard a semi-portable CO_2 fire extinguisher of about 20 kg of CO_2 shall be provided
- In the proximity of any section board having a power of 20 kW and upwards at least one powder extinguisher
- Any service space where deep fat cooking equipment is installed shall be fitted with at least one powder fire extinguisher
- In the proximity of any paint or flammable locker at least one powder extinguisher shall be provided
- In control stations at least one CO_2 fire extinguisher shall be provided.

2.3 Periodical test

2.3.1 Fire extinguishers shall be periodically examined and subjected to such tests as the Society may require.

See Part A, Chapter 3.

3 Fixed fire-extinguishing systems

3.1 Types of fixed fire-extinguishing systems

3.1.1

A fixed fire extinguishing system could be any of the following systems:

a) a fixed gas fire-extinguishing system complying with the provisions of Sec 13

b) a fixed high expansion foam fire-extinguishing system complying with the provisions of Sec 13

c) a fixed pressure water-spraying and water-mist fire-extinguishing system complying with the provisions of Sec 13.

d) any other fire-extinguishing system considered appropriate by the Society and the Naval Authority.

3.1.2 Where a fixed fire-extinguishing system not required by this Chapter is installed, such system shall meet the relevant requirements of this Chapter.

3.2 Closing appliances for fixed gas fire-extinguishing systems

3.2.1 Where a fixed gas fire-extinguishing system is used, means shall be provided to close, at the starting of the system, all openings which may admit air to or allow gas to escape from a protected space.

3.3 Storage rooms for fire-extinguishing medium

3.3.1 Gas fire-extinguishing medium bottles or containers for fixed or semi-fixed systems shall have their safety device (rupture disc), and where appropriate their main safety valve (or rupture disc) provided with an exhausted pipe discharging to the open.

Dedicated storage rooms for gas fire-extinguishing medium bottles, or containers, shall have fire integrity complying with Sec 5, considering such rooms as control stations.

The arrangements of non dedicated storage rooms for gas fire- extinguishing medium bottle, or containers, shall comply with the requirements for dedicated rooms as the Society may consider practicable and reasonable.

In any case the requirements of Sec 13 shall be comply with

Where manned control stations are provided with semi-fixed gas fire extinguishing medium systems their ventilation system is to be provided with at least two exhaust outlets positioned well apart.

3.4 Water pumps for other fire-extinguishing systems

3.4.1 Pumps required for the provision of water for other fire-extinguishing systems required by this chapter, their sources of power and their controls shall be installed outside the space or spaces protected by such systems and shall be so arranged that a fire in the space or spaces protected will not put any such system out of action.

4 Fire-extinguishing arrangements in machinery spaces

4.1 Machinery spaces arrangement

4.1.1 General

a) The arrangement of machinery spaces is to be such that safe storage and handling of flammable liquids is ensured.

b) The ventilation of machinery spaces shall be sufficient under all normal conditions to prevent accumulation of oil vapour.

All spaces where oil-consuming installations, settling tanks or daily service fuel tanks are located are to be easily accessible and well ventilated.

c) Where leakage of flammable liquids may occur during normal service or routine maintenance work, a special arrangement is to be made to prevent these fluids from reaching other parts of the machinery where danger of ignition may arise.

d) Materials used in machinery spaces are not normally to have properties increasing the fire potential of these rooms. Neither combustible nor oil-absorbing materials are to be used as flooring, bulkhead lining, ceiling or deck in the control room, machinery spaces, shaft tunnel or rooms where oil tanks are located. Where penetration of oil products is possible, the surface of the insulation is to be impervious to oil or oil vapours.

4.1.2 Segregation of fuel oil purifiers, JP5-NATO (F44) purifiers and other systems for preparing flammable liquids

a) The system (such as purifiers) for preparing flammable liquids for use in boilers and machinery, and separate oil systems with working pressure above 1,5 MPa which are not part of the main engines, auxiliary engines or boilers etc., are subject to the following additional requirements.

b) The main components in the systems are to be placed in a separate room, enclosed by steel bulkheads extending from deck to deck and provided with self-closing steel doors.

c) Rooms in which flammable liquids are handled as specified in a) above are to be provided with:

- independent mechanical ventilation or ventilation arrangements which can be isolated from the machinery space ventilation
- a fire detecting system
- a fixed fire-extinguishing installation. The extinguishing installation is to be capable of being activated from outside the room. The extinguishing system is to be separated from the room, but may be a part of the main fire-extinguishing system for the machinery space. Closing of ventilation openings is to be effected from a position close to where the extinguishing system is activated.

d) Where the size of the engine room makes it impracticable to locate the main components of such systems in a separate space, special consideration will be given by the Society with regard to the location, containment of possible leakages and shielding of the components, and to ventilation.

A local fixed fire-extinguishing system is to be provided, capable of being activated automatically or activated manually from the machinery control position or from another suitable location. If automatic release is provided, additional manual release is to be arranged.

e) Arrangements and fire safety measures of JP5-NATO (F44) purifiers for aircrafts and/or helicopters shall comply with the requirements of items b) and c).

4.2 Machinery spaces containing oil fired boilers or fuel oil units

4.2.1 Fixed fire-extinguishing systems

Machinery spaces of category A containing oil fired boilers or fuel oil units shall be provided with any one of the fixed fire-extinguishing systems in [3.1].

In each case if the engine and boiler rooms are not entirely separate, or if fuel oil can drain from the boiler room into the engine room, the combined engine and boiler rooms shall be considered as one compartment.

4.2.2 Additional fire-extinguishing arrangements

a) There shall be in each boiler room at least one set of portable foam applicator units complying with the provisions of Sec 13.

b) There shall be at least two portable foam extinguishers or equivalent in each firing space in each boiler room and in each space in which a part of the fuel oil installation is situated. There shall be not less than one approved foam-type extinguisher of at least 135 l capacity or equivalent in each boiler room.

For fire extinguishers in the proximity of any electric switchboard or section board see item [2.1.1].

c) The portable foam applicator in item a) and the 135 l capacity extinguisher in item b) may be omitted where the fire stations, see item [1.1.2], are provided with foam making arrangements by the 12 m length fire hose.

4.3 Machinery spaces containing internal combustion machinery

4.3.1 Fixed fire-extinguishing systems

Machinery spaces of category A containing internal combustion machinery (such as gas turbines) shall be provided with one of the fire-extinguishing systems required in [3.1].

4.3.2 Additional fire-extiguishing arrangements

a) At least one set of portable foam applicator units complying with the provisions of Sec 13.

b) In each such space approved foam-type fire extinguishers, each of at least 45 l capacity or equivalent, sufficient in number to enable foam or its equivalent to be directed on to any part of the fuel and lubricating oil pressure systems, gearing and other fire hazards.

c) In the case of machinery spaces containing both boilers and internal combustion engines [4.2] and [4.3] apply, with the exception that one of the foam fire extinguishers of at least 45 l capacity or equivalent may be omitted provided that the 136 l extinguisher can efficiently and readily protect the area covered by the 45 l extinguishers.

d) For fire extinguishers in the proximity of electric switchboard or section board see item [2.2.1] .

e) The portable foam applicator in item a) and the fire extinguishers 45 l and 136 l in item b) may be omitted where the fire stations, see item [1.1.2], are provided with foam making arrangements by the 12 m length fire hose.

4.4 Other machinery spaces

4.4.1 Where in the opinion of the Society, a fire hazard exists in any machinery space for which no specific provisions for fire-extinguishing appliances are prescribed in [4.2], [4.3] and [4.5], there shall be provided in, or adjacent to, that space such a number of approved portable fire extinguishers or other means of fire extinction as the Society may deem sufficient.

4.5 Fixed local application fire-extinguishing systemsnes

4.5.1

In addition to the fixed fire-extinguishing system required in [3.1.1], machinery spaces of category A shall be protected by an approved type of fixed water-based or equivalent local application fire-extinguishing system. In the case of periodically unattended machinery spaces, the fire-extinguishing system shall have both automatic and manual release capabilities. In the case of continuously manned machinery spaces, the fire-extinguishing system is only required to have a manual release capability.

The automatic activation of the system may be achieved by means of a detection system capable of reliably identify the protected area.

The possibility of false alarms is to be taken into consideration when designing such an achievement.

4.5.2

Fixed local application fire-extinguishing systems are to protect areas such as the following without the necessity of engine shutdown, personnel evacuation, or sealing of the spaces:

- the hazard portions of internal combustion machinery used for ship's main propulsion and power generation
- boiler fronts
- the fire hazard portions of incinerators, and
- purifiers for heated fuel oil.

4.5.3

Activation of any local application system shall give a visual and distinct audible alarm in the protected space, at a continuously manned damage control station. The alarms shall indicate the specific system activated. The alarm requirements described within this paragraph are in addition to, and not to substitute for, the detection and fire alarm system required elsewhere in this Chapter.

4.5.4

This item [4.5.4] applies to the installation of electrical and electronic equipment in spaces protected by fixed water-based local application fire-fighting systems (FWBLAFFS).

a) The following definitions apply (see also Fig 1):

   1) Protected space: a machinery space where an FWBLAFFS is installed

   2) Protected areas: areas within a protected space which is required to be protected by FWBLAFFS

   3) Adjacent areas:

      - areas, other than protected areas, exposed to direct spray
      - areas, other than those defined above, where water may extend.

b) Unless it is essential for safety or operational purposes, electrical and electronic equipment is not to be located within areas protected by FWBLAFFS or in adjacent areas where water may extend.

c) The electrical and electronic equipment located within areas protected by FWBLAFFS and that within adjacent areas exposed to direct spray is to have a degree of protection not less than IP44.

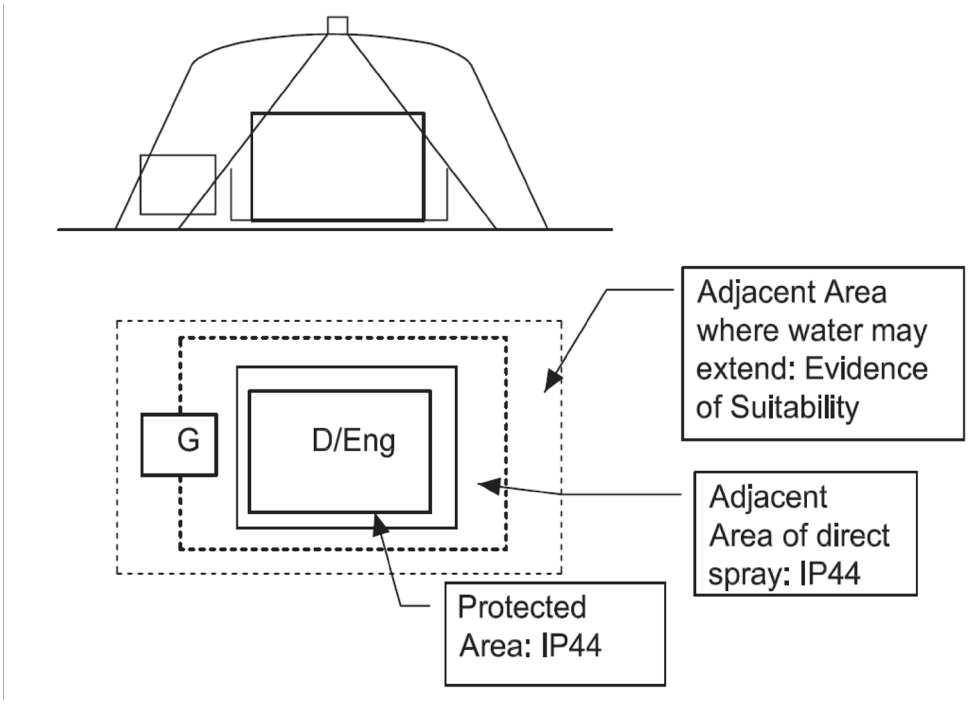
d) Electrical and electronic equipment within adjacent areas not exposed to direct spray may have a lower degree of protection provided evidence of suitability for use in these areas is submitted taking into account the design and equipment layout, e.g. position of inlet ventilation openings, filters, baffles, etc. to prevent or restrict the ingress of water mist/spray into the equipment. The cooling airflow for the equipment is to be assured.

