

INTERNATIONAL STANDARD



Electrical installations in ships –
Part 504: **Special features** –
Automation, control and instrumentation



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INTERNATIONAL STANDARD



Electrical installations in ships –
Part 504: **Special features** –
Automation, control and instrumentation

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CONTENTS

FOREWORD	7
INTRODUCTION	10
1 Scope	11
2 Normative references	11
3 Terms and definitions	13
4 General requirements	16
4.1 Dependability	16
4.2 Safety	16
4.3 Segregation	17
4.4 Performance	17
4.5 Usability	17
4.6 Integration	17
4.7 Development activities	17
5 Environmental type testing parameters	17
5.1 General	17
5.2 Performance	18
6 Design	25
6.1 Environmental and supply conditions	25
6.2 Circuit design	25
6.3 Mutual effects	25
6.4 Electrical subdivision	25
6.5 Signal level	25
6.6 Power supply	25
6.6.1 Independent supplies	25
6.6.2 Capacity	26
6.6.3 Protection	26
7 Construction and materials	26
7.1 Adjustments	26
7.2 Accessibility	26
7.3 Replacement	26
7.4 Non-interchangeability	26
7.5 Cooling	26
7.6 Mechanical load on connectors	26
7.7 Mechanical features of cabinets	27
7.8 Shock and vibration absorbers	27
7.9 Internal wiring	27
7.10 Cable connections	27
8 Installation and ergonomics	27
8.1 General	27
8.1.1 Layout	27
8.1.2 Compatibility	27
8.1.3 Labelling	28
8.1.4 Labels	28
8.1.5 Display colours	28
8.1.6 Illumination	28

8.1.7	Protection against fluid leakage	28
8.1.8	Protection from condensation	28
8.1.9	External cables and wiring	28
8.2	Sensors	28
8.2.1	Location of sensors	28
8.2.2	Temperature sensors	29
8.2.3	Pressure sensors	29
8.2.4	Water level detectors on bulk carriers	29
8.2.5	Enclosure	29
8.2.6	Testing and calibration	29
8.2.7	Presentation of information	29
8.3	Controls	29
8.3.1	Remote controls	29
8.3.2	Man-machine interface	30
8.4	~~Alarm~~ Alert systems	30
9	Specific installations	30
~~9.1~~	~~Fire protection control installations~~	~~35~~
9.1	Fire safety systems	35
9.2	Bilge systems	36
~~9.3~~	~~Automatic control installations for electrical power supply~~	~~36~~
9.3	Machinery ~~alarm~~ alert alert installations	36
9.3.1	General	36
9.3.2	~~Alarm~~ Alert requirements	36
9.3.3	Display of information	37
9.3.4	Supply arrangements	38
9.3.5	Design	38
9.4	Power management systems	42
9.4.1	General	42
9.4.2	Automatic starting and stopping of main power supply equipment	44
9.4.3	Heavy load request and power reserve calculation	45
9.4.4	Black-out recovery	45
9.4.5	Load sharing and frequency control	45
9.4.6	Shut-down of diesel engine	45
9.4.7	Automatic disconnection of non-essential consumers	46
9.4.8	Design requirements of power management systems (PMSs)	46
9.5	Automatic starting installations for electrical motor-driven auxiliaries	47
9.5.1	~~Introduction~~ General	47
9.5.2	Automatic sequence starting	47
9.5.3	Starting installations for stand-by auxiliaries	47
9.5.4	Control voltages	48
9.5.5	Manual control	48
9.5.6	Mechanically driven auxiliaries in low speed range	48
9.5.7	Mechanically driven auxiliaries	48
9.5.8	Sensors	48
9.6	Machinery control installations	48
9.6.1	~~Introduction~~ General	48
9.6.2	General requirements	49
9.6.3	Transfer of control	49
9.6.4	Remote control of propulsion machinery from the bridge	49

9.6.5	Indicators for remote control of machinery	50
9.6.6	Manual override.....	50
9.7	Machinery protection ~~and~~ (safety) systems	51
9.7.1	~~Introduction~~ General	51
9.7.2	General requirements	51
9.8	Bow, inner, side shell and stern doors.....	52
9.8.1	Application.....	52
9.8.2	Remote control	52
9.8.3	Indicator system	52
9.8.4	Mode selection	52
9.8.5	~~Fail-to-safe~~ Failsafe	53
9.8.6	Testing	53
9.8.7	Independence.....	53
9.8.8	Display	53
9.8.9	Sensors	53
9.8.10	Television surveillance	53
9.8.11	Water leakage detection	53
9.8.12	Drainage alarm.....	54
9.8.13	Control location	54
9.9	Power-operated watertight doors	54
9.9.1	General	54
9.9.2	Indications	54
9.9.3	Alarm.....	54
9.9.4	Closure rate.....	54
9.9.5	Power supply	54
9.9.6	Dedicated circuits	55
9.9.7	Location of equipment	55
9.9.8	Enclosures	55
9.9.9	Leakage	55
9.9.10	Independent circuits	55
9.9.11	Failure of alarm circuits	55
9.9.12	Failure of control circuits	55
9.9.13	Power supply monitoring.....	56
9.9.14	Mode selection	56
9.9.15	Indication on navigation bridge	56
9.9.16	Remote opening	56
9.10	Public address systems on passenger ships	56
9.10.1	~~Audibility~~ General	56
9.10.2	Override	56
9.10.3	Operation	57
9.10.4	Emergency broadcast	57
9.10.5	Level adjustment	57
9.10.6	Minimum sound level	57
9.10.7	Interference	57
9.10.8	Fault tolerance.....	57
9.10.9	Protection.....	57
9.10.10	Fire zones	57
9.10.11	Segregation.....	57
9.10.12	Power supplies	57

9.10.13	Cabling	58
10	Computer based systems	58
10.1	General.....	65
~~10.2~~	~~System safety~~	~~65~~
10.2	General requirements	65
~~10.3~~	~~System configuration~~	~~65~~
10.3	System categories	65
~~10.4~~	~~System integration~~	~~66~~
10.4	System configuration	66
10.4.1	General	66
10.4.2	Power supply	67
10.4.3	Hardware	67
10.4.4	Software	67
10.4.5	Data communication links	67
10.4.6	Wireless data communication	67
10.4.7	Network/integration of systems	68
10.4.8	User interface	68
10.4.9	Input devices	69
10.4.10	Output devices	69
10.4.11	Graphical user interface.....	69
~~10.5~~	~~Power supply~~	~~69~~
10.5	Protection against modification and loss of data.....	69
~~10.6~~	~~Data communications links.....~~	~~70~~
10.6	Software maintenance	70
~~10.7~~	~~User interface~~	~~70~~
10.7	Remote access	70
10.7.1	General	70
10.7.2	Remote software maintenance.....	70
~~10.8~~	~~Alarm, control and safety functions~~	~~70~~
10.8	Documentation.....	70
10.8.1	General	70
10.8.2	Hardware.....	71
10.8.3	System functional description	71
10.8.4	Software	71
10.8.5	User interface	72
10.8.6	Test and evidence	72
~~10.9~~	~~Software~~	~~72~~
~~10.10~~	~~Tests~~	~~72~~
11	Additional requirements for periodically unattended machinery spaces or for reduced attendance	74
11.1	~~Introduction~~ General	74
~~11.2~~	~~General requirements~~	~~74~~
11.2	Fire precautions	74
11.3	Protection against flooding.....	75
11.4	Control of propulsion machinery.....	75
11.5	Alarm system and engineers' alarm	75
11.6	Protection (safety) systems.....	76
11.7	Machinery, boiler and electrical installations	77
12	Commissioning and testing.....	77

12.1	Tests of completed installation	78
12.2	Operational tests	78
13	Documentation	78
~~13.1~~	~~Apparatus description~~	~~78~~
~~13.2~~	~~Circuit diagrams~~	~~78~~
	Bibliography.....	79
	Figure 1 – Typical designs of power management systems	43
	Table 1 – Type tests, test procedures and severities.....	19
	~~Table 2 – Maximum spacing of detectors~~	~~65~~
	Table 2 – System categories.....	65
	Table 3 – Examples of assignment to system categories.....	66
	Table 4 – Tests and evidence according to the system category	73

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL INSTALLATIONS IN SHIPS –

**Part 504: ~~Special features~~ –
Automation, control and instrumentation**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60092-504 has been prepared by IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units.

This fourth edition cancels and replaces the third edition published in 2001. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) the part title has been changed, the term “Automation” was added;
- b) the contents of the corrigendum of January 2011 have been included;
- c) a new subclause 5.1 “General” with general requirements for type testing has been added;
- d) Table 1 contents aligned with current version of document IACS Req. 1991/Rev. 5, 2006;
- e) the revised IMO Resolution A.1021(26), Code on alerts and indicators:2009 has been taken into account;
- f) IMO Resolution MSC.302(87) has been taken into account. As a consequence, the term “alert” has been used where the generic term applies. This concerns, in particular, the text in 8.4 and 9.3;
- g) a new subclause 8.2.4: The revised IMO Resolution MSC.145(77), Performance standards for water level detectors on bulk carriers:2003 has been taken into account;
- h) subclause 9.1 about fire detection and alarm systems has been completely revised, IMO Resolution MSC.98(73) (FSS Code) with amendment MSC.292(87): 2010 has been taken into account;
- i) a new subclause 9.2 “Bilge systems” has been added;
- j) the subclauses 9.4 “Automatic control installations for electrical power supply” and 9.5 “Automatic starting installations for electrical motor-driven auxiliaries” have been completely revised;
- k) Clause 10 “Computer based systems” has been completely revised;
- l) a new subclause 10.3.6 about wireless data communication has been added;
- m) a new subclause 10.5 about remote access has been added.

The text of this standard is based on the following documents:

FDIS	Report on voting
18/1539/FDIS	18/1545/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 60092 series, under the general title *Electrical installations in ships*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

IEC 60092 forms a series of international standards ~~intended to ensure safety in the design, selection, installation, maintenance and use of electrical equipment for the generation, storage, distribution and utilization of electrical energy for all purposes~~ for electrical installations in sea-going ships, incorporating good practice and coordinating, as far as possible, existing rules.