Note 1: Additional precautions may be required to be taken in respect of:

- tracking as a result of water entering the equipment
- potential damage as a result of residual salts from sea water systems
- high voltage installations
- personnel protection against electric shock.

Equipment may require maintenance after being subjected to water mist/spray.

Figure 1 :



5 Fire-extinguishing arrangements in accommodation spaces, service spaces and control stations

5.1 Sprinkler systems

5.1.1 Ships shall be equipped with a sprinkler system complying with the requirements of Sec 13, [8] in all service spaces, control stations] and accommodation spaces, including corridors and stairways. Alternatively, control stations where water may cause damage to essential equipment may be fitted with an approved fire extinguishing system of another type such as systems stated in item [3.1.1] f). Spaces having little or no fire risk such as void, public toilets and similar spaces need not be fitted with a sprinkler system.

5.2 Spaces containing flammable liquid

5.2.1 Paint lockers and flammable liquid lockers shall be protected by an appropriate fire-extinguishing arrangement approved by the Society.

For this purpose, the above lockers shall be provided with a fixed fire-extinguishing system which is to be operable from a position outside the protected locker. The system is to use as fire-extinguishing medium carbon dioxide, dry chemical powder, pressure spray water or another medium considered to be as effective.

If a carbon dioxide fixed fire-extinguishing system is provided, the quantity of carbon dioxide available is to be sufficient to give a minimum volume of free gas equal to 40 per cent of the gross volume of the protected locker. If a fixed pressure water-spraying system is provided, the system may be fed by a connection from the ship's fire main. The number and arrangement of the nozzles are to be such as to ensure an effective distribution of water of at least 5 l/ m^2 per minute over the whole deck surface of the protected locker. If a fixed dry chemical powder fire-extinguishing system is provided, the number and arrangement of the nozzles are to be such as to ensure an effective distribution of powder inside the protected locker with a ratio of at least 0,5 kg/ m^2.

5.3 Deep fat cooking equipment

5.3.1

Deep-fat cooking equipment shall be fitted with the following:

a) an automatic or manual extinguishing system tested to an international standard acceptable to the Society (see Note 1);

b) a primary and backup thermostat with an alarm to alert the operator in the event of failure of either thermostat;

c) arrangements for automatically shutting off the electrical power upon activation of the extinguishing system;

d) an alarm for indicating operation of the extinguishing system in the galley where the equipment is installed; and

e) controls for manual operation of the extinguishing system which are clearly labelled for ready use by the crew.

Note 1: Refer to the recommendations by the International Organization for Standardization, in particular, Publication ISO 15371:2000 on Fire-extinguishing systems for protection of galley deep-fat cooking equipment.

6 Fire-extinguishing arrangements in ammunitions spaces

6.1 Fixed fire-extinguishing systems

6.1.1 Ammunitions spaces shall be provided with a fixed pressure water-spraying fire-extinguishing system complying with Sec 13.

7 Protection of fuel pump rooms

7.1 Fixed fire-extinguishing systems

7.1.1 In addition to complying with [4.5.2], each fuel pump room and/or JP5-NATO (F44) pump room shall be provided with a fixed pressure water-spraying system complying with Sec 13, suitable for machinery spaces and operable locally from a readily accessible position outside the pump room.

8 Firefighter's outfits

8.1 Types of firefighter's outfits

8.1.1 Firefighter's outfits shall comply with Sec 13.

8.2 Number of firefighter's outfits

8.2.1 Each safety zone shall be provided with at least 6 firefighter's outfits.

8.2.2 A firefighter's outfit shall be located nearby torpedo magazines.

8.3 Storage of firefighter's outfits

8.3.1

a) The firefighter's outfits or sets of personal protecting equipment shall be so stored as to be easily accessible and ready for use.

b) In any case the storages of firefighter's outfits in the ships shall be such that at least two firefighter's outfits in each main vertical zone shall be ready reachable from exterior ship's spaces.

9 Emergency escape breathing devices (EEBD)

9.1 Types of EEBD

9.1.1 The emergency escape breathing devices shall comply with Sec 13.

9.2 Number of EEBD

9.2.1

a) There shall be provided and assigned an emergency escape breathing device to each crew member on board of the ship.

b) at least four emergency escape breathing devices shall be carried in each main vertical zone. However, this requirement do not apply to stairway enclosures which constitute individual main vertical zones and for the main vertical zones in the fore or aft end of a ship which do not contain spaces of categories (6), (7), (8), (12), (14) or (15) defined in Sec 5, [1.2.2].

c) In addition each ship shall be provided with a number of EEBD at least equal to 50 percent of the total number of EEBD required in above paragraph.

d) Personnel EEBD and ship EEBD shall be located as stated by the Naval Authority.

SECTION 7 SUPPRESSION OF FIRE AND EXPLOSION STRUCTURAL INTEGRITY

1 Material of hull, superstructures, structural bulkheads, decks and deckhouses

1.1 General

1.1.1

The hull, superstructure, structural bulkheads, decks and deckhouses shall be constructed of steel or other equivalent material. For the purpose of applying the definition of steel or other equivalent material as given in Sec 1, [2.32.1], the "applicable fire exposure" shall be according to the integrity and insulation standards given in Tables 1 to 4 of Sec 5. Where an A class division is required by such Tables the applicable fire exposure shall be of an hour and where an B class division is required by the same Tables the applicable fire exposure shall be of half an hour.

2 Structure of aluminium alloy

2.1 General

2.1.1 Unless otherwise specified in [1.1.1], in cases where any part of the structure is of aluminium alloy, the following shall apply:

a) The insulation of aluminium alloy components of A or B class divisions, except structures which, in the opinion of the Society, are non-load-bearing, shall be such that the temperature of the structural core does not rise more than 200°C above the ambient temperature at any time during the applicable fire exposure to the standard fire test.

b) Special attention shall be given to the insulation of aluminium alloy components of columns, stanchions and other structural member required to support A class divisions (see Sec 5, Tab 1 to Sec 5, Tab 2) to ensure that the temperature rise limitation specified in the preceding item a) shall apply at the end of one hour.

c) With reference to item a) above:

1) When spaces of categories 1 to 10 in Sec 5, [1.2.3] are located on top of aluminium decks , the deck does not need to be insulated from the upper side.

2) A load-bearing division is a deck or bulkhead including stiffeners, pilars, stanchions and other structural members which, if eliminated, would adversely affect the designated structural strength of the ship.

3 Crowns and casings of machinery spaces of category A

3.1 General

3.1.1 Crowns and casings of machinery spaces of Category A shall be of steel construction adequately insulated and openings therein, if any, shall be suitably arranged and protected to prevent the spread of fire.

4 Materials of overboard fittings

4.1 General

4.1.1 Materials readily rendered ineffective by heat shall not be used for overboard scuppers, sanitary discharges, and other outlets.

SECTION 8 ESCAPE

1 Notification of crew and embarked personnel

1.1 General emergency alarm system

1.1.1 A general emergency alarm system as required in Ch 3, Sec 3 shall be installed to notify crew of a fire.

1.2 Public address systems

1.2.1

A public address system (main broadcast system) or other effective means of communication complying with the requirements of Ch 2, Sec 3 shall be available throughout the accommodation and service spaces and control stations and open decks.

2 Means of escape

2.1 General

2.1.1 Unless expressly provided otherwise in this item, at least two widely separated and ready means of escape are to be provided from all spaces or groups of spaces as specified hereafter.

2.1.2 Lifts shall not be considered as forming one means of escape required by [2].

2.2 Means of escape from control stations, accommodation and service spaces

2.2.1 General requirements *(1/1/2017)*

a) As far as practicable and reasonable, a corridor, lobby, or part of a corridor from which there is only one escape route should not be built.

b) All stairways and ladders shall be of steel frame construction . Stairways shall have at least 800 mm width and ladders at least 350 mm width.

c) Where an accommodation space or a control station has a surface deck area greater than 50 m^2 there shall be provided with two exit doors one of which may be an emergency exit door. The main door shall have width appropriate to the number of persons.

d) Corridors used as means of escape shall be not less than 800 mm in clear width. Doorways, corridors, and intermediate landings included in means of escape shall be sized in the same manner as stairways.

e) Other dimensions for doors, corridors and intermediate landings may be considered on the basis of the results of preliminary mobility analysis, if requested in [2.4].

2.2.2 Means of escape

a) General

Stairways and ladders shall be so arranged as to provide ready means of escape from all crew accommodation spaces and from spaces in which the crew is normally employed other than machinery spaces.

b) Escape from spaces below the bulkhead deck

Two means of escape shall be provided from each watertight compartment or similar restricted space or group of spaces. However, on proposal of Naval Authority, the Society may dispense with one of these means of escape, due regard being paid to the nature and location of spaces and number of persons who might normally be employed there.

c) Escape from spaces above the bulkhead deck

Above the bulkhead deck there shall be at least two means of escape from each main vertical zone or similarly restricted space or group of spaces at least one of which shall give access to a stairway forming a vertical escape.

d) Direct access to stairway enclosures

Stairway enclosure, if fitted, in accommodation and service spaces shall have direct access to corridors and be of a sufficient area to prevent congestion, having in view the number of persons likely to use them in an emergency.

e) Details of means of escape

As far as practicable and reasonable the design of ship means of escape required by previous item b) and c) should consist of a readily accessible enclosed stairway, which should provide a continuous fire shelter from the level of its origin to the evacuation stations.

Means of closing of the horizontal opening of stairways and ladders shall be as required by the Naval Authority for naval operations.

f) Marking of escape routes

The means of escape including stairways and exits shall be marked by lighting or photoluminescent strip indicators placed not more than 0,3 m above the deck at all points of the escape route including angles and intersections. The marking must enable crew to identify all the routes of escape and readily identify the escape exits. If electric illumination is used, it shall be supplied by the emergency source of power and it shall 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, all escape route signs and fire equipment location markings shall be of photoluminescent material or marked by lighting. Such lighting or photoluminescent equipment shall be evaluated, tested and applied to the satisfaction of the Society.

2.3 Means of escape from machinery spaces

2.3.1 Means of escape from each machinery space shall comply with the provisions given in the following items (a) to (d).

a) Escape from spaces below the bulkhead deck

Two sets of steel ladders as widely separated as possible, leading to doors in the upper part of the space similarly separated and from which access is provided to a safe escape route. As far as reasonable and practicable one of these ladder should be provided with a continuous fire shelter.

b) Escape from spaces above the bulkhead deck

The two means of escape shall be as widely separated as possible and the doors leading from such means of escape shall give access to a safe escape route.

c) Dispensation from two means of escape

Where the machinery spaces are below the bulkhead deck , the Society may dispense with one of the means of escape , due regard being paid to the width and disposition of the upper part of the space .

Where the machinery spaces are above the bulkhead deck , the Society may dispense with one means of escape from any such a space so long as either a door or a steel ladder provides a safety escape route to a safe position.

d) Escape from machinery control stations

Two means of escape shall be provided from a machinery control station located within a machinery space at least one of which , as far as possible and practicable , should provide continuous fire shelter to a safe position outside the machinery space.

e) Access to vehicle spaces, ro-ro vehicle spaces or hangarses

One of the escape routes from the machinery spaces where the crew is normally employed shall avoid direct access to any vehicle space, ro-ro vehicle space or hangar.

2.4 Means of escape in vehicle spaces , ro-ro vehicle spaces or hangers

2.4.1 In vehicle spaces, ro-ro vehicle spaces or hangers the number and disposition of means of escape both below and above the bulkhead deck shall be to the satisfaction of the Society and in general shall be at least equivalent to that provided for in items b), c), and e) of [2.2.2].

2.5 Evacuation analysis and escape plan

2.5.1 Evacuation analysis

For ships capable of carrying more than 240 persons including the crew, the escape routes shall be evaluated by an evacuation analysis early in the design process. The analysis, carried out according to the indications of the Society, shall be used to identify and eliminate, as far as practicable, congestion which may develop during an emergency situations.

2.5.2 Means of escape plans

The ships shall be provided with means of escape plans indicating the following:

a) the number of the crew in all normal occupied spaces,

b) primary and secondary means of escape,

c) widths of stairways, doors, horizontal hatches and corridors.

SECTION 9 FIRE CONTROL PLANS

1 Fire control plans

1.1 Compilation of the fire control plans

1.1.1 General arrangement plans shall be permanently exhibited for the guidance of the crew, showing clearly for each deck the main vertical zones, the horizontal zones, the safety zones, the NBC citadel or sanctuary, the control stations, the various fire sections enclosed by A class divisions, the sections enclosed by B class divisions together with particulars of the fire detection and fire alarm systems, the sprinkler installation, the fire-extinguishing appliances, means of access to different compartments, decks, etc. and the ventilating system including particulars of the fan control positions, the position of dampers and identification numbers of the ventilating fans serving each section, and the position of fuel oil quick-closing valve remote control and fuel oil pump stops. Alternatively, at the discretion of the Naval Authority, the aforementioned details may be set out in a booklet, a copy of which shall be supplied to crew members, and one copy shall at all times be available on board in an accessible position. Plans and booklets shall be kept up to date, any alterations being recorded therein as soon as practicable. Description in such plans and booklets shall be in the official language of the Naval Authority. If the language of the Naval Authority is not English, a translation into such language is to be included. In addition, instructions concerning the maintenance and operation of all the equipment and installations on board for the fighting and containment of fire shall be kept under one cover, readily available in an accessible position.

1.2 Location of the fire control plans

1.2.1 In all ships a duplicate set of fire control plans or a booklet containing such plans shall be permanently stored in a prominently marked weathertight enclosure outside the deckhouse for the assistance of shoreside fire-fighting personnel.

SECTION 10 HELICOPTER FACILITIES

1 General

1.1 Application

1.1.1 *(1/1/2017)*

For Helicopter Facilities see Additional Class Notation **HELICOPTER**, Pt E, Ch 4, Sec 2.

SECTION 11 ALTERNATIVE DESIGN AND ARRANGEMENTS

1 Purpose

1.1

1.1.1 The purpose of this Section is to provided a methodology for alternative design and arrangements for fire safety.

2 General

2.1

2.1.1 Fire safety design and arrangements may deviate from the prescriptive requirements set out in this Chapter, Part D or Part E as applicable, provided that the design and arrangements meet the fire safety objectives and the functional requirements set out in the Rules.

2.2

2.2.1 When fire safety design or arrangements deviate from the prescriptive requirements of this Chapter, engineering analysis, evaluation and approval of the alternative design and arrangements is to be carried out in accordance with this Section.

3 Engineering analysis

3.1

3.1.1 The engineering analysis is to be prepared and submitted to the Society based on the IMO's guidelines provided in MSC/Circ.1002 as considered applicable, on a case by case basis, by the Society and the Naval Authority.

The engineering analysis shall include, as a minimum the following elements:

a) determination of the ship type and space(s) concerned;

b) identification of prescriptive requirement(s) with which the ship or the space(s) will not comply;

c) identification of the fire and explosion hazards of the ship or the space(s) concerned, including:

1) identification of the possible inition sources

2) identification of the fire growth potential of each space concerned

3) identification of the smoke and toxic effluent generation potential for each space concerned

4) identification of the potential for the spread of fire, smoke and toxic effluents from the space(s) concerned to other spaces

d) Determination of the required fire safety performance criteria for the ships or the space(s) concerned addressed by the prescriptive requirement(s) in particilar:

1) performance criteria is to be based of the fire safety objectives and on the functional requirements of this Chapter, Part D or Part E as applicable

2) performance criteria shall provide a degree of safety not less than that achieved by using the prescriptive requirements, and

3) performance criteria is to be quantifiable and measurable

e) detailed description of the alternative design and arrangements, including a list of the assumptions used in the design and any proposed operational restrictions or conditions; and

f) technical justification demonstrating that the alternative design and arrangements meet the required fire safety performance criteria.

4 Evaluation of the alternative design and arrangements

4.1

4.1.1 The engineering analysis required in [3] is to be evaluated and approved by the Society and the Naval Authority taking into account IMO's guidelines MSC/Circ.1002 as considered applicable, on a case by case basis, by the Society and Naval Authority.

4.2

4.2.1 A copy of the documentation, as approved by the Society and Naval Authority indicating that the alternative design and arrangements comply with this Section is to be carried on boad the ship.

5 Re-evaluation due to change of conditions

5.1

5.1.1 If the assumptions, and operational restrictions that where stipulated in the alternative design and arrangements are changed, the engineering analysis is to be carried out under the changed condition and is to be approved by the Society and Naval Authority.

SECTION 12 PROTECTION OF VEHICLE SPACES AND RO-RO VEHICLE SPACES AND HANGARS

1 General

1.1 Application

1.1.1 The fuel used by vehicle engine or aircrafts or carried amphybious shall either have flash point greater than 60°C, or be JP5-NATO (F44).

1.1.2 In addition to complying with the requirements of this section, vehicle spaces, ro-ro vehicle spaces and hangars shall comply also with the requirements of other sections of this chapter as appropriate.

1.2 Basic principle

1.2.1 The basic principle underlying the provisions of this section is that the normal main vertical zoning may not be practicable in vehicle spaces, ro-ro vehicle spaces or hangars. Therefore, equivalent protection must be obtained in such spaces on the basis of the horizontal zone concept and by the provision of an efficient fixed fire extinguishing system. For the purpose of this section, a horizontal zone may include vehicle spaces, ro-ro vehicle spaces or hangars on more than one deck provided that the total overall clear height for vehicles does not exceed 10 m.

1.2.2 The integrity of decks and bulkheads forming boundaries of horizontal zones is to be ensured by complying with those requirements of this chapter relevant to integrity of main vertical zones with respect to ventilation systems, openings in "A" class divisions and penetrations in "A" class divisions.

2 Special arrangement for vehicle spaces, ro-ro vehicle spaces and hangars

2.1 Ventilation systems

2.1.1 Capacity of ventilation systems

An effective power ventilation system, capable of providing at least 10 air changes per hour, shal be provided for closed vehicle spaces, closed ro-ro vehicle spaces and hangars.

2.1.2 Performance of ventilation systems

a) The ventilation system for vehicle spaces, ro-ro vehicle spaces and for hangars shall be entirely separated from other ship ventilation systems.

   Ventilation ducts serving such spaces, capable to be sealed, shall be separated for each spaces . The system shall be capable of being controlled locally from a position outside such spaces and from the central damage control station.

b) The ventilation shall be such as to prevent air stratification and the formation of air pockets.

c) Fans are to meet the requirement of Sec 7, [1.7].

2.1.3 Indication of ventilation systems

Means shall be provided to indicate on the bridge and in the central damage control station any loss or reduction of the required ventilating capacity.

2.1.4 Closing appliances of openings in ventilation systems of vehicle spaces, ro-ro vehicle spaces and hangars

a) Arrangements shall be provided to permit a rapid shutdown and effective closure of the ventilation system in case of fire, taking into account the weather and sea conditions.

b) Ventilation ducts, including dampers, shall be made of steel and their arrangement shall be to the satisfaction of the Society.

2.2 Electrical equipment and wiring

2.2.1

Electrical equipment and wiring in vehicle spaces, ro-ro vehicle spaces and hangars shall be of a type suitable for use in an explosive petrol and air mixture (see Note 1). For the purpose of this requirement, due regard is to be provided to their location, risk of presence of explosive or flammable vapours and means of ventilation provided. Alternative arrangement may be evaluated on a case by case basis.

Note 1: Refer to the recommendations of the International Electrotechnical Commission, in particular publication 60079.

Note 2: The part of the space located above a height of 450 mm from the deck level can be considered as hazardous zone 2. The rest of the space can be considered as hazardous zone 1.

2.3 Electrical equipment and wiring in exhaust ventilation ducts

2.3.1

Electrical equipment and wiring, if installed in ventilation ducts of vehicle spaces, ro-ro vehicle spaces and hangars shall be of a safety type approved suitable for use in an explosive petrol and air mixture and the outlet from any exhaust duct shall be located in a safe position having regard to other possible sources of ignition. Alternative arrangement may be evaluated on a case by case basis.

2.4 Other ignition sources

2.4.1 Other equipment which may constitute a source of ignition of flammable vapours is not be permitted.

2.5 Bilge pumping and discharge

2.5.1 Scuppers shall not be led to machinery or other spaces where sources of ignition may be present.

3 Fire detection and alarm

3.1 Fixed fire detection and fire alarm systems

3.1.1 There shall be provided a fixed fire detection and fire-alarm system complying with the requirements of Sec 13. The fixed fire detection system shall be capable of rapidly detecting the onset of fire. The type of detectors and their spacing and location shall be to the satisfaction of the Society taking into account the effects of ventilation and other relevant factors. After being installed, the system shall be tested under normal ventilation conditions and shall give an overall response time to the satisfaction of the Society.

3.1.2

The smoke detector sections in vehicle, special category, and ro-ro spaces may be provided with an arrangement (e.g. a timer) for disconnecting detector sections during loading and unloading of vehicles to avoid "false" alarms.

The time of disconnection is to be adapted to the time of vehicle operations. The central unit is to indicate whether the detector sections are disconnected or not.

However, manual call points are not to be capable of being disconnected by the arrangement referred to above.

3.2 Manually operated call points

3.2.1 Manually operated call points shall be provided as necessary throughout the vehicle spaces , ro-ro vehicle spaces and hangars and one shall be placed close to each exit from such spaces.

4 Structural protection

4.1 General

4.1.1

Notwithstanding the provisions of Pt C, Ch 4, Sec 5, the boundary bulkheads and decks of special category and ro-ro spaces shall be insulated to A-60 class standard. However, where a category (5), (9) or (10) space defined in [3.3.4] is on one side of the division the standard may be reduced to A-0. Where fuel oil tanks are below a special category space or a ro-ro space, the integrity of the deck between such spaces, may be reduced to A-0 standard.

4.1.2 Indicators

Indicators shall be provided on central damage control station which shall indicate when any fire door leading to or from vehicle spaces, ro-ro vehicle spaces or aircraft hangars is closed.

4.2 Basic principle

4.2.1 The basic principle underlying the provisions of this section is that the normal main vertical zoning may not be practicable in vehicle spaces, ro-ro vehicle spaces or hangars. Therefore, equivalent protection must be obtained in such spaces on the basis of the horizontal zone concept and by the provision of an efficient fixed fire extinguishing system. For the purpose of this section, a horizontal zone may include vehicle spaces, ro-ro vehicle spaces or hangars on more than one deck provided that the total overall clear height for vehicles does not exceed 10 m.

4.2.2 The integrity of decks and bulkheads forming boundaries of horizontal zones is to be ensured by complying with those requirements of this chapter relevant to integrity of main vertical zones with respect to ventilation systems, openings in “A” class divisions and penetrations in “A” class divisions.

5 Fire-extinguishing

5.1 Fixed fire-extinguishing systems

5.1.1

Vehicle spaces, ro-ro vehicle spaces and hangars shall be fitted with a fixed high expansion foam fire-extinguishing system or a water spraying system complying with the requirement of the requirement of Sec 13. or an approved fixed pressure water spraying system for manual operation which shall protect all parts of any deck and vehicle platform in such spaces. Such water spray systems shall have:

a) a pressure gauge on the valve manifold;

b) clear marking on each manifold valve indicating the spaces served;

c) instructions for maintenance and operation located adjacent to the operating valves or at the activation point;

d) a sufficient number of drainage valves.