~~This part of IEC 60092 also incorporates and co-ordinates, as far as possible, existing rules and forms a code of interpretation, where applicable, of the requirements of the International Maritime Organization, and serves as~~ These standards form a code of practical interpretation and amplification of the requirements of the International Convention for the Safety of Life at Sea, a guide for future regulations which may be prepared and a statement of practice for use by ship owners, shipbuilders and appropriate organizations, ~~and by constructors and appropriate organizations.~~

~~This standard is based on equipment and practices which are in current use, but it is not intended in any way to impede development of new or improved techniques.~~

ELECTRICAL INSTALLATIONS IN SHIPS –

Part 504: ~~Special features –~~ Automation, control and instrumentation

1 Scope

This part of IEC 60092 ~~deals with~~ specifies electrical, electronic and programmable equipment intended for automation, control, monitoring, ~~alarm alert, and safety~~ and protection systems for use in ships.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary (IEV)* (available at www.electropedia.org)

IEC 60068-2-1, *Environmental testing – Part 2: Tests – Tests A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2: Tests – Tests B: Dry heat*

IEC 60068-2-6, *Environmental testing – Part 2: Tests – Tests Fc: Vibration (sinusoidal)*

IEC 60068-2-30, *Environmental testing – Part 2: Tests – Tests Db ~~and guidance~~: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-52, *Environmental testing – Part 2: Tests – Tests Kb: Salt mist, cyclic (sodium chloride solution)*

~~IEC 60092 (all parts), Electrical installations in ships~~

IEC 60092-101:1994, *Electrical installations in ships – Part 101: Definitions and general requirements*

IEC 60092-101:1994/AMD1:1995

IEC 60092-201:1994, *Electrical installations in ships – Part 201: System design – General*

IEC 60092-202, *Electrical installations in ships – Part 202: System design – Protection*

~~IEC 60092-204, Electrical installations in ships – Part 204: System design – Electric and electrohydraulic steering gear~~

IEC 60092-302, *Electrical installations in ships – Part 302: Low-voltage switchgear and controlgear assemblies*

~~IEC 60092-375, Electrical installations in ships. Shipboard telecommunication cables and radio-frequency cables. General instrumentation, control and communication cables~~

~~IEC 60092-376, Electrical installations in ships – Part 376: Shipboard multicore cables for control circuits~~

~~IEC 60092-401, Electrical installations in ships – Part 401: Installation and test of completed installation~~

IEC 60092-501, Electrical installations in ships – Part 501: Special features – Electric propulsion plant

IEC 60092-502, Electrical installations in ships – Part 502: Tankers – Special features

IEC 60447, Basic and safety principles for man-machine interface ~~(MMI)~~, marking and identification – Actuating principles

IEC 60529, Degrees of protection provided by enclosures (IP Code)

IEC 60533, Electrical and electronic installations in ships – Electromagnetic compatibility (EMC) – Ships with a metallic hull

IEC 60945, Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results

IEC 61000-4-2, Electromagnetic compatibility (EMC) – Part 4-2: Testing and ~~measurement~~ measuring techniques – Electrostatic discharge immunity test. ~~Basic EMC Publication~~

IEC 61000-4-3, Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test

IEC 61000-4-4, Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test. ~~Basic EMC Publication~~

IEC 61000-4-5:2014, Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test

IEC 61000-4-6, Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields

IEC 61000-4-11, Electromagnetic compatibility (EMC) – Part 4-11: Testing and ~~measuring~~ measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests

IEC 61355-1, Classification and designation of documents for plants, systems and equipment – Part 1: Rules and classification tables

IEC 62443 (all parts), Industrial communication networks – Network and system security

ABS publication, Guidance notes on the application of ergonomics to marine systems (2014-02)

CISPR 16-1-1, Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus

CISPR 16-2-1, Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements

EN 54 (all parts), *Fire detection and fire alarm systems*

~~IMO Assembly Resolution A.830 (19)1995, Code on Alarms and Indicators⁴~~

IMO Resolution A.1021(26):2009, *Code on alerts and Indicators*

~~NOTE Other informative IMO documents are referenced within the text of this standard.~~

IMO Resolution MSC.302(87):2010, *Adoption of performance standards for bridge alert management (BAM)*

IMO Resolution A.813(19):1995, *General Requirements for Electromagnetic Compatibility (EMC) for all Electrical and Electronic Ship's Equipment*

IMO Resolution MSC.98(73):2000, *Adoption of the international code for fire safety systems (FSS Code)*

SOLAS, *International Convention for the Safety of Life at Sea (SOLAS):1974, consolidated edition, 2009*

3 Terms and definitions

For the purposes of this document, the **terms and definitions**, ~~having special application to the control, monitoring, alarm and protection equipment~~ given in IEC 60050 as well as the following apply. ~~For definitions of general and more particular terms, reference is made to IEC 60050 (IEV) and other normative documents.~~

3.1

accuracy

quality which characterizes the closeness of a measured value to the corresponding true value

~~3.2~~

~~**alarm functions**~~

~~functions intended to alert relevant personnel, by visual and audible means, in the event of any condition requiring their attention~~

3.2

administration

Government of the State whose flag the ship is entitled to fly

[SOURCE: SOLAS, Chapter I, Regulation 2, Definition (b)]

3.3

availability

ability of an item to be in a state to perform a required function under given conditions at a given time interval, assuming that the required external resources are provided

3.4

centralized control

control of all operations of a controlled system from one central control position

⁴ ~~See IMO 867E:1996, Code on Alarms and Indicators, 1995~~

3.5

computer based system

system that consists of one or more programmable electronic devices with their connections, peripherals and software necessary to carry out automatically specified functions

Note 1 to entry: The following types of programmable devices could form part of a computer system: main-frame, mini-computer, micro-processor-based computer, programmable logic controller.

3.6

control functions

functions intended to regulate the behaviour of equipment or systems

3.7

control position

control station

group of control devices by which an operator can control the performance of a machine, apparatus, process or assembly of machines and apparatus

Note 1 to entry: A control position will generally enable an operator to verify the achievement of the desired conditions by means of an appropriate monitoring system

3.8

dependability

extent to which a system can be relied upon to perform its intended functions under defined operational and environmental conditions

3.9

essential services

functions necessary for the propulsion, steering and safety of the ship and its personnel

3.10

~~fail-to-safe~~

~~principle by which a failure or malfunction of a component of the system causes its output to automatically adjust to a predetermined safe state~~

failsafe

design property of an item which prevents its failures from resulting in critical faults

Note 1 to entry: The safe state, according to the application, will be predetermined in terms of priority for the safety of the ship and may generally be taken as the least critical one for the main components and auxiliaries of, for example, the propulsion/manoeuvring plant.

[SOURCE IEC 60050-821: 1998, 821-01-10, modified – a note has been added.]

3.11

function

elementary operation performed by the system which, in conjunction with other elementary operations (system functions), enables the system to perform a task

~~3.12~~

~~indication functions~~

~~functions intended to inform relevant personnel, by visual and/or audible means, of any equipment or system status~~

3.12

integrity

capability of a system to satisfactorily perform the required functions under all the stated conditions within a stated period of time

3.13**machinery control room**

room or spaces where centralized controls and measuring and monitoring equipment for main equipment and essential auxiliary machinery are located together with the appropriate means of communication

3.14**maintainability**

ability of an item under given conditions of use, to be retained in, or restored to, a state in which it can perform a required function, when maintenance is performed under given conditions and using stated procedures and resources

Note 1 to entry: The term "maintainability" is also used as a measure of maintainability performance.

3.15**monitoring functions**

functions intended to collect data from equipment and systems for the purpose of display and recording

3.16**protection functions**

functions intended to prevent damage to equipment or systems in the event of a fault

3.17**reliability (performance)**

ability of an item to perform a required function under given conditions for a given time interval

Note 1 to entry: It is generally assumed that the item is in a state to perform this required function at the beginning of the time interval.

Note 2 to entry: Generally, reliability performance is quantified using appropriate measures. In some applications, these measures include an expression of reliability performance as a probability, which is also called reliability.

[SOURCE: IEC 60050-312:2001, 312-07-06, modified – notes 1 and 2 have been added.]

3.18**protection and safety functions**

functions intended to prevent harm or danger to personnel and protect equipment/systems

3.19**software**

computer programs, procedures, rules and associated documentation of a digital information processing system pertaining to the operation ~~of a computer system~~ and including application (user) program, middleware and operating system (firmware) program

3.20**system**

collection of components organised to accomplish a specific function or set of functions

3.21**usability**

extent to which a system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use

3.22**bridge and deck zone**

area from which the ship is steered and navigated and where the antennas are located

3.23 machinery space

spaces between the watertight boundaries of a space containing the main and auxiliary propulsion machinery, including boilers, generators and electric motors primarily intended for propulsion

Note 1 to entry: In case of unusual arrangements, the administration may define the limits of the machinery spaces.

[SOURCE: SOLAS Chapter II-1, Regulation 2, Definition 15]

3.24 remote control

control of an operation at a point distant from the controlled switching device

[SOURCE IEC 60050-441:2000, 441-16-07]

3.25 process

systematic series of actions that lead to a particular result of an executing instance of a computer program

3.26 automation system

system to monitor and control a process

3.27 instrumentation

instruments and their application for monitoring, measurement and control

3.28 significant modification

modification of the system functionality and/or safety of the system

3.29 PMS power management system

automatic control system for the generation and distribution of electrical energy

Note 1 to entry: This note applies to the French language only.

4 General requirements

4.1 Dependability

Systems shall be suitable for the user, the task and the application.

System integrity shall be appropriate for the functions supported, with due regard to factors such as availability, reliability and maintainability.

4.2 Safety

Systems shall be designed such that risk of harm to persons or the environment is reduced to a level acceptable to the ~~appropriate authority~~ **administration**, both in normal operation and under failure conditions. Functions shall be designed on the ~~fail-to-safe~~ **failsafe** principle.

4.3 Segregation

Systems shall be designed such that failure of one component part or sub-system will not unduly affect any other system, sub-system or component and, as far as is practicable, shall be detectable.

Failure in an automation system shall not influence the protection and safety functions.

Protection ~~(and safety)~~ functions shall be independent of control ~~and monitoring (alarm)~~ functions. As far as is practicable, control and monitoring (~~alarm~~ alert) functions shall also be independent.

Standby systems, or other redundancy arrangements, are to be functionally independent.

4.4 Performance

Systems shall maintain specified levels of performance in operation, and where necessary, under fault conditions.

Repeatability and accuracy shall be adequate for the proposed use and shall be maintained at their specified value during their expected lifetime and normal use.

Systems shall be stable throughout their operational range.

4.5 Usability

Systems shall be readily usable under all intended operating conditions and shall support effective and efficient operation.

Adequate safeguards against incorrect operation shall be provided.

4.6 Integration

Where safety of personnel may directly depend on correct system operation or failure, such systems shall not be integrated with, or be mutually dependent upon, any other system, except those providing complementary functions.

Where safety may indirectly depend on system operation or failure, the integrity of the integrated system shall be to the satisfaction of the ~~appropriate authority~~ administration.

4.7 Development activities

Activities undertaken in the development process, from initial design through to eventual realisation, and any modifications in use thereafter, shall be planned and structured in a systematic manner, and are to be properly managed. Persons responsible for carrying out these activities shall be competent to do so.

Activities, scopes, responsibilities and competencies shall be documented.

5 Environmental type testing parameters

5.1 General

Standard atmospheric conditions during functional test to equipment specification are defined in Table 1, No. 2.

The tests specified in Table 1 are applicable, but not confined, to all equipment used for

- automation, control, protection and safety;
- internal communication.

Electrical and electronic equipment on board ships required neither by classification rules nor by International Conventions, liable to cause electromagnetic disturbance shall be of a type which fulfils the test requirements of test specifications regarding radiated and conducted emissions, see Table 1, No. 19 and No. 20.

5.2 Performance

Where equipment or systems are subject to type testing, the test procedures and severities specified in Table 1 shall apply.

NOTE Compliance with IMO Resolution A.813(19)² will require all ships' electrical and electronic equipment to be tested to the relevant electromagnetic compatibility standard.

² ~~IMO A.813 (19):1995, General requirements for electromagnetic compatibility (EMC) for all electrical and electronic ships equipment~~

Table 1 – Type tests, test procedures and severities

No.	Test ^a	Procedure according to	Test parameters, severity		Other information Additional requirement/s	
1	Visual inspection				Examination of the equipment for: – conformity to drawings and design data; – compliance with applicable IEC standards; – quality of workmanship and construction.	
2	Functional test to equipment specification		Standard atmospheric conditions: – temperature: 25 °C ± 10 °C – relative humidity: 60 % ± 30 % – air pressure: 96 kPa ± 10 kPa			
3	High voltage test		Rated insulation voltage U_n V	Test voltage AC V	Frequency of test voltage: 50 Hz or 60 Hz. Separate circuits to be tested against each other. All circuits connected with each other are to be tested against earth. Contact pieces are to be tested across their open points of contact. Printed circuits with electronic components which could be subject to damage may be removed during the test.	
			$U_n \leq 65$ $66 < U_n \leq 250$ $251 < U_n \leq 500$ $501 < U_n \leq 690$	$2 \times U_n + 500$ 1 500 2 000 2 500		
			Period of application of test voltage: 1 min			
4a	Power supply variations	IEC 61000-4-11	AC supply			
			Combina- tion No.	Voltage variation (permanent) %	Frequency variation (permanent) %	Each combination shall be tested.
			1	+6	+5	
			2	+6	–5	
			3	–10	–5	
			4	–10	+5	
				Voltage transient (duration 1,5 s)	Frequency transient (duration 5 s)	
			5	+20	+10	
			6	–20	–10	
			DC supply			

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No.	Test ^a	Procedure according to	Test parameters, severity				Other information Additional requirement/s
			Voltage tolerance continuous	±10 %			
			Voltage cyclic variation	5 %			
			Voltage ripple	10 %			
			Electrical 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.				
4b	Power supply failure	IEC 61000-4-11	Three interruptions during 5 min 30 s break time				Verification of: – specified action of the equipment on loss and restoration of supply; – possible corruption of program or data held in programmable electronic systems, where applicable.
5	Insulation resistance ^b		Rated supply voltage	Test voltage	Minimum insulation resistance		Between all circuits and earth; on the supply terminals where appropriate. Resistance shall be measured before and after high voltage test, damp heat test, cold test and salt mist test.
			V	V	MΩ		
					Before test	After test	
			$U_n \leq 65$	$2 \times U_n$ min. 24	10	1	
			$U_n > 65$	500	100	10	
6	Cold with gradual change of temperature ^c	IEC 60068-2-1 Test Ab for non-heat dissipating equipment IEC 60068-2-1 Test Ad for heat dissipating equipment	Temperature +5 °C ± 3 °C Duration 2 h		Temperature –25 °C ± 3 °C Duration 2 h		Initial measurement of insulation resistance (see test No 5). Equipment not operating during conditioning except for operational tests. Operational test during last hour at test temperature. Insulation resistance measurement and operational test after recovery.
7	Dry heat with gradual change of temperature ^d	IEC 60068-2-2 Test Bb for non-heat dissipating equipment	Temperature 55 °C ± 2 °C Duration 16 h		Temperature 70 °C ± 2 °C Duration 16 h		Equipment operating during conditioning. Operational test during last hour at test temperature. Operational test after recovery.
		IEC 60068-2-2 Test Be for heat dissipating equipment	Temperature 55 °C ± 2 °C Duration 16 h		Temperature 70 °C ± 2 °C Duration 16 h		Equipment operating during conditioning with cooling system on if provided. Operational test during last hour at test temperature. Operational test after recovery.

No.	Test ^a	Procedure according to	Test parameters, severity	Other information Additional requirement/s
8	Damp heat, cyclic (12 h+12 h cycle) ^j	IEC 60068-2-30 Test Db	Temperature: 55 °C Humidity: 95 % Duration: two cycles (12 h + 12 h)	Measurement of insulation resistance before test. Equipment operating during the complete first cycle and switched off during second cycle except for functional test. Functional test during the first 2 h of the first cycle at the test temperature and during the last 2 h of the second cycle at the test temperature. Recovery at standard atmosphere conditions. Insulation resistance measurements and performance test.
9	Salt mist ^o	IEC 60068-2-52 Test Kb	Four spraying periods with a storage of 7 days after each	Initial measurement of insulation resistance and initial functional test. Equipment in its normal position during test. Equipment not operating during conditioning. Operational test on day 7 of each spraying period. Insulation resistance measurement and performance test 4 h to 6 h after the recovery period.
10	Vibration (sinusoidal)	IEC 60068-2-6 Test Fc	For general applications: 2 ⁺³₋₀ Hz to 13,2 Hz Amplitude ± 1 mm > 13,2 Hz to 100 Hz Acceleration ± 0,7 g Endurance at: – each resonance frequency at which an amplification factor $Q \geq 2$ is recorded; – 30 Hz if no resonance frequency is recorded. For equipment mounted on reciprocating machines, installed in steering gear compartment or similar locations: 2,0 Hz to 25 Hz Amplitude ± 1,6 mm > 25 Hz to 100 Hz Acceleration ± 4 g Endurance at: – each resonance frequency at which an amplification factor $Q \geq 2$ is recorded; – 30 Hz if no resonance frequency is recorded.	During the vibration test, operational conditions shall be demonstrated. Tests shall be carried out in three mutually perpendicular planes. It is recommended as guidance that Q does not exceed 5. If sweep test is chosen, where several resonance frequencies are detected close to each other, duration of test shall be 120 min.

No.	Test ^a	Procedure according to	Test parameters, severity	Other information Additional requirement/s
			Only for extreme conditions: 40 Hz to 2 000 Hz, acceleration ± 10 g Duration 90 min	For example on exhaust manifolds of diesel engines
11a	Inclination steady ^{a,1}		22,5°	Each direction Equipment operating
11b	Inclination dynamic		22,5° 0,1 Hz	Each direction Equipment operating Duration of test not less than 15 min
12	Enclosure protection	IEC 60529	Dependent on location	Minimum requirements for the degree of protection are given in IEC 60092-201.
13	Electrostatic discharge	IEC 61000-4-2	Contact discharge: 6 kV Air discharge: 8 kV Interval between single discharges: 1 s Number of pulses: 10 per polarity According to test level 3 ~~severity standard~~	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 ^f .
14	Electro-magnetic field	IEC 61000-4-3	Frequency range: 80 MHz to 6 GHz Modulation: 80 % AM at 1 000 Hz Field strength: 10 V/m Frequency sweep rate: $\leq 1,5 \times 10^{-3}$ decades/s (or 1 %/3 s) According to test level 3 ~~severity standard~~	Electromagnetic fields radiated by different transmitters. If for tests of equipment an input signal with a modulation frequency of 1 000 Hz is necessary, a modulation frequency of 400 Hz may be chosen. Performance criterion A ^g .
15	Conducted low frequency	IEC 60533	AC power supply port: Frequency range: rated frequency to 200 th harmonic Test voltage (r.m.s.): 10 % of supply voltage to 15 th harmonic reducing to 1 % at 100 th harmonic and maintain this level to the 200 th harmonic, max. 2 W DC power supply port: Frequency range: 50 Hz to 10 kHz Test voltage (r.m.s.): 10 % of supply voltage, max. 2 W	Distortions in the power supply system generated for instance by electronic consumers and coupled in as harmonics. Method of the test in accordance with IEC 60945. Performance criterion A ^g .
16	Conducted radio frequency	IEC 61000-4-6	Frequency range: 150 kHz to 80 MHz Amplitude: 3 V r.m.s. ^h Modulation: 80 % AM at 1 000 Hz Frequency sweep range $\leq 1,5 \times 10^{-3}$ decades/s (or 1 %/3 s) According to test level 2 ~~severity standard~~	Electromagnetic fields coupled as high frequency into the test specimen via the connecting lines. If for tests of equipment an input signal with a modulation frequency of 1 000 Hz is necessary, a modulation frequency of 400 Hz may be chosen. Performance criterion A: see note ^g .