Note 1: For approved fixed pressure water spraying systems refer to the recommendation on fixed fire-extinguishing systems for special category spaces adopted by the IMO by resolution A.123(V).

5.1.2

Areas that are intended for the refuelling or maintenance of vehicles shall be provided with at least one portable foam applicator to be located near the interested area.

5.1.3

As an alternative to [5.1.1], upon agreement by the Society and the Naval Authority and upon full scale tests, in conditions simulating a flowing fuel oil fire in vehicle spaces or ro-ro vehicle spaces or hangars, have shown not to be less effective of previous systems, the following systems may be fitted:

a) an approved fixed water mist fire -extinguishing system,

b) an approved fixed clean agent fire-extinguishing system

Furthermore, upon agreement by Society and Naval Authority, may be fitted:

c) a carbon dioxide system shall be provided for each protected spaces. Its arrangements shall be such as to ensure that at least 2/3 of the gas required for the space is introduced in 10 minutes, to ensure that the quantity of gas available is at least sufficient to give a minimum volume of free gas of 45% of the gross volume of the space and shall comply with the provisions of Sec 13.

5.1.4

When fixed pressure water-spraying systems are fitted, during the operation of the fixed pressure in view of the serious loss of stability which could arise due to large quantities of water accumulating on deck or decks during the operation of the fixed pressure water-spraying system, the following arrangements shall be provided:

a) In vehicle spaces, ro-ro vehicle spaces and hangar, any valve for scuppers (which by provisions of Ch 1, Sec 10 is to be provided with positive means of closing) shall be kept open and any closing of such valves shall be recorded in the central damage control station. Crew is to be instructed that such valves are to be open when water system is operated. Valves are to be operable from a position above the bulkhead deck or from the central damage control station.

b) The drainage and pumping shall be such as to prevent the build-up of free surface. If this is not possible the adverse effect upon stability of the added weight and free surface of water shall be taken into account to the extent deemed necessary by the Society and included in the stability booklet submitted for approval.

5.2 Portable fire extinguishers

5.2.1

There shall be provided in any vehicle space , ro-ro vehicle space and in any hangar portable fire extinguishers spaced not more than 20 metres apart on both sides of the space. At least one portable fire-extinguisher shall be located at each access to such spaces.

In addition, in vehicle, ro-ro, hangar and special category spaces intended for the carriage of vehicles with fuel in their tanks for their own propulsion, the following fire extinguishing appliances shall be provided:

- at least three water-fog applicators;
- one portable foam applicator provided that at least two such units are available in the ship for use in such spaces.

When hangars and vehicles spaces contains refuelling facilities, an approved foam-type fire extinguishers, of at least 45 l capacity or equivalent is to be provided.

SECTION 13 FIRE SAFETY SYSTEMS

1 General

1.1 Application

1.1.1 This Section applies to fire safety systems as required in the other sections of this Chapter.

2 International shore connection and Stanag 1169

2.1 Engineering specifications for international shore connection

2.1.1 Standard dimensions

Standard dimensions of flanges for the international shore connection shall be in accordance with Tab 1 (see also Fig 1).

Figure 1 : International shore connection

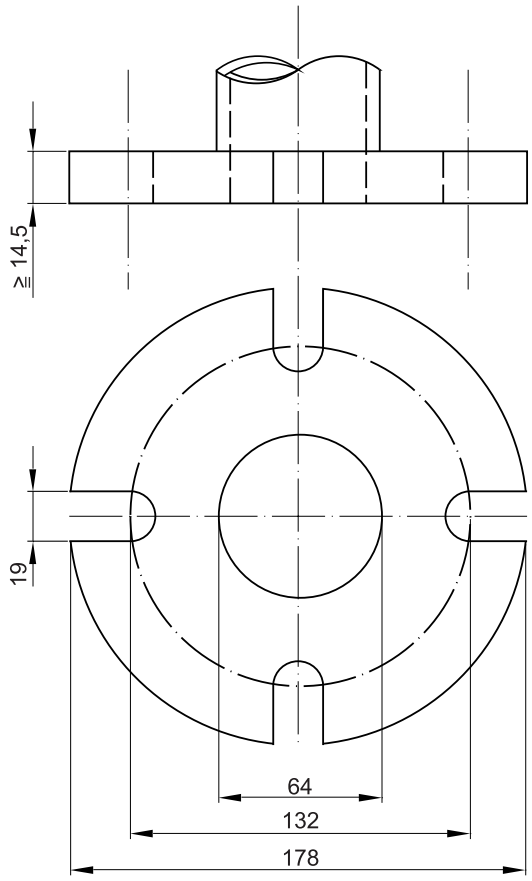


Table 1 : Standard dimensions

Description	Dimension
Outside diameter	178 mm
Inside diameter	64 mm
Bolt circle diameter	132 mm
Slots in flange	4 holes 19 mm in diameter spaced equidistantly on a bolt circle of the above diameter, slotted to the flange periphery
Flange thickness	14,5 mm minimum
Bolts and nuts	4, each of 16 mm diameter, 50 mm in length

2.1.2 Materials and accessories

The connection shall be of steel or other suitable material and shall be designed for 1,0 MPa services. The flange shall have a flat face on one side and on the other shall be permanently attached to a coupling that will fit the ship's hydrant and hose. The connection shall be kept aboard the ship together with a gasket of any material suitable for 1,0 MPa services, together with four bolts of 16 mm diameter and 50 mm in length, four nuts of 16 mm diameter, and eight washers.

2.1.3 The ship shall be provided also with a connection complying with standard Stanag 1169.

3 Personnel protection and emergency escape breathing devices

3.1 Engineering specifications

3.1.1 General

The breathing apparatus, head cover. the axe in the stowage peace of firefighther's equipment in each safety zone as well as the protective clothing, boots and gloves, head cover, rigid helmet and electric safety lamp of personal equipment, shall be in accordance with the requirement of the standards of the Naval Authority.

In absence of such standards the following [3.1.2] shall be complied with.

3.1.2 Personnel protection and other fittings

A firefighter's outfit shall consist of a set of personal equipment and a breathing apparatus.

a) Personal equipment

Personal equipment shall consist of:

1) Protective clothing of material to protect the skin, including gloves and boots, from the heat radiating from the fire and from burns and scalding by steam. The outer surface shall be water-resistant.
2) Boots and gloves of rubber or other electrically non-conducting material, suitable for the maximum voltage installed on the ship.
3) A rigid head cover providing effective protection against impact
4) An electric safety lamp (hand lantern) of an approved type with a minimum burning period of three hours

b) Breathing apparatus

A breathing apparatus of approved type is either a self-contained compressed air-operated, the volume of air contained in its cylinders is at least 1200 l, or another self-contained breathing apparatus capable of functioning for at least 30 minutes. 2 complete spare sets shall be provided for each breathing apparatus. In addition, for each safety zone, a refilling station for the bottles of breathing apparatuses shall be provided capable of being put in use within 30 minutes.

c) Head cover

The head cover shall be such as to be capable of being donned over the mask of a breathing apparatus and, when donned, it shall cover the head except a window for viewing.

The inside of the head cover shall be provided with an automatic two-way radio apparatus.

d) Axe.

The stowage place of firefighter's equipment in each safety zone shall be provided with an axe.

3.1.3 Emergency escape breathing devices (EEBD)

a) The EEBD shall consist of a head covering which completely covers the head, the neck and may cover portions of the shoulders (hood piece).

b) The EEBD shall be supplied with breathable or oxygen air and shall have a service duration of at least 10 minute.

c) The hood piece shall be constructed of flame resistant materials and shall include a clear window for viewing.

d) When inactivated the EEBD shall be capable of being carried hands-free.

4 Portable fire-extinguishing appliances

4.1 Engineering specifications

4.1.1 Fire extinguisher

a) Safety requirements

Fire extinguishers are not permitted if they contain an extinguishing medium which, in the opinion of the Society, either by itself or under the expected conditions of use, gives off toxic gases in such quantities as to endanger persons or which is an ozone depleting substance.

b) Quantity of medium

1) The fire extinguishing capability of a fire extinguisher shall be at least equivalent to that of a 9 l fluid extinguisher.

Each power or carbon dioxide extinguisher is to have a capacity of at least 5 kg.

2) Other The Society fire extinguishers may be accepted if considered equivalente by the Society.

4.1.2 Portable foam applicators

A portable foam applicator unit shall consist of a foam nozzle of an inductor type capable of being connected to the fire main by a fire hose, together with a portable container of at least 20 l of foam-making liquid and one spare charge. The nozzle shall be capable of producing effective foam suitable for extinguishing an oil fire, at the rate of at least 1,5 m^3/min.

5 Fixed gas fire-extinguishing systems

5.1 Engineering specifications

5.1.1 General

a) Fire-extinguishing medium

1) Where the quantity of fire-extinguishing medium is required to protect more than one space, the quantity of medium available need not be more than the largest quantity required for any one space so protected.

When the ship is subdivided in safety zones, the system is to be arranged in such a way to ensure the availability of the above quantity of medium in case of lost of any one safety zone; the requirement may be accomplished by means of two CO_2 rooms located in different safety zone and interconnected each other.

The volume of any air receiver located in a protected space, converted to free air volume, is to be added to the gross volume of the space when calculating the necessary quantity of extinguishing medium.

Alternatively, a discharge pipe from the safety valves may be fitted and led directly to the open air.

2) Means shall be provided for the crew to safely check the quantity of medium in the containers.

3) Containers for the storage of fire-extinguishing medium and associated pressure components shall be designed to pressure codes of practice to the satisfaction of the Society, having regard to their locations and maximum ambient temperatures expected in service.

b) Installation requirements

1) The piping for the distribution of fire-extinguishing medium shall be arranged and discharge nozzles so positioned that a uniform distribution of medium is obtained.

2) Except as otherwise permitted by the Society, pressure containers required for the storage of fire-extinguishing medium, other than steam, shall be located outside protected spaces in accordance with Sec 6, [3.3].

3) Spare parts for the system shall be stored on board and be to the satisfaction of the Society.

c) System control requirements

1) The necessary pipes for conveying fire-extinguishing medium into protected spaces shall be provided with control valves so marked as to indicate clearly the space to which the pipes are led. In general the above-mentioned control valves are to be located within the medium storage room.

Suitable provision shall be made to prevent inadvertent release of the medium into the space.

The pipes may pass through accommodations providing that they are of substantial thickness and that their tightness is verified with a pressure test, after their installation, at a pressure head not less than 5 N/mm^2. In addition, pipes passing through accommodation areas shall be joined only by welding and shall not be fitted with drains or other openings within such spaces.

The pipelines shall not pass through refrigerated spaces.

2) Means shall be provided for automatically giving visual and audible warning of the release of fire-extingushing medium into any space in which personnel normally work or to which they have access.

The pre-discharge alarm is to be automatically activated. The alarm is to sound for the period of time necessary to evacuate the space, but not less than 20 seconds.

Where audible alarms are fitted to warn of the release of fire-extinguishing medium into fuel pump rooms, they may be of the pneumatic or electrical type:

- Pneumatically operated alarms

The alarms may be operated by the fire extinguishing system or by clean and dry air.

- Eletrically operated alarms

When electrically operated alarms are used, the arrangements should be such that the electrical actuating mechanism is located outside the pump room and if fitted inside the fuel pump room should be certified safety type.

3) The means of control of any fixed gas fire-extinguishing system shall be readily accessible and simple to operate and shall be grouped together in as few locations as possible at positions not likely to be cut off by a fire in a protected space. At each location there shall be clear instructions relating to the operation of the system having regard to the safety of personnel.

4) Automatic release of fire-extinguishing medium shall not be permitted, except as allowed by the Society under request of Naval Authority.