No.	Test ^a	Procedure according to	Test parameters, severity	Other information Additional requirement/s																								
17	Burst/fast transients	IEC 61000-4-4	Single pulse time: 5 ns (between 10 % and 90 % value) Pulse width: 50 ns (50 % value) Amplitude (peak): – 2 kV line on power supply port to earth port (PE); – 1 kV on I/O data control and communication ports (with coupling clamp); Pulse period: 300 ms Burst duration: 15 ms Duration per polarity: 5 min According to test level 3-severity standard	Arcs generated when actuating electrical contacts. Interference effect occurring on the power supply, as well as the external wiring of the test specimen. Performance criterion B f.																								
18	Surge/slow transients	IEC 61000-4-5	Test applies to AC and DC power supply ports. Pulse rise time: 1,2 µs (between 10 % and 90 % value) Pulse width: 50 µs (50 % value) Amplitude (peak): 1 kV line-to-earth 0,5 kV line-to-line Repetition rate ≥1 pulse/min Number of pulses: 5 per polarity Application: continuous According to test level 2-severity standard	Interference generated for instance, by switching "ON" or "OFF" high power inductive consumers. Procedure in accordance with Figure 10 of IEC 61000-4-5:2014 for equipment where power and signal lines are identical. Performance criterion B f.																								
19	Radiated emission	CISPR 16-1-1 CISPR 16-2-1	<table><tr><td colspan="2">For equipment installed in the bridge and deck zone:</td></tr><tr><td><u>Frequency range:</u> MHz</td><td><u>Limits:</u> dBµV/m</td></tr><tr><td>0,15 to 0,3</td><td>80 to 52</td></tr><tr><td>0,3 to 30</td><td>52 to 34</td></tr><tr><td>30 to ~~2 000~~ 6 000</td><td>54</td></tr><tr><td>except for: 156 to 165</td><td>24</td></tr><tr><td colspan="2">For equipment installed in the general power distribution zone:</td></tr><tr><td><u>Frequency range:</u> MHz</td><td><u>Limits:</u> dBµV/m</td></tr><tr><td>0,15 to 30</td><td>80 to 50</td></tr><tr><td>30 to 100</td><td>60 to 54</td></tr><tr><td>100 to ~~2 000~~ 6 000</td><td>54</td></tr><tr><td>except for: 156 to 165</td><td>24</td></tr></table>	For equipment installed in the bridge and deck zone:		<u>Frequency range:</u> MHz	<u>Limits:</u> dBµV/m	0,15 to 0,3	80 to 52	0,3 to 30	52 to 34	30 to ~~2 000~~ 6 000	54	except for: 156 to 165	24	For equipment installed in the general power distribution zone:		<u>Frequency range:</u> MHz	<u>Limits:</u> dBµV/m	0,15 to 30	80 to 50	30 to 100	60 to 54	100 to ~~2 000~~ 6 000	54	except for: 156 to 165	24	Procedure in accordance with the standard but at a distance of 3 m between equipment and antenna.
For equipment installed in the bridge and deck zone:																												
<u>Frequency range:</u> MHz	<u>Limits:</u> dBµV/m																											
0,15 to 0,3	80 to 52																											
0,3 to 30	52 to 34																											
30 to ~~2 000~~ 6 000	54																											
except for: 156 to 165	24																											
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100 to ~~2 000~~ 6 000	54																											
except for: 156 to 165	24																											

No.	Test ^a	Procedure according to	Test parameters, severity	Other information Additional requirement/s																
20	Conducted emission	CISPR 16-1-1 CISPR 16-2-1	For equipment installed in the bridge and deck zone: <table><tr><th>Frequency range:</th><th>Limits: dBμV</th></tr><tr><td>10 kHz to 150 kHz</td><td>96 to 50</td></tr><tr><td>150 kHz to 350 kHz</td><td>60 to 50</td></tr><tr><td>350 kHz to 30 MHz</td><td>50</td></tr></table> For equipment installed in the general power distribution zone: <table><tr><th>Frequency range:</th><th>Limits: dBμV</th></tr><tr><td>10 kHz to 150 kHz</td><td>120 to 69</td></tr><tr><td>150 kHz to 500 kHz</td><td>79</td></tr><tr><td>0,5 MHz to 30 MHz</td><td>73</td></tr></table>	Frequency range:	Limits: dBμV	10 kHz to 150 kHz	96 to 50	150 kHz to 350 kHz	60 to 50	350 kHz to 30 MHz	50	Frequency range:	Limits: dBμV	10 kHz to 150 kHz	120 to 69	150 kHz to 500 kHz	79	0,5 MHz to 30 MHz	73	
Frequency range:	Limits: dBμV																			
10 kHz to 150 kHz	96 to 50																			
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Frequency range:	Limits: dBμV																			
10 kHz to 150 kHz	120 to 69																			
150 kHz to 500 kHz	79																			
0,5 MHz to 30 MHz	73																			
21	Flame retardancy (cables)	IEC 60092-101	Flame application: — 5 times, 15 s each Interval between each application: — 15 s	The burnt out or damaged part of the specimen is not to exceed 60 mm in length																

^a The static inclination test is not required on equipment with no moving parts.

^b Insulation resistance test to be carried out before and after damp heat test, cold test and salt mist test.

^c For equipment installed in non-weather-protected locations or cold locations, test is to be carried out at –25 °C.

^d Dry heat at 70 °C is to be carried out to withstand a high degree of heat, for example for equipment to be mounted in consoles, housings.

^e Salt mist test to be carried out for equipment to be installed in non-weather protected areas, for example on open deck.

^f Performance criterion B: the equipment under test (EUT) shall 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.

Recovery times shall be consistent with continued safe operation, taking due account of the need to preserve essential services.

^g Performance criterion A: the equipment under test (EUT) shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed, as defined in the technical specification published by the manufacturer.

^h For equipment installed on the bridge and deck zone the test levels shall be increased to 10 V r.m.s. for spot frequencies in accordance with IEC 60945 at 2,0 MHz; 3,0 MHz; 4,0 MHz; 6,2 MHz; 8,2 MHz; 12,6 MHz; 16,5 MHz; 18,8 MHz; 22,0 MHz; 25,0 MHz.

ⁱ On ships for the carriage of liquid gases and chemicals, the emergency power supply ~~must~~ shall also remain operational with the ship flooded up to maximum athwartship inclination of 30°.

^j This test shall be carried out for equipment located in non-air-conditioned spaces.

6 Design

6.1 Environmental and supply conditions

Equipment shall be designed to operate satisfactorily within the expected environmental and supply conditions, with due regard to the limits specified in Annex B of IEC 60092-101:1994.

6.2 Circuit design

Circuits shall be designed to enable efficient test, calibration, maintenance and repair. ~~Preferably, they shall be suitable for repair by unit or card replacement. In some cases, it may be desirable to provide simulation circuits or similar means to check correct operation of the equipment.~~

6.3 Mutual effects

Systems shall be arranged such that faults will not affect any function provided by any other system.

6.4 Electrical subdivision

Design of circuits shall be such that there is no direct connection to any point of the ship's main power supply system, for example isolating transformers shall be used for power supplies. The chassis may not form part of any circuit, except earthing for functional reasons.

It is recommended that extensive systems be subdivided and the supplies to the sections be electrically separated or individually protected.

Control circuits shall be separated from signal and indicating circuits in such a way that faults in the indicating circuits will not impair the operation of the equipment or apparatus, and vice versa.

6.5 Signal level

Signal levels shall be kept high enough to overcome the effects of contact corrosion and noise pick-up.

Transducers and amplifiers shall be situated as close to each other as is practicable.

Particular attention shall be paid to the earthing (grounding) of screens and signal reference systems.

To avoid possible interference on control and instrumentation cables, suitable installation features shall be provided, such as:

- screening and/or twisted pairs;
- use of balanced input amplifiers;
- separation between signal and other cables.

6.6 Power supply

6.6.1 Independent supplies

Where required, ~~for example by the administration~~, redundant power supplies shall be independent and the system selectively fed.

6.6.2 Capacity

The capacity of any back-up source shall be sufficient to ensure the normal operation of the system until safety conditions are reached.

6.6.3 Protection

Each circuit shall be separately protected against short circuits and overloads.

7 Construction and materials

7.1 Adjustments

Where necessary, equipment shall be arranged for simple adjustment. The set points shall be readily identifiable and suitable means shall be provided to protect against changes, for example due to environmental effects.

7.2 Accessibility

Ease of access to interchangeable parts for repairs and maintenance shall be ensured.

As far as is practicable, equipment shall be free of voltage, temperature, or other such factors which may present unsafe working conditions.

7.3 Replacement

Each replaceable assembly shall be simple to replace and shall be constructed for easy and safe handling.

7.4 Non-interchangeability

Preferably, all replaceable parts shall be so arranged that it is not possible to connect them incorrectly or to use incorrect replacements. Where this is not practicable, the replaceable parts, as well as the associated connecting device, shall be clearly identified.

7.5 Cooling

Preferably, apparatus shall not depend on forced cooling media.

Consideration shall be given, when necessary, to prevent the build-up of deposits on cooling surfaces.

If forced cooling is required, ~~a redundant supply of cooling medium shall be provided for essential services~~ it shall be considered during any assessment of system redundancy requirements. An ~~alarm~~ alert shall be provided in the event of cooling system failure.

For other services appropriate means shall be provided to prevent damage to the equipment due to temperature rise.

~~NOTE Special precautions are required~~ Measures shall be taken for forced ventilated cabinets in machinery spaces to prevent pollution deposits from causing insulation breakdown.

7.6 Mechanical load on connectors

If plug and socket connections are used, the contacts shall not carry any mechanical load, other than that which is necessary for ensuring satisfactory contact pressure, even when withdrawing or replacing a unit.

Plug-in trays, printed circuit boards and other multi-point connectors shall incorporate a retainer to prevent ejection due to mechanical loads such as shock or vibration.

7.7 Mechanical features of cabinets

Cabinets shall be of ~~simple~~ **stable** mechanical construction. All nut and bolt connections shall be locked.

EXAMPLE Use of self-locking nuts, locking washers, suited adhesives.

7.8 Shock and vibration absorbers

If anti-shock or anti-vibration mounts are used, adequate clearance shall be provided ~~between cabinet and rack~~ to allow full freedom of travel. Systems with shock or vibration mounts in series shall be avoided. Connecting leads shall be arranged so that they do not interfere with the shock and vibration isolation.

7.9 Internal wiring

Cables and insulated conductors used for internal wiring shall ~~normally~~ be at least of a flame retardant type. In the case of wiring adjacent to equipment containing hydraulic or other oils, the insulation shall be resistant to that oil, or be adequately shielded from it.

~~Special precautions shall be taken to avoid mechanical damage to cables and insulated conductors due to vibration.~~

Chafing of cables and insulated wires caused by vibration on surfaces and edges shall be avoided.

7.10 Cable connections

Terminal boards on control equipment, including transducers, shall be constructed so that sufficient space is available to enable cables to be satisfactorily connected, preferably each conductor on its own terminal. All terminals shall be clearly identified and suitable arrangements provided to connect cable screens.

8 Installation and ergonomics

8.1 General

8.1.1 Layout

Control positions shall be ergonomically arranged for the convenience of the operator and hence the accuracy and safety of the operation.

Area or group identification shall be considered, especially in complex layouts, for example adequate spacing between display and control groups.

NOTE Equipment in the bridge ~~area~~ **and deck zone** shall meet the requirements for navigation and communication equipment according to IEC 60945.

8.1.2 Compatibility

The arrangements of indicating instruments and control shall follow a logical sequence.

As far as possible, operating movements and the resulting movements of the indicating instruments shall be consistent with each other.

8.1.3 Labelling

Each operator control panel, subpanel, indicating instrument, control handle, ~~alarm~~, signal lamp, recording instrument, etc., shall be clearly and systematically identified by means of self-explanatory and unambiguous labels.

8.1.4 Labels

Labels shall be permanently secured and consistently placed relative to controls and instrumentation and shall be made of durable material having clear and indelible characters.

8.1.5 Display colours

Colours for differentiation of operating conditions shall be readily distinguishable and identifiable.

NOTE Reference ~~may be~~ is made to IMO Resolution ~~A.830(19), Code on Alarms and Indicators, 1995~~ A.1021(26).

8.1.6 Illumination

Instruments and controls shall be illuminated so that they can be clearly read and operated in all ambient light conditions under which they are intended to be operated, without having uncomfortable shadow or glare. If the surrounding illumination makes it difficult to detect an indicator light, a suitable shade shall be provided. If equipment is installed in the bridge ~~area~~ ~~and deck zone~~, means shall be provided to avoid interference with navigation by the output of any light source. Equipment mounted outside (e.g. on bridge wings) shall be satisfactorily illuminated for operation in both daylight and darkness.

8.1.7 Protection against fluid leakage

~~Electrical~~ Equipment ~~covered by this standard~~ shall not be installed in the same panel or cabinet as equipment employing a hydraulic medium, or pipelines carrying water, oil or steam unless effective means have been provided to protect the ~~electrical~~ equipment in case of leakage.

Pipelines carrying hydraulic mediums, water, oil or steam shall be avoided in the vicinity of control panels ~~and shall be in accordance with the requirements in IEC 60092-201:1994, Table 5.~~

8.1.8 Protection from condensation

As far as is practicable, arrangements shall be made to prevent condensation in enclosures.

8.1.9 External cables and wiring

External cables and wiring shall comply with relevant IEC 60092 standards.

NOTE See ~~IEC 60092-375~~, IEC 60092-376.

~~Special consideration shall be given to the mechanical strength and insulation qualities of cables and interconnecting wiring of smaller sizes than indicated in the above standards.~~

8.2 Sensors

8.2.1 Location of sensors

All sensors shall be located such that their output is a realistic measure of the parameter. Sensors shall be installed in places where there is a minimum risk for damage during normal overhaul, maintenance ~~and operation~~.

8.2.2 Temperature sensors

Temperature sensors shall be installed in pockets of suitable material. Connections shall be arranged ~~to draw out~~ so that they can be removed for testing purposes.

8.2.3 Pressure sensors

Pressure sensors exposed to shocks and large vibration in their working medium shall be protected by damping chambers.

8.2.4 Water level detectors on bulk carriers

SOLAS Chapter XII, Regulation 12 shall apply. The detector indicating the water level should be capable of activating to an accuracy of ± 100 mm. Visual and audible alerts should conform to the to the IMO Resolution A.1021(26) as applicable to an emergency alarm for the preservation or safety of the ship.

8.2.5 Enclosure

The enclosure of sensors and their terminal boxes shall be adequately protected for the expected place of installation, and for the type of cables installed.

8.2.6 Testing and calibration

Facilities shall be provided for testing and calibration of sensors which cannot be tested during normal operational conditions.

8.2.7 Presentation of information

Information shall be presented in a clear, consistent, and unambiguous manner.

8.3 Controls**8.3.1 Remote controls****8.3.1.1 Continuous information**

At the remote control station, the users shall receive continuous information on the effects of ~~his~~ their orders.

8.3.1.2 Independent control

Where control may be affected from more than one location, the failure of any control equipment at one location shall not affect the ability to control from any other location.

8.3.1.3 Exclusive control

Where a process may be controlled from several locations, only one shall be in control of that process at any time.

8.3.1.4 Transfer of control

This requirement is applicable to command locations of the same priority level.

Actual control shall not be transferred before being acknowledged by the receiving command location unless the command locations are located close enough to allow direct visual and audible contact. Transfer of control shall ~~give audible pre-warning~~ be indicated.

8.3.1.5 Main command location

Where a designated main command location is required for operational or safety reasons, or by the ~~appropriate authority~~ **administration**, this location shall have the capability to take control without acknowledgement.

8.3.1.6 Security

Significant alteration of process parameters shall be prevented during transfer of control from one location to another.

8.3.1.7 Status indication

On each alternative command location, it shall be indicated when this location is in control.

8.3.1.8 Interlocks

Control system elements shall include safety interlocks when the consequence of erroneous user actions may lead to damage or loss of essential services.

8.3.2 Man-machine interface

The man-machine interface shall be designed in accordance with IEC 60447.

8.4 ~~Alarm~~ **Alert** systems

The audible and visual signals and indications used in ~~alarm~~ **alert** systems (the former "machinery alarm systems") shall comply with the relevant requirements of IMO Resolution ~~867E, Code on Alarms and Indicators, 1995~~ **A.1021(26)**.

Emergency alarms shall be assigned to category A according to IMO Resolution MSC.302(87).

Further alarms specified in IMO Resolution A.1021(26) shall be assigned to category B according to IMO Resolution MSC.302(87).

9 Specific installations

~~9.1 Fire protection control installations~~

~~9.1.1 Introduction~~

~~Subclause 9.1 relates to electrical fire protection control installations, which are provided for the purpose of fire safety on board ships.~~

~~NOTE Some clauses of SOLAS Chapter II.2 are not included in this clause.~~

~~9.1.2 General~~

~~9.1.2.1 Applications~~

~~Such fire protection control installations may include:~~

- ~~— automatic fire detection and fire alarm systems, such as are used in unattended machinery spaces, in accommodation spaces, etc.;~~
- ~~— control installations for fire extinction, such as the remote stopping equipment for ventilation fans and fuel oil pumps, remote starting of fire pumps, etc.~~

~~9.1.2.2 — Design and test~~

~~Fire protection equipment and systems shall be suitably designed and tested, when required, according to Clauses 6 and 5 respectively.~~

~~9.1.2.3 — Indications~~

~~The audible and visual signals and indications used shall comply with the relevant requirements of IMO Resolution 867E, Code on Alarms and Indicators, 1995.~~

~~9.1.3 — Fixed fire detection and fire alarm systems~~

~~9.1.3.1 — Detectors~~

~~**9.1.3.1.1** Detectors shall be activated 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, provided that they are no less sensitive than the detectors first mentioned. Flame detectors shall only be used in addition to smoke or heat detectors.~~

~~**9.1.3.1.2** Smoke detectors required by 9.1.3.4.5 shall be certified to operate before the smoke density exceeds 12,5 % obscuration per metre, but not until the smoke density exceeds 2 % obscuration per metre. Smoke detectors to be installed in other spaces shall operate within sensitivity limits to the satisfaction of the appropriate authority, having regard to the avoidance of detector insensitivity or oversensitivity.~~

~~**9.1.3.1.3** Heat detectors shall be certified to operate before the temperature exceeds 78 °C, but not until it exceeds 54 °C, when raised to those limits at a rate of less than 1 °C per min. At higher rates of temperature rise, the heat detector shall operate within temperature limits to the satisfaction of the appropriate authority, having regard to the avoidance of detector insensitivity or oversensitivity.~~

~~**9.1.3.1.4** At the discretion of the appropriate authority, 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.~~

~~**9.1.3.1.5** When fire detectors are provided with means to adjust their sensitivity, the arrangements shall be such that the set point can be fixed and readily identified.~~

~~**9.1.3.1.6** All detectors shall be of such a type that they can be tested for correct operation and restored to normal surveillance without the renewal of any component.~~

~~9.1.3.2 — Power supplies~~

~~**9.1.3.2.1** Any fixed fire detection and fire alarm system with manually operated call points shall be capable of immediate operation at all times. 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 to the satisfaction of the appropriate authority.~~

~~**9.1.3.2.2** Where a fixed fire detection and fire alarm system is provided, but is not required by the International Convention for the Safety of Life at Sea (SOLAS), it shall be supplied by two sources of power, one of which shall be an auxiliary source of power that is separate from the main source. Where such an auxiliary source of power is an accumulator battery, it shall be of sufficient capacity for supplying the fire alarm and fire detecting system for 6 h at least without recharging. For this duration, the system voltage shall not fall to less than 88 % of its nominal voltage.~~

~~During charging the voltage of the battery shall not exceed 12 % above its nominal voltage.~~

~~The supplies shall be provided by separate feeders reserved solely for that purpose. Such feeders shall run to an automatic changeover switch situated in, or adjacent to, the control panel for the detection system.~~

~~9.1.3.3 System requirements~~

~~9.1.3.3.1 Power supplies and electric circuits necessary for the operation of the system shall be designed with self-monitoring properties for loss of power, and at least the following conditions:~~

- ~~— failure of detecting loops due to wire breakage;~~
- ~~— failure due to short circuit;~~
- ~~— insulation failure of isolated systems.~~

~~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.~~

~~9.1.3.3.2 Means shall be provided for testing each detecting loop. Indicators shall be fitted to show when a detector or loop has been disconnected.~~

~~9.1.3.3.3 Simultaneous activation of detectors shall not impair the operation of the system.~~

~~9.1.3.3.4 Where necessary, for example in machinery spaces, means shall be provided for adjusting the response sensitivity of detectors to meet local needs.~~

~~9.1.3.3.5 Detectors and manually operated call points shall be grouped into sections. 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. Indicating units shall denote the section in which a detector or manually operated call point has operated. This signal shall be maintained until it is acknowledged on the control panel. Total resetting of activated section(s) shall only be possible when the detectors are within set points. If it is impossible to identify at a control panel which detector has been activated, each detector shall be equipped with a visual indicator. This signal shall be maintained until it is acknowledged. Indication of detectors shall be provided outside normally locked rooms, unless this indication is given at the control panel.~~

~~NOTE 1 Section: group of fire detectors and manually operated call points as reported in the indicating unit(s).~~

~~NOTE 2 Loop: electrical circuit linking detectors of various sections and connected to the control panel.~~

~~9.1.3.3.6 Clear information shall be displayed on or adjacent to each indicating unit about the spaces covered and the location of the sections.~~

~~9.1.3.3.7 In spaces where detectors are liable to be activated by certain operations, for example welding, cargo handling, etc., the detectors may be rendered temporarily inoperative, providing this is displayed on the indicating unit. The period of time shall be determined by considering, as far as is practicable, the time that the space is occupied. After this predetermined period of time, the detectors shall become operational automatically, unless they have been previously reset.~~

~~9.1.3.3.8 If the signals have not received attention within 2 min, an audible alarm shall be automatically sounded throughout the crew accommodation and service spaces, control stations and machinery spaces of category "A" according to SOLAS. This alarm sounder system need not be an integral part of the detection system.~~