5.1.2 Automatic local carbon dioxide systems for engines inside box and for unmanned rooms for switch boards or electronic or informatic equipment

The carbon dioxide bottles may be positioned inside or outside the box or the room.

The quantity of carbon dioxide inside the bottles shall be sufficient to give a minimum volume of free gas equal to 40 per cent of the gross volume of the box containing the engine(s) or of the room.

For the purpose of this item the volume of free carbon dioxide shall be calculated at 0,56 m^3/kg.

The manual or automatic release of the medium shall activate visual and audible alarms inside and outside the box or the room and in the central damage control station.

In case of access in the box or in the room the discharge of the system is to be intercept. A notice on the access door is to be fitted for such purpose .

5.1.3 Flexible hoses and expansion joints in fixed fire-fighting systems

Flexible hoses and expansion joints are to be made of materials resistant to the marine environment and to the fluid they are to convey. Metallic materials are to comply with Pt C, Ch 1, Sec 10, [2.1], as applicable.

Flexible hoses are to be designed and constructed in accordance with recognised national or international standards acceptable to Tasneef.

Flexible hoses constructed of rubber or plastic materials are to incorporate a single or double closely woven integral wire braid or other suitable material reinforcement.

Flexible hoses are to be complete with approved end fittings in accordance with the Manufacturer's specification.

End connections that do not have a flange are to comply with Pt C, Ch 1, Sec 10, [2.4.5], as applicable, and each type of hose/fitting combination is to be subject to prototype testing to the same standard as that required by the hose.

The use of hose clamps and similar types of end attachments is not acceptable for flexible hoses in piping systems for carbon dioxide. In other piping systems, the use of hose clamps may be accepted where the working pressure is less than 0,5 MPa and provided there are double clamps at each end connection.

Flexible hoses and expansion joints are to be so designed as to withstand the tests indicated in Tab 2.

Flexible hose assemblies are to be selected for the intended location and application taking into consideration ambient conditions, compatibility with fluids under working pressure and temperature conditions consistent with the Manufacturer's instructions.

Type approval tests are to be carried out on flexible hoses or expansion joints of each type and of sizes to be agreed with Tasneef, in accordance with Tab 2 (see also the "Rules for the type approval of flexible hoses and expansion joints").

The flexible hoses or expansion joints subjected to the tests are to be fitted with their connections.

Table 2 : Type tests to be performed for flexible hoses and expansion joints

Test	Flexible hoses and expansion joints in non-metallic material	Flexible hoses and expansion joints in metallic material
Bursting test	X	X
Fire resistance test	X **(1)**	NR
Flexibility test	X **(2)**	NR
Elastic deformation test	NR	X
Resistance of the material **(3)**	X	X

(1) Gas extinguishing systems: not requested for flexible hoses and expansion joints installed in the CO2 room; fire endurance test according to item 2.3.1 of Appendix 2 to Pt C, Ch 1 (L1 level) for flexible hoses and expansion joints installed within protected spaces and spaces with high fire hazard.

Water-based systems: fire endurance test according to item 2.3.1 of Appendix 2 to Pt C, Ch 1 (L1 level) for flexible hoses and expansion joints installed within protected spaces and spaces with high fire hazard if normally operating in dry conditions; fire endurance test according to item 2.3.1 of Appendix 2 to Pt C, Ch 1 (L3 level) for flexible hoses and expansion joints installed within protected spaces and spaces with high fire hazard if normally operating in wet conditions.

(2) Only for flexible hoses conveying low temperature fluids.

(3) Internal to the conveyed fluid to be demonstrated by suitable documentation and or tests.

6 Fixed foam fire-extinguishing systems

6.1 Engineering specifications

6.1.1 General

Fixed foam fire-extinguishing systems shall be capable of generating foam suitable for extinguishing oil fires.

6.1.2 Fixed high expansion foam fire-extinguishing systems

a) Quantity and performance of foam concentrates

1) The foam concentrates of high expansion foam fire-extinguishing systems shall be approved by the Society.

2) Any required fixed high expansion foam system in machinery spaces shall be capable of rapidly discharging through fixed discharge outlets a quantity of foam sufficient to fill the greatest space to be protected at a rate of at least 1 m in depth per minute. The quantity of foam-forming liquid available shall be sufficient to produce a volume of foam equal to five times the volume of the largest space to be protected. The expansion ratio of the foam shall not exceed 1000 to 1.

3) The Society may permit alternative arrangements and discharge rates provided that it is satisfied that equivalent protection is achieved.

4) Any required fixed high expansion foam system in vehicle spaces and in ro-ro vehicle spaces and hangars is to be capable of protecting all the deck parts of the space and also any platforms. The system shall be capable of discharging a quantity of foam sufficient to:

- fill the greatest space to be protected at a rate of 1 metre in depth per minute, referring to the maximum horizontal area of the space itself
- fill the whole space to be protected within 5 minutes.

A quantity of foam-forming liquid sufficient to produce a volume of foam not less than 5 times the volume of each space to be protected shall be available on board.

b) Installation requirements

1) Supply ducts for delivering foam, air intakes to the foam generator and the number of foam-producing units shall, in the opinion of the Society, be such as will provide effective foam production and distribution.

2) The arrangement of the foam generator delivery ducting shall be such that a fire in the protected space will not affect the foam generating equipment.

3) The foam generator, its sources of power supply, foam-forming liquid and means of controlling the system shall be readily accessible and simple to operate and shall be grouped in as few locations as possible at positions not likely to be cut off by a fire in the protected space.

4) The systems shall be activated from a position nearby the foam generator(s) and from the central damage control station.

5) The local or remote operation of the system shall activate visual and audible alarms in the protected spaces, in the generator room(s) and in the central damage control station.

6.1.3 Fixed low expansion foam fire-extinguishing systems

a) Quantity and performance of foam concentrates

1) The foam concentrates of low expansion foam fire-extinguishing systems shall be approved by the Society.

2) The system shall be capable of discharging through fixed discharge outlets in not more than five minutes a quantity of foam sufficient to cover to a depth of 200 mm the area over which fuel oil is liable to spread. The foam concentrate is to be enough for two discharge required by the protected area. The expansion ratio of the foam shall not exceed 12 to 1.

b) Installation requirements

1) Means shall be provided for effective distribution of the foam through a permanent system of piping and control valves or cocks to suitable discharge outlets, and for the foam to be effectively directed by fixed sprayers on the main fire hazards in the protected space. The means for effective distribution of the foam are to be proven acceptable to the Society through calculation or by testing.

2) The means of control of any such systems shall be readily accessible and simple to operate and shall be grouped together in as few locations as possible at positions not likely to be cut off by a fire in the protected space.

3) The systems shall be activated from a position nearby the foam generator(s) and from the central damage control station.

4) The local or remote operation of the system shall activate visual and audible alarms in the protected spaces , in the generator room(s) and in the central damage control station

7 Fixed pressure water-spraying and water-mist fire-extinguishing systems

7.1 Engineering specifications

7.1.1 Fixed pressure water-spraying fire-extinguishing systems

a) Nozzles and pumps

1) The number and arrangement of the nozzles of any required fixed pressure water-spraying fire-extinguishing system in machinery spaces shall be to the satisfaction of the Society and shall be such as to ensure an effective average distribution of water of at least 5 l/m^2 per minute in the spaces to be protected. Where increased application rates are considered necessary, these shall be to the satisfaction of the Society.

2) The number and arrangement of the nozzles of any required fixed pressure water-spraying fire-extinguishing system in vehicle spaces and ro-ro vehicle spaces, hangars and ammunitions spaces are to be such as to ensure an effective average distribution of water of at least

for ammunitions spaces:

- 20 l/(m^{2}min)

and for other spaces:

- 3,5 l/(m^{2}min) for spaces having a height not exceeding 2,5 m
- 5 l/(m^{2}min) for spaces having a height more than 2,5 m.

3) Precautions shall be taken to prevent the nozzles from becoming clogged by impurities in the water or corrosion of piping, nozzles, valves and pump.

Furthermore, if the water-spraying fire-extinguishing system is not fed by the fire main the following requirements shall be complied with:

4) In machinery spaces the pump shall be capable of simultaneously supplying at the necessary pressure all sections of the system in any one compartment to be protected.

In vehicle spaces and ro-ro vehicle spaces and hangars the pump or pumps shall be capable of providing simultaneously, at all times, a sufficient supply of water at the required pressure to all nozzles of the system or at least to those of two sections.

5) For machinery spaces the pump may be driven by independent internal combustion machinery but, if it is dependent upon power being supplied from the emergency generator fitted in compliance with the provisions of Chapter 2 as appropriate, that generator shall be so arranged as to start automatically in case of main power failure so that power for the pump required by the previous item 4 is immediately available. The independent internal combustion machinery for driving the pump shall be so situated that a fire in the protected space or spaces will not affect the air supply to the machinery.

6) The pressure water-spraying systems protecting the ammunitions spaces are to be fed by the fire main.

b) Installation requirements for machinery spaces

1) Nozzles shall be fitted above bilges, tank tops and other areas over which fuel oil is liable to spread and also above other specific fire hazards in the machinery spaces.

2) The system may be divided into sections, the distribution valves of which shall be operated from easily accessible positions outside the spaces to be protected and will not be readily cut off by a fire in the protected space.

3) The pump and its controls, in the case of previous item a) 4), shall be installed outside the space(s) to be protected. It shall not be possible for a fire in the space(s) protected by the water-spraying system to put the system out of action.

c) Installation requirements for vehicle spaces and ro-ro vehicle spaces and hangars

The system is to protect the whole space but may be subdivided into sections. Each section is to be not less than 20 m long. These sections are, as a rule, to have the

same width as the space width except for those ships where the space is subdivided by A class longitudinal fire divisions forming the boundaries of stairways or other spaces, for which the section width may be reduced in proportion. An even water distribution to the whole space to be protected is to be ensured. The distribution valves for the system are to be located in an easily accessible position, adjacent to but outside the space to be protected, which will not readily be cut off by a fire within the space. Direct access to the distribution valves from the space and from outside the space is to be provided. Adequate ventilation means is to be fitted in the space containing the distribution valves. The water supply to the system is to be provided by the fire main except where the system is fed by dedicated pump or pumps. In any case, the fire main is to be connected to the fire-extinguishing system of the space to be protected by non-return valves which will prevent a backflow from the pressure water-spraying system to the fire main.

d) System control requirements

For machinery spaces the system shall be kept charged at the pressure and the pump supplying the water for the system shall be put automatically into action by a pressure drop in the system. It shall be possible to start the pump(s) locally and from the central damage control station.

For vehicle spaces and ro-ro vehicle spaces and hangars the dedicated pump or pumps are to be capable of being brought into operation by remote control from the same position at which the distribution valves are located and from the central damage control station..

For machinery spaces, vehicle spaces, ro-ro vehicle spaces , hangars and ammunitions spaces:

1) the valves of sections of the water-spray system shall be operable locally nearby the spaces and remotely from the central damage control station;

2) the water-spray system shall be activated from a position near by the spaces and from the central control station;

3) the local or remote operation of the water-spray system shall activate visual and audible alarms in the protected space , in the pump(s) place, in section valve position and in the central damage control station.

7.1.2 Equivalent water-mist fire-extinguishing systems for machinery spaces and fuel or JP5-NATO (F44) pump rooms

Water-mist fire-extinguishing systems for machinery spaces and fuel pump rooms are to be approved by the Society accounting the guidelines annexed to IMO MSC/Circ.668.

In particular the following requirements are to be complied with:

a) The system shall be capable of manual local and remote release.

b) The system shall be capable of fire extinction , and tested to the satisfaction of the Society in accordance with Appendix B of IMO MSC/Circ.668.

c) The system shall be available for immediate use and capable of continuously supplying water for at least 30 minutes in order to prevent re-ignition or fire spread within that period of time. Systems which operate at a reduced discharge rate after the initial extinguishing period shall have a second full fire-extinguishing capability available within a 5-minute period of initial activation.