~~9.1.3.3.9 Where the fire detection system does not include means of remotely identifying each detector individually, no section covering more than one deck within accommodation, service 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 appropriate authority. In no case shall more than 50 enclosed spaces be permitted in any section. 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.~~

~~The requirements that a section shall not cover more than one deck and shall not protect more than 50 enclosed spaces are considered to be met by a system with remotely and individually identifiable fire detectors by dividing the loop into various sections by means of isolating devices and limiting each section to that required by the above definitions.~~

~~**9.1.3.3.10** In passenger ships, 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; neither shall it be situated in more than one main vertical zone, unless the appropriate authority is satisfied that the protection of the ship against fire will not thereby be reduced, in which case it may permit such a section of detectors to serve both sides of the ship and more than one deck. In passenger 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.~~

~~**9.1.3.3.11** The requirement on passenger ships contained in 9.1.3.3.10 that a section shall not serve spaces on both sides of the ship and shall not serve more than one deck, is considered to be met by a system with remotely and individually identifiable fire detectors when the loops are divided into various sections by means of isolating devices in such a way that each section covers only one side of the ship.~~

~~**9.1.3.3.12** The requirement on passenger ships contained in 9.1.3.3.10 that a section shall not be situated in more than one main vertical zone, is considered to be met by a system with a remotely and individually identifiable fire detector when a loop is limited to a main vertical zone.~~

~~**9.1.3.3.13** A section of fire detectors which covers a control station, a service space, or an accommodation space, shall not include a machinery space specified as being category "A" according to SOLAS.~~

~~**9.1.3.3.14** For fire detection systems with remotely and individually identifiable fire detectors, the requirement contained in 9.1.3.3.13 is considered to be met when a loop which covers control stations, service spaces and accommodation spaces does not include machinery spaces of category A.~~

~~**9.1.3.3.15** Fire detection systems with a zone address identification capability shall be so arranged that:~~

- ~~— a loop cannot be damaged at more than one point by a fire;~~
- ~~— all arrangements enable the initial configuration of the system to be restored in the event of failure (electrical, electronic, informatic);~~
- ~~— the first initiated fire alarm will not prevent any other detector from initiating further fire alarms.~~

~~**9.1.3.3.16** The requirement contained in clause 9.1.3.3.15 that a system shall be so arranged that a loop cannot be damaged at more than one point by a fire, is considered satisfied by arranging the loop such that the data highway will not pass through a space covered by a detector more than once.~~

~~**9.1.3.3.17** The requirement contained in 9.1.3.3.15 that a system shall be arranged to ensure that any fault occurring in the loop shall not render the whole loop ineffective, is considered satisfied when a fault occurring in the loop only renders ineffective a part of the~~

~~loop not larger than a section of a system and without means of remotely identifying each detector.~~

~~**9.1.3.3.18** The fire detection system shall not be used for any other purpose, except for initiating the closure of fire doors and similar functions, which may be permitted at the control panel.~~

~~**9.1.3.3.19** The function of the detection system shall be tested on installation and thereafter periodically by means of equipment producing hot air at the appropriate 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.~~

~~NOTE Attention is drawn to the fact that computer based systems may require additional provisions (see clause 10).~~

~~**9.1.3.4 — Installation requirements**~~

~~**9.1.3.4.1** The control panel shall be located on the navigation bridge or in the main fire control station.~~

~~**9.1.3.4.2** Indicating units shall, as a minimum, denote the section in which a detector or 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, when at sea or in port, except when the ship is out of service. One indicating unit shall be located on the navigation bridge if the control panel is located in the main fire control station.~~

~~**9.1.3.4.3** Detectors shall be located for optimum performance. A sufficient number and range of detector types shall be installed and positioned such that a fire will be rapidly detected and alarmed. 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. Detectors installed in spaces occupying elevated positions shall be at a minimum distance of 0,5 m away from bulkheads.~~

~~Smoke detectors working on the ionization chamber principle shall be installed in accordance with the applicable requirements for personal protection~~

~~**9.1.3.4.4** Manually operated call points shall be installed throughout the accommodation spaces, service spaces and control stations. One manually operated call point shall be located at each exit. 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 manually operated call point.~~

~~**9.1.3.4.5** 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 exhaust ventilation ducting.~~

~~**9.1.3.4.6** Where a fixed fire detection and fire alarm system is required for the protection of spaces other than those specified in 9.1.3.4.5, at least one detector complying with 9.1.3.1.1 shall be installed in each such space.~~

~~**9.1.3.4.7** The maximum spacing of detectors shall be in accordance with table 2.~~

Table 2 — Maximum spacing of detectors

Type of detector	Maximum floor area per detector m ²	Maximum distance apart between centres m	Maximum distance away from bulkheads m
Heat	37	9	4,5
Smoke	74	11	5,5
NOTE — The appropriate authority may require or permit other spacings based upon test data which demonstrate the characteristics of the detectors.			

~~9.1.3.4.8 — Electrical wiring which forms part of the system shall be so arranged as to avoid galleys, machinery spaces of category "A" according to SOLAS 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.~~

~~9.1.3.5 — Instructions and spares~~

~~Suitable instructions and component spares for testing and maintenance shall be provided.~~

~~9.1.4 — Remote control installations for fire extinction~~

~~9.1.4.1 — Subdivision of remote stop circuits~~

~~9.1.4.1.1 — Ventilation fan motors for cargo spaces, machinery spaces and accommodation spaces shall not be connected to the same remote stop circuit.~~

~~9.1.4.1.2 — Remote stop circuits for machinery for essential services and for their stand-by units shall be electrically separated.~~

~~9.1.4.2 — Resetting of remote stop circuits~~

~~The activation of a remote stop circuit, manually initiated, shall continue until it is manually reset. When the possibility exists that, after resetting, motors may restart automatically, this shall be indicated at the remote stop position.~~

~~9.1.4.3 — Running indication of fire pump~~

~~Where a fire pump is provided with a means of remote start, running indication shall be provided.~~

9.1 Fire safety systems

Arrangement and installation of fire detection and fire alarm systems shall be in accordance with SOLAS Chapter II-2 and IMO Resolution MSC.98(73), Fire Safety Systems Code (FSS Code).

Fire protection equipment and systems shall be suitably designed and tested according to the approval standards as stated in the relevant part of the EN 54 series and the specific test requirements for maritime environment of this standard, see Table 1.

Integration of fire safety systems into a monitoring and control system is permissible with approval of administration, see SOLAS Chapter II-2, Part F, Regulation 17.

The audible and visual signals and indications used shall comply with the relevant requirements of IMO Resolution A.1021(26).

9.2 Bilge systems

For bilge pumping arrangements, SOLAS Chapter II-1, Part B, Regulation 21 applies.

For bilge areas, the monitoring arrangement shall indicate the compartment in which the fault has occurred.

Where the bilge pumps are capable of being started automatically, means shall be provided to indicate when the influx of liquid is greater than the pump capacity, or when the pump is operating more frequently than would normally be expected.

Where automatically controlled bilge pumps are provided, special attention shall be given to oil pollution prevention requirements.

9.3 Machinery ~~alarm~~ alert installations

~~9.2.1 Introduction~~

~~This subclause relates to machinery alarm installations which are provided in order to give warning of abnormal conditions in ship's machinery systems.~~

9.3.1 General

A machinery ~~alarm~~ alert installation shall have the following objectives:

- to direct the attention of personnel to an abnormal condition in a ship's machinery system;
- to help establish the nature and location of the abnormal condition;
- to enable effective, corrective and, where possible, precautionary action to be taken;
- to have acknowledgement of the ~~alarm~~ alert and the return to normal condition indicated.

9.3.2 Alarm Alert requirements

9.3.2.1 Repeater ~~alarm~~ panels

Where repeater ~~alarm~~ panels are required, these shall also be provided with both visual and audible signals. These signals may be common for all, or for a group of ~~alarms~~ alerts connected to the machinery ~~alarm~~ alert installation. An existing alert shall not prevent annunciation of subsequent alerts because of previous alert acknowledgement.

~~9.2.3.2 Labelling~~

~~At the centralised control position, there shall be clear indication on each alarm of the fault conditions, for example "low lubrication oil pressure". At remote group alarm panels, the indication may be limited to a general fault condition.~~

9.3.2.2 Allocation

When local control panels with group alert up to the centralised control system are provided, it is acceptable that the group alert only is shown in the centralised control system.

9.3.2.3 Acknowledgement

~~Alarms shall be maintained until they are accepted and the visual indications of individual alarms shall remain until the fault has been corrected, at which time the alarm system shall reset automatically to the normal operation condition.~~

Generally, IMO Resolution MSC.302(87) applies.

Alarms and warnings shall be indicated until the abnormal condition has been corrected and the alarm or warning has been acknowledged.

Acknowledgement of the alarm ~~condition~~ or warning shall be indicated by an alteration of the visual signal, for example, from flashing to steady light.

Acknowledgement shall be possible only from the machinery space concerned, or the centralised control position associated with that machinery space.

The silencing of an audible alarm or warning at a repeater ~~alarm~~ panel shall not lead automatically to the acknowledgement of the ~~original~~ alarm or warning at the ~~centralised~~ control position.

The acknowledgement shall not reset the abnormal condition which caused the alarm or warning.

9.3.2.4 Inhibition

Inhibition of an alert channel shall be clearly indicated. ~~For essential services such channels are to be monitored or duplicated, such that no fault shall cause alarms to be inhibited without indication.~~ A list of manually inhibited channels shall be available in the system.

9.3.3 Display of information

9.3.3.1 Group arrangement

All visual ~~alarm~~ alert indications within the same priority group shall have the same colour significance and be arranged in logical groups.

9.3.3.2 Legibility

The ~~alarm~~ alert text, legend or symbol shall be clearly visible from the ~~alarm acknowledgement~~ control position.

9.3.3.3 Common audible ~~alarm~~ alert

If the audible ~~alarm~~ alert signal is also used for other purposes, for example telegraph or telephone, it shall be accompanied by (a) luminous call panel(s) indicating the system concerned, and comply with the relevant requirements of IMO Resolution ~~867E, Code on Alarms and Indicators, 1995~~ A.1021(26).

9.3.3.4 ~~Alarm~~ Alert differentiation

An existing ~~alarm~~ alert shall not prevent ~~the indication of further faults~~ annunciation of subsequent alerts because of previous alert acknowledgement.

9.3.3.5 ~~First failure~~ Alert indication

~~In alarm systems for complex machinery installations, consideration shall be given to means for indicating the first failure.~~

According to IMO Resolution MSC.302(87).