A pressure tank shall be provided complying with the following:

1) The water capacity of the tank shall be based on the design criteria of the following item k) plus the filling capacity of the piping,

2) Arrangements shall be provided for maintaining an air pressure in the tank such as to ensure that where the standing charge of fresh water in the tank has been used the pressure will be not less than the working pressure of the systems nozzles, plus the pressure exerted by a head of water measured from the bottom of the tank to the highest system nozzle . Suitable means of replenishing the air under pressure and of replenishing the fresh water charge in the tank shall be provided. A glass gauge shall be provided to indicate the correct level of the water in the tank.

d) The system and its components shall be suitably designated to withstand ambient temperature changes, vibration, humidity, shock, impact, clogging and corrosion normally encountered in machinery spaces, or fuel or JP5-NATO (F44) pump-rooms, of ships; system components within the protected spaces shall be designed to withstand the elevated temperatures which could occur during a fire.

e) The system and its components shall be designed and installed in accordance with international standards acceptable to the Society and manufactured and tested to the satisfaction of the Society in accordance with appropriate elements of Appendices A and B to IMO MSC/Circ.668.

f) The nozzles location, type of nozzle and nozzle characteristics shall be within the limits tested to provide fire extinction as referred in the previous item b).

g) The electrical components of the pressure source for the system shall have a minimum rating of IP54. The system shall be supplied by all electrical switchboards being the ship provided with at least two such electrical switchboards which cannot be put out of service in any event at the same time.

h) The system shall be provided with a redundant means of pumping or otherwise supplying the water-based extinguishing medium. The system shall be fitted with a permanent sea inlet and be capable of continuous operation using seawater.

i) The piping system shall be sized in accordance with an hydraulic calculation technique such as the Hazen-Williams Method with the following values of the friction factor "C" for different pipe types which may be considered should apply:

Pipe type C

Black or galvanized mild steel 100

Copper and copper alloys 150

Stainless steel 150.

j) Systems capable of supplying water at the full discharge rate for 30 minutes may be grouped into separate sections within a protected space. The sectioning of the system within such spaces shall be approved by the Society in each case.

k) In all cases the capacity and design of the system should be based on the complete protection of each space protected by the system.

l) The system operation controls shall be available at easily accessible positions outside the spaces to be protected and from central damage control station and shall not be liable to be cut off by a fire in the protected spaces.

m) Pressure source components of the system shall be located outside the protected spaces.

n) A means for testing the operation of the system for assuring the required pressure and flow shall be provided.

o) Activation of any water distribution valve shall give a visual and audible alarm in the protected spaces at the valves station and in the central damage control station. An alarm in the central damage control station shall indicate the specific valve activated.

p) Operating instructions for the system shall be displayed at each operating position. The operating instructions shall be in the official language of the Naval Authority.

q) Spare parts and operating and maintenance instruction for the system shall be provided as recommended by the manufacturer.

8 Sprinkler systems

8.1 Type of systems

8.1.1

Sprinkler systems may be:

- manual systems with or without fusible element nozzles according to [8.2] or
- automatic sprinkler for detection and alarm systems according to [8.3].

When the automatic system is adopted, it is to be demonstrated that the vibrations and shock does not induce undue intervention of the system.

8.2 Manual sprinkler systems with or without fusible element nozzles

8.2.1 The sections of sprinkler systems shall be fed by sea water through valves connecting the section main pipes to the fire main which shall be at any time appropriated pressured by sea water.

The sprinkler system shall at least comply with the followings:

a) The connecting valves of system sections to the fire main shall be operated by the the central damage control station. Manual operation of the section valves through the electric feeding system of sprinkler system locally shall be also possible. Such stations shall be located outside the protected area of the concerned section and shall be readily accessible, clearly and permanently marked and protected from unauthorized use.

b) The system and equipment shall be suitably designed to withstand ambient temperature changes, vibration, humidity, shock, impact, clogging and corrosion normally encountered in ships.

c) The system and its components shall be designed and installed in accordance with international standards acceptable to the Society and manufactured and tested to the satisfaction of the Society.

d) The system shall be sized in accordance with an hydraulic calculation technique such as the Hazen-Williams Method with the following friction factor C for different pipe types.

Pipe type C

Black or galvanized mild steel 120

Copper and copper alloys 150

Stainless steel 150.

Plastic 150

e) Sprinklers shall be grouped into separate sections.

If the nozzles of the system are not provided with fusible elements the deck area protected by a section shall not be greater than 80 m^2 or a space if this has a surface greater than 80 m^2 .

If the nozzles of the system are provided with fusible elements, any section of the system shall not serve more than two decks of one main vertical zone

f) Sprinkler section piping shall not be used for any other purpose.

g) The section valves of sprinkler system shall be outside category A machinery spaces.

h) The activation of each section valve of the system shall initiate a visual and audible alarms at valve location and in the central damage control station.

i) A sprinkler control plan shall be displayed in the central damage control station showing the spaces covered and the location of the ship zone in respect of each section.

j) The nozzles with or without fusible elements shall be approved by the Society.

k) In accommodation and service spaces the fusible elements of nozzles shall have a nominal temperature rating of 57°C to 79°C , except that in locations such as drying rooms , where high ambient temperatures might be expected, the nominal temperature may be increased by not more than 30°C above the maximum deckhead temperature.

l) If nozzles with fusible elements are installed, supplying water components shall be sized so as to be capable of maintaining the required flow to the hydraulically most demanding area of not less than 280 m^2. For application to a small ship with a total protected area of less than

280 m^2, the Society may specify the appropriate area sizing the alternative supply components

m) The section valves and the alarms shall be fed by ship's electrical switchboards being the ship provided by at least two electrical switchboards which can not be put out of service at the same time by any event.

The feeders shall be so arranged as to avoid galleys, machinery spaces and other enclosed spaces of high fire risk except in so far as it is necessary to reach the appropriate switchboards.

8.3 Automatic sprinkler, fire detection and alarm systems

8.3.1 Engineering specification

a) Type of sprinkler systems

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 Society, this is a necessary precaution.

b) Equivalent fire extinguishing automatic sprinkler systems

Fire extinguishing automatic sprinkler systems equivalent to those specified in [8.3.2] to [8.3.4] shall be approved by the Society taking into account the IMO directives (see Note 1).

Note 1: See the revised Directive for the approval of sprinklers equivalent to those foreseen by the SOLAS Convention Rule II-2/12, adopted by IMO through the Resolution A.800(19).

8.3.2 Sources of power supply

There shall be not less than two sources of power supply for the sea water pump and automatic alarm and detection system. Where the sources of power for the pump are electrical, these shall be a main generator and an emergency source of power. One supply for the pump shall be taken from the main switchboard, and one from the emergency switchboard by separate feeders reserved solely for that purpose. The feeders shall be so arranged as to avoid galleys, machinery spaces and other enclosed spaces of high fire risk except in so far as it is necessary to reach the appropriate switchboards, and shall be run to an automatic change-over switch situated near the sprinkler pump. This switch shall permit the supply of power from the main switchboard so long as a supply is available therefrom, and be so designed that upon failure of that supply it will automatically change over to the supply from the emergency switchboard. The switches on the main switchboard and the emergency switchboard shall be clearly labelled and nor-mally kept closed. No other switch shall be permitted in the feeders concerned. One of the sources of power supply for the alarm and detection system shall be an emergency source. Where one of the sources of power for the pump is an internal combustion engine it shall, in addition to com-plying with the provisions of item c) of [8.3.4], be so situ-ated that a fire in any protected space will not affect the air supply to the machinery.

8.3.3 Component requirements

a) Sprinklers

1) The sprinklers shall be resistant to corrosion by marine atmosphere. In accommodation and service spaces the sprinklers shall come into operation within the temperature range from 68°C to 79°C. However, in locations where high ambient temperatures might be expected, such as drying rooms, the operating temperature may be increased by not more than 30°C above the maximum deckhead temperature of the considered space.

2) The number of spare sprinkler heads to be provided for all types and on board installed flow rates are given in Tab 3.

3) The number of spare sprinkler heads of a given type shall not be necessarily greater than the total number of installed sprinklers of this type.

b) Pressure tanks

1) A pressure tank having a volume equal to at least twice that of the charge of water specified in this item shall be provided. This tank shall contain a standing charge of fresh water, equivalent to the amount of water which would be discharged in one minute by the pump referred to in item c) 2). Arrangements shall be provided for maintaining an air pressure in the tank such as to ensure that where the standing charge of fresh water in the tank has been used the pressure will be not less than the working pressure of the sprinkler, plus the pressure exerted by a head of water measured from the bottom of the tank to the highest sprinkler in the system. Suitable means of replenishing the air under pressure and of replenishing the fresh water charge in the tank shall be provided. A glass gauge shall be provided to indicate the correct level of the water in the tank.

2) Means shall be provided to prevent the passage of sea water into the tank.

c) Sprinkler pumps

1) An independent power pump shall be provided solely for the purpose of continuing automatically the discharge of water from the sprinklers. The pump shall be brought into action automatically by the pressure drop in the system before the standing fresh water charge in the pressure tank is completely exhausted.

2) The pump and the piping system shall be capable of maintaining the necessary pressure at the level of the highest sprinkler to ensure a continuous output of water sufficient for the simultaneous coverage of a minimum area of 280 m^2 at the application rate specified in [8.3.5]. When deemed necessary by the Society, the piping hydraulic capacity shall be checked by examination of the hydraulic calculations and testing results of the system.

3) The pump shall have fitted on the delivery side a test valve with a short open-ended discharge pipe. The effective area through the valve and pipe shall be adequate to permit the release of the required pump output while maintaining the pressure in the system specified in item b) 1) above.

Table 3 : Spare sprinkler heads

Total number of heads	Required number of spare heads
< 300	6
300 to 1000	12
> 1000	24

8.3.4 Installation requirements

a) General

Any parts of the system which may be subjected to temperatures in service equal or below 0°C shall be suitably protected against freezing.

b) Piping arrangements

1) Sprinklers shall be grouped into separate sections, each of which shall contain not more than 200 sprinklers. Any section of sprinklers shall not serve more than two decks and shall not be situated in more than one main vertical zone. However, the Society may permit such a section of sprinklers to serve more than two decks or be situated in more than one main vertical zone, if it is satisfied that the protection of the ship against fire will not thereby be reduced.

2) Each section of sprinklers shall be capable of being isolated by one stop valve only. The stop valves shall be readily accessible, outside their corresponding sections, or inside a box situated in stairway casings. The valves location shall be clearly and permanently indicated. Means shall be provided to prevent the operation of the stop valves by any unauthorized person.

3) A test valve shall be provided for testing the automatic alarm for each section of sprinklers by a discharge of water equivalent to the operation of one sprinkler. The test valve for each section shall be situated near the stop valve for that section.

4) The sprinkler system shall have a connection from the ship's fire main by way of a lockable screw-down non-return valve at the connection which will prevent a backflow from the sprinkler system to the fire main.

5) A gauge indicating the pressure in the system shall be provided at each section stop valve and at a central station.

6) The sea inlet to the pump shall, wherever possible, be in the space containing the pump. It shall be so arranged that when the ship is afloat it will not be necessary to shut off the supply of sea water to the pump for any purpose other than the inspection or repair of the pump.

c) Location of systems

The sprinkler pump and tank shall be situated in a position reasonably remote from any machinery space of category A and shall not be situated in any space required to be protected by the sprinkler system.

8.3.5 System control requirements

a) Ready availability

1) Any required automatic sprinkler, fire detection and fire alarm system shall be capable of immediate operation at all times and no action by the crew shall be necessary to set it in operation.

2) The automatic sprinkler system shall be kept charged at the necessary pressure and shall have provision for a continuous supply of water as required in this Section.

b) Alarms and indication

1) Each section of sprinklers shall include means for giving a visual and audible alarm signal automatically at one or more indicating units whenever any sprinkler comes into operation. Such alarm systems shall be such as to indicate if any fault occurs in the system. Such units shall indicate in which section served by the system fire has occurred and shall be centralized on the navigating bridge or the permanently manned central safety control station. Moreover, they shall activate visible and audible alarms placed in a position other than on the above mentioned spaces, so as to ensure that the indication of fire is immediately received by the crew.

2) Switches shall be provided at one of the indicating positions referred to in the previous item 1) which will enable the alarm and the indicators for each section of sprinklers to be tested.

3) Sprinklers shall be placed in an overhead position and spaced in a suitable pattern to maintain an average application rate of not less than 5 l/m^2 per minute over the area covered by the sprinklers. However, the Society may permit the use of sprinklers providing such an alternative amount of water suitably distributed as has been shown, to the satisfaction of the Society, to be no less effective.

4) A list or plan shall be displayed at each indicating unit showing the spaces covered and the location of the zone in respect of each section. Suitable instructions for testing and maintenance shall be available.

c) Testing

Means shall be provided for testing the automatic operation of the pump on reduction of pressure in the system.

9 Fixed fire detection and fire alarm systems

9.1 Engineering specifications

9.1.1 General requirements

a) Any required fixed fire detection and fire alarm system with manually operated call points shall be capable of immediate operation at all times.

b) The fire detection system shall not be used for any other purpose, except that closing of fire doors and similar functions may be permitted at the control panel in the central damage control station.

c) The system and equipment shall be suitably designed to withstand supply voltage variation and transients, ambient temperature changes, vibration, humidity, shock, impact and corrosion normally encountered in ships.

d) Fire detection systems with a zone address identification capability shall be so arranged that:

1) means are provided to ensure that any fault (e.g. power break, short-circuit, earth) occurring in the loop will not render the whole loop ineffective

Note 1: Loop means an electrical circuit linking detectors of various sections in a sequence and connected (input and output) to the indicating unit(s).

2) all arrangements are made to enable the initial configuration of the system to be restored in the event of failure (electrical, electronic, informatic)

3) the first initiated fire alarm will not prevent any other detector from initiating further fire alarms.

4) no loop will pass through a space twice. When this is not practical (e.g. for large public spaces), the part of the loop which by necessity passes through the space for a second time shall be installed at the maximum possible distance from the other parts of the loop.

9.1.2 Sources of power supply

There shall be not less than two sources of power supply for the electrical equipment used in the operation of the fire detection and fire alarm system, one of which shall be an emergency source which may be a second main switchboard where both feeding switchboards can not be put out of service at the same time in any event. Furthermore the feeders shall feed the control panel through buffer battery. The supply shall be provided by separate feeders reserved solely for that purpose. Such feeders shall run to an automatic change-over switch situated in or adjacent to the control panel for the fire detection system.

The main (respective emergency) feeder shall run from the main (respective emergency) switchboard to the change-over switch without passing through any other distributing switchboard.

9.1.3 Component requirements

a) Detectors

1) Detectors shall be operated by heat, smoke or other products of combustion, flame, or any combination of these factors. Detectors operated by other factors indicative of incipient fires may be considered by the Society provided that they are no less sensitive than such detectors. Flame detectors shall only be used in addition to smoke or heat detectors.

2) Smoke detectors required in all stairways, corridors and escape routes within accommodation spaces shall be certified to operate before the smoke density exceeds 12,5 per cent obscuration per metre, but not until the smoke density exceeds 2 per cent obscuration per metre. Smoke detectors to be installed in other spaces shall operate within sensitivity limits to the satisfaction of the Society having regard to the avoidance of detector insensitivity or oversensitivity.

3) Heat detectors shall be certified to operate before the temperature exceeds 78°C but not until the temperature exceeds 54°C, when the temperature is raised to those limits at a rate less than 1°C per minute. At higher rates of temperature rise, the heat detector shall operate within temperature limits to the satisfaction of the Society having regard to the avoidance of detector insensitivity or oversensitivity.

4) At the discretion of the Society, the permissible temperature of operation of heat detectors may be increased to 30°C above the maximum deckhead temperature in drying rooms and similar spaces of a normal high ambient temperature.

5) All detectors shall be of a type such that they can be tested for correct operation and restored to normal surveillance without the renewal of any component.

9.1.4 Installation requirements

a) Sections

1) Detectors as well as manually operated call points shall be grouped into separate sections.

Note 1: Section means group of fire detectors or manually operated call points as shown in the indicating unit(s) required in item a)3) of [9.1.5].

2) A section of fire detectors which covers a control station, a service space or an accommodation space shall not include a machinery space of category A or ammunitions spaces.

For fire detection systems with remotely and individually identifiable fire detectors the requirement set out in this item 2) is considered to be met when a loop covering an accommodation space, a service space and a control station does not include machinery spaces of category A or ammunitions spaces.

3) Where the fire detection system does not include means of remotely identifying each detector individually, no section covering more than one deck within accommodation spaces, service spaces and control stations shall normally be permitted except a section which covers an enclosed stairway. In order to avoid delay in identifying the source of fire, the number of enclosed spaces included in each section shall be limited as determined by the Society. The detectors sections shall be as the sections of sprinkler system in [8.2]. If the detection system is fitted with remotely and individually identifiable fire detectors, the sections may cover several decks and serve any number of enclosed spaces.

4) If there is no fire detection system capable of remotely and individually identifying each detector, a section of detectors shall not serve spaces on both sides of the ship nor on more than one deck and neither shall it be situated in more than one main vertical zone except that the Society if it is satisfied that the protection of the ship against fire will not

thereby be reduced, may permit such a section of detectors to serve both sides of the ship and more than one deck. In ships fitted with individually identifiable fire detectors, a section may serve spaces on both sides of the ship and on several decks but may not be situated in more than one main vertical zone.

b) Positioning of detectors

1) Detectors shall be located for optimum performance. Positions near beams and ventilation ducts or other positions where patterns of air flow could adversely affect performance and positions where impact or physical damage is likely shall be avoided. In general, detectors which are located on the overhead shall be a minimum distance of 0,5 m away from bulkheads.

2) The maximum spacing of detectors shall be in accordance with Tab 4. The Society may require or permit other spacings based upon test data which demonstrate the characteristics of the detectors.

c) Arrangement of electric wiring

1) Electrical wiring which forms part of the system shall be so arranged as to avoid galleys, machinery spaces of category A, and other enclosed spaces of high fire risk except where it is necessary to provide for fire detection or fire alarm in such spaces or to connect to the appropriate power supply.

2) The fire detection systems with a zone address identification shall be capable to operate and to identify detectors even if the loop is damaged in more than one point by the fire.

9.1.5 System control requirements

a) Visual and audible fire signals

1) The activation of any detector or manually operated call point shall initiate a visual and audible fire signal at the control panel and indicating units. If the signals have not received attention within two minutes an audible alarm shall be automatically sounded throughout the crew accommodation and service spaces, control stations and machinery spaces of category A. This alarm sounder system need not be an integral part of the detection system.

2) The control panel shall be located the central damage control station.

3) Indicating units shall, as a minimum, denote the section in which a detector is activated or a manually operated call point has operated. At least one unit shall be so located that it is easily accessible to responsible members of the crew at all times. One indicating unit shall be located on the navigating bridge.

4) Clear information shall be displayed on or adjacent to each indicating unit about the space covered and the location of the sections.

5) Power supplies and electric circuits necessary for the operation of the system shall be monitored for loss of power or fault conditions as appropriate. Occurrence of a fault condition shall initiate a visual and audible fault signal at the control panel which shall be distinct from a fire signal.

b) Test

Suitable instructions and component spares for testing and maintenance shall provided.

Table 4 : Maximum spacing of detectors

Type of detector	Maximum floor area per detector	Maximum distance apart between centres	Maximum distance away from bulkheads
Heat	37 m^2	9 m	4,5 m
Smoke	60 m^2	10 m	5,0 m

APPENDIX 1 CARBON DIOXIDE SYSTEMS

1 General

1.1 Quantity of fire-extinguishing medium

1.1.1

a) For spaces other than machinery spaces the quantity of carbon dioxide available shall, unless otherwise provided, be sufficient to give a minimum volume of free gas equal to 30 per cent of the gross volume of the largest space so protected in the ship.

b) For machinery spaces the quantity of carbon dioxide carried shall be sufficient to give a minimum volume of free gas equal to the larger of the following volumes, either:

- 40 per cent of the gross volume of the largest machinery space so protected, the volume to exclude that part of the casing above the level at which the horizontal area of the casing is 40 per cent or less of the horizontal area of the space concerned taken midway between the tank top and the lowest part of the casing, or
- 35 per cent of the gross volume of the largest machinery space protected, including the casing. In the calculation of 35 per cent of the above mentioned volume, the net volume of the funnel shall be considered up to a height equal to the whole casing height if the funnel space is in open connection with the machinery space without inter-position of closing means.

c) For the purpose of this item the volume of free carbon dioxide shall be calculated at 0,56 m^3/kg.

d) For machinery spaces the fixed piping system shall be such that 85 per cent of the gas can be discharged into the space within 2 minutes.

e) For ro-ro spaces and vehicle spaces, other than special category spaces, the fixed piping shall be such that at least 2/3 of the required gas quantity is to be discharged within 10 minutes.

1.2 Controls

1.2.1

Carbon dioxide systems shall comply with the following requirements:

- Two separate controls shall be provided for releasing carbon dioxide into a protected space and to ensure the activation of the alarm. One control shall be used for opening the valve of the piping which conveys the gas into the protected space and a second control shall be used to discharge the gas from its storage containers; Positive means shall be provided so they can only be operated in that order; and
- The two controls shall be located inside a release box clearly identified for the particular space. If the box containing the controls is to be locked, a key to the box shall be in a break-glass type enclosure conspicuously located adjacent to the box.

2 High-pressure carbon dioxide

2.1 High pressure carbon dioxide systems

2.1.1

When carbon dioxide is contained in high pressure bottles, in addition to the requirements of Sec 13, [5.1] the following shall be complied with.

a) Bottle room

The bottle room and not dedicated bottle room are to be bounded by bulkheads and decks made of steel or other equivalent material and are to be located in a safe and easily accessible position.

In general, the bottle room and not dedicated bottle room are not to be adjacent to heated storage tanks. If this is not possible, bottle room and not dedicated bottle room bulkheads which are adjacent to heated storage tanks are to be suitably insulated as required for bulkheads of bottle rooms and not dedicated bottle rooms which are exposed to solar radiation.

Doors of bottle rooms and not dedicated bottle rooms giving access to accommodation spaces, except for corridors, are not allowed.

The bulkheads and the ceiling deck of the bottle room and not dedicated bottle room, when in an exposed position, are to be insulated against solar radiation so that the temperature inside the room does not exceed 55°C.

The bottle room and not dedicated bottle room are to be wide enough to allow maintenance, weighing operations etc. to be performed easily.

A device for checking the mass of the bottles is to be provided in the bottle room. A bar for anchoring the weighing device is to be fitted.