9.3.3.6 Alert recording

Alerts shall be recorded in chronological order with date and time stamp. The status of coming, acknowledging and going of any alert shall be clearly recorded.

9.3.4 Supply arrangements

9.3.4.1 ~~Stand-by~~ Power supply

~~Consideration shall be given to the provision of A stand-by power supply for the alarm installation.~~

The machinery alert installation shall be continuously powered. A stand-by power supply with automatic change-over shall be provided with a capacity of at least 30 min.

9.3.4.2 ~~Alarm~~ Alert for supply failure

Visual and audible ~~alarm signals~~ alerts shall be initiated at the failure of the ~~alarm installation~~ power supplies of the machinery alert installation.

9.3.5 Design

~~9.2.6.1~~ ~~Separation of functions~~

~~Alarm installations shall be separated from control systems and, as far as is practicable, their sensors.~~

9.3.5.1 Monitoring equipment

~~Alarm system~~ Machinery alert installations may be combined with monitoring equipment, such as equipment provided with analogue read-outs of measured variables or with data loggers, ~~or alarm data printers.~~

9.3.5.2 Time delays

~~Alarm~~ Alert channels, where necessary, shall be provided with suitable time delays.

Transients phenomena, such as pressure waves in protected pressure systems, sensor contact bouncing or electromagnetic interference from other systems, shall not cause the ~~alarm~~ alert installation to operate. All level ~~alarms~~ alerts shall have a time delay related to the frequency of the ship's movements.

9.3.5.3 ~~Closed~~ Circuits

~~Normally closed circuits shall be used to prevent non-indication of an alarm due to a broken sensor loop. Alternatively, open circuits may be used, if they are monitored for sensor circuit faults.~~

Alarm signals should be based on normally closed loops, giving alarm upon signal failure.

Shut-down circuits of essential machinery should be based on normally open circuits with loop monitoring.

9.3.5.4 Earth fault

Earth fault(s) in alarm sensor circuits shall cause the alarm to operate, or to be indicated in an alternative manner, or otherwise not prevent indication of alarm(s).

9.3.5.5 Mutual fault independence

A fault in any one ~~alarm~~ alert channel, particularly in the external incoming and outgoing circuits, shall, as far as is practicable, not influence the normal operation of any other channels.

9.3.5.6 ~~Audible alarm~~ Alert independence

A fault in ~~alarm-indicating lamps, including a short-circuit in a lamp or lamp holder,~~ the visual indication of an alert shall not affect the operation of the audible ~~alarm~~ indication and vice versa.

9.3.5.7 System integrity

As far as is practicable, test facilities for checking the proper function ~~or~~ of the electrical ~~alarm~~ circuits, including audible and visual devices, shall be provided.

~~9.3 Automatic control installations for electrical power supply~~**~~9.3.1 Introduction~~**

~~This subclause relates to automatic control installations for generating sets, which are provided in order to safeguard the electrical power supply.~~

~~9.3.2 General~~

~~Such automatic control systems for generating sets may include:~~

- ~~— automatic starting of a set;~~
- ~~— automatic connecting onto a dead bus bar;~~
- ~~— automatic parallelling and load sharing;~~
- ~~— automatic shut-down of a set;~~
- ~~— automatic disconnecting of non-essential services;~~
- ~~— automatic analysis of power reserve.~~

~~9.3.3 Automatic starting~~**~~9.3.3.1 Initiation of starting commands~~**

~~Commands for automatic starting may be given, for example, by:~~

- ~~— no voltage (blackout);~~
- ~~— prolonged voltage drop;~~
- ~~— prolonged frequency drop;~~
- ~~— expected frequency reduction or expected stop of running set;~~
- ~~— overload (mechanical or electrical or both);~~
- ~~— increase of power demand;~~
- ~~— start signal for large electric power consumer(s), for example transverse thruster motor;~~
- ~~— failure of running sets;~~
- ~~— pressure drop in exhaust gas boilers;~~
- ~~— remote manual means.~~

~~9.3.3.2 Delay of signal~~

~~In order to avoid inadvertent starting, signals caused by acceptable transient conditions, for example high motor starting currents, shall not cause the automatic starting of a set.~~

~~9.3.3.3 — Transfer of starting order~~

~~If more than one set is fitted with automatic starting devices, consideration shall be given to fitting either a sequence system, which, in case of starting failure, automatically transfers the starting order to the next set(s), or a selector switch for manual use.~~

~~9.3.3.4 — Pre-starting conditions~~

~~Means shall be provided to ensure that proper starting and running conditions exist at any time regarding starting air, fuel, cooling water, etc.~~

~~9.3.3.5 — Stand-by indication~~

~~Stand-by indication shall be arranged at the control panel and, to safeguard personnel, locally at the individual machine(s).~~

~~9.3.3.6 — Starting interlock~~

~~Every set shall be capable of being interlocked against inadvertent starting in order that maintenance and repair may be carried out in safety. Indication shall be provided to warn that the set is unavailable for automatic starting.~~

~~9.3.3.7 — Start indication and restriction~~

~~9.3.3.7.1 — The automatic starting and running of a set shall be indicated.~~

~~9.3.3.7.2 — The number and the duration of starting attempts in case of starting failure shall be limited.~~

~~9.3.3.7.3 — Starting failure of a set shall give a visual and audible alarm signal.~~

~~9.3.4 — Automatic connecting onto a dead bus bar~~

~~9.3.4.1 — Connection at blackout~~

~~It shall be ensured, when closing a generator circuit-breaker onto a bus bar, that the generator voltage is sufficiently high. In order that the initial load does not exceed the capability of the generator, consideration shall be given to limiting or sequencing the reconnection of the loads, or both.~~

~~9.3.4.2 — Non-simultaneous closing~~

~~Simultaneous automatic closing of two or more generator circuit-breakers shall be prevented.~~

~~9.3.4.3 — Undue closing~~

~~Means shall be provided to prevent automatic closing of the generator circuit-breaker in the event of any failure of the starting order sensing element, e.g., erroneous operation of a low voltage relay.~~

~~9.3.4.4 — Short circuit~~

~~After a short circuit, stand-by generator circuit-breakers shall be prevented from closing on to a faulty bus-bar section. A manual reset shall be provided for this facility. Generator circuit-breakers shall not be permitted more than one attempt to close onto a short circuit.~~

~~9.3.4.5 — Disconnecting of a running set~~

~~If a set has been started, due to a prolonged voltage or frequency drop not directly causing a running generator to trip, consideration shall be given to having the faulty generator set disconnected as soon as the stand by set is ready for taking over.~~

~~9.3.5 — Automatic load management~~

~~9.3.5.1 — Required conditions~~

~~In order to achieve automatic paralleling, it will be necessary to ensure efficient automatic synchronising and automatic closure of the circuit breaker.~~

~~NOTE Attention is drawn to the possibility of fast frequency fluctuations occurring due to heavy load rushes. Where this may be expected, the use of quick closing circuit breakers, or synchronising reactors, or similar means should be considered.~~

~~A reverse power tripping device shall be provided for electrical generators intended for parallel operation.~~

~~Where an automatic load sharing function is provided, a fault in any system providing such a function should not result in the loss of the main electrical power.~~

~~9.3.6 — Automatic shut-down~~

~~9.3.6.1 — Initiation of shut-down~~

~~In the case of failures which may cause damage to a set, e.g. overspeed or low pressure of lubrication oil, the set shall be automatically disconnected and shut down.~~

~~9.3.6.2 — Prediction alarm~~

~~In order to prevent unnecessary shut-down, consideration shall be given to the provision of an additional visual and audible alarm signal, thus allowing manual precautions to be taken before the dangerous condition is reached.~~

~~9.3.6.3 — Disconnection due to decrease of load~~

~~In systems with automatic generator disconnection upon decrease of load, the disconnection shall be delayed.~~

~~9.3.6.4 — Sets cooling down~~

~~Where necessary, or desired, a running out sequence may be programmed, permitting the set to smooth the thermal-mechanical effects of sudden change from high to no load.~~

~~9.3.6.5 — Indication of shut-down~~

~~Automatic shut-down of a set due to a failure shall cause a visual and audible alarm signal.~~

~~9.3.6.6 — Prevention of restarting~~

~~Automatic restarting of a set after an automatic stop due to a failure shall be prevented.~~

~~9.3.6.7 — Power supply~~

~~The power supply to the system providing automatic shutdown functions shall be taken from an independent source. Consideration shall be given to providing visual and audible alarm indication that the power supply has failed. Where auxiliary power is necessary to maintain the main electrical power supply, for example power to electronic governors, at least two~~

~~independent auxiliary power systems shall be provided. Generator protection equipment shall be located in separate cubicles as for other generators.~~

~~9.3.7 Automatic disconnecting of non-essential services~~

~~9.3.7.1 Causes of disconnecting~~

~~In order to safeguard electrical power supply for essential services, provision of a system to disconnect automatically non-essential services shall be considered in the following cases:~~

- ~~— when one generating set is normally used to supply the electrical load, but where the possibility exists that, due to the automatic switching on of additional loads, whether manually or automatically initiated, the total load exceeds the rated generator capacity;~~
- ~~— when generators are operated in parallel to supply the load and when, in case of failure of one of the running generators, the total load exceeds the combined capacity of the remaining generator(s).~~

~~9.3.7.2 Design conditions~~

~~When designing the protection system to trip the non-essential services in case of generator overload, due account shall be taken of loads with power factors deviating from rated values, the decreased efficiency of engines, etc. In order to safeguard the electrical power supply in such cases, consideration shall also be given to providing, for example, low-frequency relays in addition to generator current relays.~~

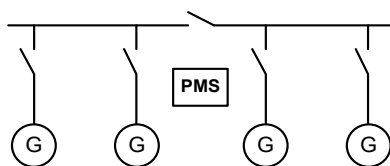
9.4 Power management systems

9.4.1 General

The requirements of 9.4 shall apply where a power management system is specified for the automatic control of electrical power generation and distribution.

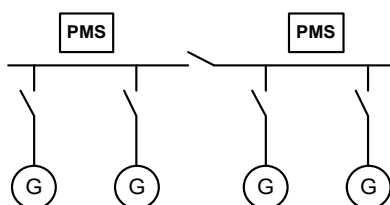
Power management systems can be categorized in three different designs (see Figure 1):

- a) one common system for all control functions;
- b) one independent system per busbar section;
- c) one independent system per main power supply unit.



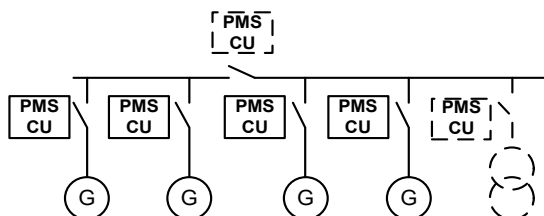
IEC

a) One common system for all control functions



IEC

b) One independent system per busbar section



IEC

c) One independent system per main power supply unit

Key

PMS Power management system

G Generator

CU Control unit

Figure 1 – Typical designs of power management systems

An independent manual control shall be provided regardless of the chosen design. Such automatic control systems for electrical power supply may include in general (see Figure 1 a), b) and c)):

- the load dependent starting/stopping of a generator-set;
- the load distribution and frequency control;
- the heavy load request and power reserve for big consumers;
- the control of equipment for the improvement of overall efficiency.

The designs shown in Figure 1 b) and c) may include the following additional functions:

- control of non-essential consumers;
- paralleling of generator-sets and busbar sections;
- shaft generator control (PTI/ PTO);
- black-out recovery.

The designs described in 9.4.1 c) and Figure 1 c) may include the following additional functions:

- 1) generator and prime mover protection;
- 2) synchronizing.

9.4.2 Automatic starting and stopping of main power supply equipment

9.4.2.1 Initiation of starting and stopping commands

Commands for automatic starting and stopping of the main power supply equipment may be initiated in the following cases:

- under-voltage;
- under-frequency;
- expected stop of running set (delayed shut-down);
- overload, overcurrent;
- load dependent start;
- load dependent stop;
- failure of running sets.

9.4.2.2 Delay of signal

In order to avoid inadvertent starting, signals caused by acceptable transient conditions, for example high motor starting currents, shall not cause the automatic starting of a set.

9.4.2.3 Disconnection due to decrease of load

In systems with automatic generator disconnection upon decrease of load, the disconnection shall be provided with an appropriate delay.

9.4.2.4 Warming up and cooling down sequence

Where necessary, or desired, a warming up and a cooling down sequence may be programmed.

9.4.2.5 Pre-starting conditions

Means shall be provided to ensure that proper starting and running conditions exist at any time regarding starting air, fuel, cooling water, etc.

9.4.2.6 Stand-by indication

Stand-by indication shall be arranged at the control panel. An alarm shall be triggered when no stand-by set is available.

9.4.2.7 Start indication and restriction

The running of a set shall be indicated.

The number and the duration of automatic starting attempts shall be limited.

The starting failure of a set shall provide a visual and audible alarm. A sequence system shall be provided, which, in case of starting failure, automatically transfers the starting order to the next set.

9.4.3 Heavy load request and power reserve calculation

A power management system shall calculate on request if the load reserve is sufficient to start a heavy consumer. Where load reserve is not sufficient the heavy consumer will be blocked until an additional generator-set is connected. When a heavy consumer is in operation the power management calculates and maintains the necessary load reserve.

9.4.4 Black-out recovery

9.4.4.1 Connection at black-out

It shall be ensured, when closing a generator circuit-breaker onto a bus bar, that the generator voltage is sufficiently high. In order that the initial load does not exceed the capability of the generator, consideration shall be given to limiting or sequencing the reconnection of the loads, or both.

9.4.4.2 Non-simultaneous closing

Simultaneous automatic closing of two or more generator circuit-breakers shall be prevented.

9.4.4.3 Short circuit

After a short circuit, stand-by generator circuit-breakers as well as bus tie-breakers shall be prevented from closing on to a faulty bus-bar section. Generator circuit-breakers shall not be permitted more than one attempt to close onto a short circuit. A resetting of a triggered short circuit protection device may be possible locally and manually only.

9.4.4.4 Disconnecting of a running set

If a set has been started, due to under-voltage or under-frequency not directly causing a running generator to trip, consideration shall be given to having the faulty generator set disconnected as soon as the stand-by set is ready for taking over (switching over via black-out).

9.4.5 Load sharing and frequency control

Where an automatic load sharing and frequency control function is provided, a fault in any system providing such a function shall not result in the loss of the main source of electrical power.

9.4.6 Shut-down of diesel engine

9.4.6.1 Shut-down

When the safety system of the diesel engine triggers a shut-down, the set shall be automatically disconnected.

9.4.6.2 Pre-alarm

Pre-alarms or delayed shut-downs shall allow a manual or automatic action before a shut-down occurs.

9.4.6.3 Prevention of restarting

The starting of a generator set shall not be possible when a shut-down or stop signal is active.

9.4.7 Automatic disconnection of non-essential consumers

In order to safeguard electrical power supply for essential services, provision of a system to disconnect automatically non-essential consumers shall be considered in the following cases:

- the total load exceeds the rated generator capacity;
- under-frequency or under-voltage;
- failure of one of the generators running in parallel if the total load exceeds the combined capacity of the remaining generator(s). In this case disconnection shall be undelayed.

9.4.8 Design requirements of power management systems (PMSs)

9.4.8.1 General

The PMS shall operate independently. The PMS shall provide different control levels: full automatic control, remote control and local control. Local control of the PMS from the switchboard applies only to Figure 1 b) and c).

For remote control of the PMS from the automation system an interface may be provided. Local control of the PMS shall have higher priority than remote control and automatic control of the PMS.

Any PMS failure shall trigger an alert.

Malfunctioning of the PMS may not lead to loss of the main source of power.

Manual control of the switchboards may not be affected by the automation system and/or PMS system.

9.4.8.2 One common system for all control functions (Figure 1 a))

The PMS shall be supplied from an uninterruptible power supply (UPS) system supplied from the main and emergency source of power.

9.4.8.3 One independent system per busbar section (Figure 1 b))

Each PMS shall be supplied from an independent UPS system supplied from main and emergency source of power. If one of the PMS fails the remaining one shall take control of the complete system.

9.4.8.4 One independent system per main power supply unit (Figure 1 c))

Each PMS shall be supplied from a UPS system supplied from the the main and emergency source of power. Each unit shall also be supplied from the busbar voltage and if applicable from the generator voltage.

If the diesel safety system and/or the generator protection are integrated in the PMS (integrated protection and control system), then a failure of the PMS shall trigger an alarm but not trip the generator-set.

Each generator-set shall be equipped with operation-, indication- and protection-devices, so as to operate the generator-set by manual means also when the integrated protection and control system has failed.

Manual operation of the prime mover means that the following functions are still available:

- a) start/stop of the engine;
- b) over-speed protection, as far as required;

- c) lubrication monitoring , as far as required;
- d) required control equipment and instrumentation;
- e) speed/load control of the engine.

Manual operation for the generator and the switchgear means:

- 1) short circuit protection;
- 2) control, indication and instrumentation in the generator panel.

9.5 Automatic starting installations for electrical motor-driven auxiliaries

9.5.1 ~~Introduction~~ General

Subclause 9.5 relates to automatic installations for electrical motor-driven auxiliaries such as lubricating oil pumps, cooling water pumps, etc.

All equipment employed in automatic starting installations for electrical motor-driven auxiliaries shall, where applicable, comply with the ~~recommendations of~~ requirements according to IEC 60092-202 and IEC 60092-302.

9.5.2 Automatic sequence starting

9.5.2.1 Prevention of overload

Controlgear used for the automatic restart of electrical motors shall, where necessary, be provided with an automatic sequence starting system to prevent overloading of the generating equipment at the moment, and during the procedure, of power restoration after the occurrence of a black-out.

9.5.2.2 Starting delays

The sequence starting system, ~~when provided,~~ shall ensure the shortest possible starting delay for those auxiliaries which are most vital for the ship's propulsion ~~or its propulsion machinery, such as steering gear motors and lubricating oil pumps.~~

~~9.4.3.3 Interlock system~~

~~If the rating of motors is such that more than one generating set is required to be connected to the supply system before the motors may start automatically, an interlock system shall be provided.~~

9.5.3 Starting installations for stand-by auxiliaries

9.5.3.1 Starting ~~order~~ commands

The starting ~~order~~ command for the stand-by machine shall be ~~given either from~~ initiated by a process value measured in the controlled medium, ~~or the electrical system, or both, as appropriate for the service concerned.~~ In case of electrical failure of the auxiliary drive in operation the stand-by auxiliary drive shall be started immediately.

The starting ~~order~~ command for a stand-by lubricating oil pump motor, for example, shall be taken from the lubricating oil pressure, ~~flow, or gravity tank level, depending on the system design,~~ and not only from the controlgear of the running lubricating oil pump motor.

9.5.3.2 Stand-by indication

Selection of the stand-by position for an electrical motor-driven auxiliary, together with the ~~state of readiness of its power supply~~ information "motor starter ready for remote operation", shall be indicated at the centralized control position, ~~where provided, and the local control~~

~~position(s)~~ as stand-by indication. If the availability of the stand-by function is lost during operation a stand-by alert shall be triggered.

9.5.3.3 Indication of start

Automatic starting of a stand-by auxiliary shall cause ~~a visual and audible alarm signal to be initiated~~ an alert.

9.5.4 Control voltages

~~The voltage of control circuits incorporating sensing elements, such as pressure sensors or similar devices mounted in the ship's machinery equipment, shall not exceed 250 V d.c. and a.c.~~

The automatic changeover system shall be supplied from a UPS system supplied from the main and emergency source of power or directly from the dedicated motor starters.

9.5.5 Manual control

~~A fault failure~~ in the controlgear of one motor ~~or in the automatic changeover system for running or stand-by motors~~ shall not render more than one motor unavailable for manual control. In case of failure in the automatic changeover system both motors shall be available for manual control.

9.5.6 Mechanically driven auxiliaries in low speed range

Where auxiliary machinery is mechanically driven from the propulsion system, stand-by units shall be provided for automatic start-up when carrying out manoeuvres in the lower speed range where the output of the mechanically-driven auxiliary machines is not adequate under these conditions.

9.5.7 Mechanically driven auxiliaries

No alert shall be triggered in case of machinery installations with mechanically connected pumps, when the independent electrical pumps start up in the course of normal operation.

9.5.8 Sensors

The sensors for stand-by circuits shall be independent from other systems, especially from the related process alerts.

9.6 Machinery control installations

9.6.1 ~~Introduction~~ General

Subclause 9.6 relates to the control of machinery essential for the propulsion and safety of the ship.

For electric and electrohydraulic steering gear SOLAS Chapter II-1, Part C, Regulation 30 applies.

For machinery controls SOLAS Chapter II-1, Part C, Regulation 31 applies.

~~NOTE Control and instrumentation~~ Requirements for ~~steering gear are given in IEC 60092-204 and for~~ the electrical propulsion plant are given in IEC 60092-501.