Alternatively, the checking of the bottle content may be performed by other means recognised as suitable by the Society.

b) Bottle arrangement

The arrangement of the bottles and not dedicated bottle room is to be made in relation to the shape of the bottle room and not dedicated bottle rooms. The bottles and not dedicated bottle rooms are to be arranged in a vertical position; when arranged in banks close to a wall, the number of adjacent rows is not to exceed two; banks

arranged in the central area of the room and not dedicated bottle room may consist of three or four bottle rows. Between the different rows, a passageway is to be provided in order to allow maintenance, weighing and dismantling of the bottles; this passageway is generally to be not less than 500 mm in width; in order to avoid corrosion on the bottom of the bottles they are to be arranged in such a way that ventilation is facilitated and cleaning is possible.

c) Bottles and their fittings

- The bottles are to be approved by the Society on the basis of the requirements of Ch 1, Sec 3. As a rule, bottles with a capacity greater than 67 litres are not allowed.
- Each bottle is to be provided with a valve recognised as suitable by the Society, built in such a way as to avoid, during gas discharge, the formation of dry ice inside. This valve is to be fitted with a standard threaded connection, for bottle filling, and with a safety device (rupture disc) set to a pressure value between 17 and 20 MPa. The minimum cross-sectional area of the device is to be not less than 50 mm^2. Lastly, the valve is to be fitted with a manual opening control which can be easily and readily operated or with another opening device approved by the Society. If the exhaust of the safety devices is led into the CO_2 collecting main, or into a proper exhaust pipe leading to the open, the Society may waive the requirement for mechanical ventilation of the room in Sec 6, [3.3] and furthermore, failing this, the discharge of such safety device is to be equipped with a jet breaker. The bottles which are fitted in not dedicated bottle rooms shall have the safety valve device (rupture disk) and the safety valve or rupture disk of the main discharging into a proper exhaust pipe leading to the opening. The opening controls of the bottles are to be provided with a seal indicating that the opening device has not been operated. The presence of these seals is not to require a supplementary manoeuvre for the operation of the control.
- The bottles are to be permanently connected to a common collecting main by means of a steel pipe complying with the requirements of item j) below or by a flexible pipe capable of withstanding a burst test at a pressure not less than four times the design pressure of the bottle. A non-return valve is to be fitted between each bottle and the collecting main.
- The filling ratio of the bottles is generally to be not greater than 0,67 kg/l. In exceptional cases, in which the ship's service is restricted to temperate zones, a filling ratio up to 0,75 kg/l may be accepted.

d) Safety devices for the CO_2 collecting mains

The CO_2 manifold located in the bottle room is to be fitted with one or more safety valves or rupture discs set to a pressure value between 17 and 20 MPa with the exhaust pipe led to the open air. The outflow cross-sectional area of these valves or rupture discs is to be not less than 300 mm^2. When the exhaust pipe of the bottle safety devices mentioned in b) is led into the CO^2 collecting mains, the minimum total outflow cross-sectional area of the abovementioned safety valves or rupture discs will be given special consideration by the Society on a case-by-case basis.

e) Carbon dioxide distribution arrangement

- The CO_2 distribution system within protected spaces is to be so designed that, when the gas quantity appropriate to that space is discharged, it is uniformly distributed through all the discharge nozzles. For the machinery space, CO_2 is to be discharged both above and below the floor as indicated in the following. The carbon dioxide is to be discharged through nozzles in a nebulised state and for such purpose the utmost care is to be taken in shaping and sizing the nozzle cones to avoid the formation of dry snow or dry ice.
- Piping dimensions are to be chosen in such a way as to avoid excessive expansion ratios of gas which could give rise to the risk of icing. Tab 1 sets forth the minimum piping diameters for the quick discharge in relation to the quantity of carbon dioxide to be discharged; different values may be accepted by the Society on the basis of the results of detailed hydraulic calculations. For the slow discharge, the piping is to have a nominal diameter, D_N, not less than 20 mm. A connection for the compressed air piping is to be provided on the collecting main for the purpose of cleaning the system piping and associated nozzles. This connection is to be threaded and closed with a threaded plug.
- The piping conveying the CO_2 to the different protected spaces is to be controlled by distribution valves or cocks arranged at locations easily accessible from outside the served spaces and arranged in such a way as not to be put out of service or cut off in the event of fire. In general, they are to be located in the bottle room. These valves or cocks are to be marked in order to clearly indicate the compartments to which the different piping branches are directed and are to be fitted with signs of open and closed position.
- The number, type and position of applicator nozzles are to be such as to obtain a uniform distribution of carbon dioxide in the protected spaces. The nozzles are not to be located near ventilation outlets and they are to be clear of machinery or devices which could hinder the outflow. The branch pipes on which the nozzles are fitted are to extend at least 50 mm beyond the last nozzle and are to be closed by a threaded plug in order to allow the removal of any residues left in sections of the piping by the gas flow. In machinery and boiler spaces at least 20 per cent of the required quantity of carbon dioxide is to be discharged below the floor. The total outflow cross-sectional area of the applicator nozzles in machinery and boiler spaces and in vehicle spaces, ro-ro vehicle spaces or in hangar(s) is to be not less than 50 per cent or greater than 85 per cent of the outflow cross-sectional area of the carbon dioxide collecting main. In general, the actual outflow cross-

sectional area of each applicator is to be between 50 and 160 mm^2 and, in the case of multiple hole applicators, the diameter of each hole is to be not less than 4 mm; different values may be accepted by the Society on the basis of the results of detailed hydraulic calculations. Nozzles are to be located, in principle, in the upper part of the space to be protected and the distance between two nozzles is generally not to exceed 12 m.

- Piping joints are to be made by means of flanges. However, threaded joints may be used within the CO2 room and within the protected spaces, subject to the limitations in Pt C, Ch 1, Sec 10, [2.4.4] and [2.4.5]. Pipes passing through accommodation spaces are to be joined only by welding.
- The piping, valves and fittings are to be properly secured to the hull structures and, when necessary, they are to be protected against possible damage. Plugs, draining devices and filters, if any, are to be arranged, where necessary, in such a way as to prevent the accumulation of condensate and residues.

  They are to be situated in easily accessible and controllable positions and, in any case, outside accommodation spaces.

  For the purpose of reducing friction loss in the piping it is to be arranged as straight as possible and along the shortest path.

f) Alarm devices

In addition to the requirements in item c)2) of Sec 13, [5.1.1], the alarm system is to be approved by the Society; it may be of the pneumatic type and operating on CO_2, with a delaying device suitable for achieving the required prealarm time interval, or of the electrical type. Furthermore, a pneumatic audible alarm is also to be provided actuated by the carbon dioxide and operating for the whole discharge of the carbon dioxide.

g) Electrical audible alarm

Where the audible alarm in (f) above is electrically operated, the following conditions are to be complied with:

- The supply to the alarm system is to be continuously powered from the emergency source of electrical power or from a battery suitably located for use in an emergency. In the event of power failure to the alarm system, an alarm is to be given in a manned position.
- Two or more audible alarm devices are to be installed in each protected space, as far away as possible from each other and such that, if one of them goes out of service, the remaining one(s) will be sufficient to give the alarm to the whole space.
- The circuits supplying the audible alarm devices are to be protected only against short-circuits.
- The arrangement of the circuits and their electrical protection are to be such that the failure of one of the audible alarm devices will not impair the operation of the others.
- The fuses, if used for short-circuit protection, are to be of the type fitted with a device indicating the fuse condition.
- The electrical cables are to be of the fire-resisting type.
- The audible alarm devices and any other equipment located in the space are to be protected within cases ensuring a degree of protection adequate to the space of installation with a minimum of IP44. Where the audible alarm devices and any other equipment are arranged in a hazardous area, the requirements set forth in Chapter 2 are to be also complied with.

h) Pilot bottles

When the simultaneous operation of the bottles is actuated by means of carbon dioxide pressure from a driver bottle, at least two pilot bottles are to be provided, with valves capable of being locally manoeuvred at all times. The pipes connecting the pilot bottles to the valves of the other bottles are to be of steel complying with the requirements in (j) below and their arrangement is to allow piping distortion due to thermal variations or, failing this, the connection is to be made by means of a flexible pipe capable of withstanding a burst test at a pressure not less than four times the design pressure of the bottle.

i) Shut-off valves

For systems in which bottle valve opening is actuated by using the pressure of carbon dioxide discharged from pilot bottles, a valve, normally to be kept shut, is to be placed between the main of the pilot bottles and the main of the other bottles. This valve is to be opened by means of the same actuating device as for the pilot bottles and is to be placed upstream of the device delaying the discharge of the non-pilot bottles.

j) Materials

The CO_2 system appliances are to be constructed of materials suitable for resisting corrosion by the marine environment; it is recommended that all important fittings of the system should be of brass, special bronze or stainless steel. The carbon dioxide piping is to be of steel, hot galvanised inside and outside. The relevant wall thicknesses are to be not less than those specified in Tab 2. Cast iron connections and fittings are not allowed, except for fittings of ductile or globular cast iron which may be installed after the distribution valves. The distribution valves or cocks are to be of such dimensions as to withstand a nominal pressure of not less than 16 MPa. The valves, flanges and other fittings of the piping between the bottles and the distribution valves are to have dimensions for a nominal pressure of not less than 16 MPa. The valves, flanges and other fittings of the piping between the distribution valves and the applicator nozzles are to have dimensions for a nominal pressure of not less than 4 MPa.

k) Inspections and tests

The bottles and associated fittings under pressure are to be subjected to a hydrostatic test pressure of 25 MPa.

The piping, valves and other fittings are to be subjected to the following tests witnessed by the Society:

- for those between the bottles and the distribution valves: hydrostatic test to 20 MPa pressure in the workshop before their installation on board and hydrostatic test to 12 MPa pressure after their installation on board
- for those led through accommodation spaces: hydrostatic test to 5 MPa pressure after their installation on board
- for those between the distribution valves and the applicator nozzles: pneumatic test, after their installation on board, to a pressure suitable to check gas tightness and absence of obstructions.
- for flexible pipes: hydrostatic test under a pressure at least equal to 1,5 times the maximum service pressure.

l) Information and instructions

Suitable indication plates are to be provided on the devices requiring a manoeuvre for their actuation; plates are to be of material resistant to corrosion by the marine environment and are to specify the main operations to be performed in the event of fire. The plates are to be adequately secured. A suitable number of instruction posters illustrating the various protected spaces, marked with different colours to distinguish them, are to be supplied as part of the system. An instruction poster for the operating scheme of the system is to be provided and located in the bottle room and near any other valve manoeuvre position of the system. On completion of each installation, documentation containing the workshop plans of the installation, the list of part numbers relevant to the bottles installed, a copy of the inspection certificates issued by the Society, the description of the system's construction, and instructions for use and maintenance are to be supplied with the system.

Table 1 : Dimensions of the CO_2 piping for the quick discharge

Diameter	Diameter	CO_2 quantity, in kg	
Nominal D_N (mm)	External d_e (mm)	Machinery and boiler spaces	Spaces, other than special category spaces intended for the carriage of motor vehicles
15	21,3	45	225
20	26,9	100	500
25	33,7	135	675
32	42,4	275	1375
40	48,3	450	2250
50	60,3	1100	5500
65	76,1	1500	7500
80	88,9	2000	10000
90	101,6	3250	16250
100	114,3	4750	23750
110	127,0	6810	34050
125	139,7	9500	47500
150	168,3	15250	76250

Table 2 : Minimum wall thickness for steel pipes for CO_2 fire-extinguishing systems

External diameter of pipes (mm)	Minimum wall thickness (mm)	
	From bottles to distribution station	From distribution station to nozzles
21,3 - 26,9	3,2	2,6
30,0 - 48,3	4,0	3,2
51,0 - 60,3	4,5	3,6
63,5 - 76,1	5,0	3,6
82,5 - 88,9	5,6	4,0
101,6	6,3	4,0
108,0 - 114,3	7,1	4,5
127,0	8,0	4,5
133,0 - 139,7	8,0	5,0
152,4 - 168,3	8,8	5,6

Notes :

1) Pipes are to be galvanised inside and outside. For pipes fitted in the engine room, galvanising may not be required, exclusively at the discretion of the Society.

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

3) For external diameters larger than those given in the Table, the minimum wall thickness will be subject to special consideration by the Society.

4) The minimum wall thickness listed in this Table is the nominal wall thicknesses and no allowance is required for negative tolerance or reduction in thickness due to bending.

5) The external diameters and thicknesses listed in the Table have been selected from ISO Standards for welded and seamless steel pipes. For pipes covered by other standards, slightly lower thicknesses may be accepted, at the Society's discretion.