SECTION 3 EQUIPMENT

1 General

1.1 Construction

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

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

1.1.3 Enclosures for electrical equipment are to be of an adequate mechanical strength and rigidity.

1.1.4 Ventilation is to be adequate to maintain the ambient temperature at or below the maximum at which the equipment is designed to operate.

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

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

1.1.7 All electrical equipment and enclosures are to be marked with:

- Manufacturer's name
- Model number or designation
- Electrical rating in volts and amperes or volts and watts
- Phase and frequency, if applicable
- Certified safe type, if applicable.

1.2 Degree of protection of enclosures

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

The minimum required degree of protection, in relation to the place of installation, is generally that specified in Ch 2, Sec 2, Tab 2.

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

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

1.2.3 Cable entrance are not to impair the degree of protection of the relevant enclosure (see Ch 2, Sec 2, [4.1.3]).

2 Switchboards

2.1 Design - construction

2.1.1 Generally, switchboards or enclosures containing switchboards are to be constructed of durable, flame-retardant and non-hygroscopic materials. In addition, mechanical features of the materials are to be suitable for the service conditions.

2.1.2 The large switchboards are to be provided with insulated handrails or handles fitted in an appropriate position at the front of the switchboard.

2.1.3 Where the aggregate capacity of generators connected to the main busbars exceeds 100 kVA, a separate cubicle for each generator is to be arranged with flame-retardant partitions between the different cubicles. Similar partitions are to be provided between the generator cubicles and outgoing circuits.

2.1.4 All parts of the switchboard are to be readily accessible for maintenance, repair or replacement. In particular, fuses are to be able to be safely inserted and withdrawn from their fuse-bases. All parts which require operation in normal use are to be placed on the front.

2.1.5 The switchboard frame or enclosures containing switchboards are to earthed.

2.1.6 No live part is to be installed on the front of the switchboards without protection.

2.1.7 Connections for cables and busbars are to be protected against loosening due to vibration.

2.1.8 Each switch or control is to be marked to indicate its use, unless the purpose of the switch is obvious and its mistaken operation will not cause a hazardous condition. Switching devices are to be so designed and arranged that when in the off position they cannot accidentally move sufficiently to close the circuit.

2.1.9 Switchboards with both d.c. and a.c. electrical systems are to be fitted with a partition to separate the a.c. and d.c. sections from each other as mentioned in Ch 2, Sec 4, [7.2].

2.2 Busbars

2.2.1 Busbars are to be dimensioned in accordance with IEC Publication 60092-302. Busbars and their connection are to be made of copper and are to be designed to withstand mechanical stresses due to short-circuit. Maximum temperature rise is to be 45°C.

2.2.2 The cross-section of neutral connection on an a.c. three-phase four wire system is to be at least 50% of the cross-section for the corresponding phases.

2.2.3 Bare busbars are to comply with the minimum clearances and creepage distances given in Tab 1.

Note 1: Clearance is the distance between two conductive parts along a string stretched the shortest way between such parts. Creepage distance is the shortest distance along the surface of an insulating material between two conductive parts.

Table 1 : Clearances and creepage distances

Rated insulation voltage, in V	Minimum clearance, in mm	Minimum creepage distance, in mm
≤ 250	15	20
> 250 to < 690	20	25
> 690 to < 1000	25	35

2.3 Instruments

2.3.1 Normal full load values are to be marked in red on the instrument scale for all indicating instruments and appropriate labels are to be fixed to digital instruments when employed.

2.3.2 Instruments for d.c generators

a) Generators of 2 kW output or more, which are not operated in parallel, are to be provided with at least one voltmeter and one ammeter

b) Generators for parallel operation are to be provided with one voltmeter for each generator (or one voltmeter and a change-over switch for its connection to each generator), one ammeter for each generator and one voltmeter for each section of busbar

c) For compound-wound generators fitted with equalizer connections, the ammeter is to be connected to the pole opposite to that connected to the series winding of the generator.

2.3.3 Instruments for a.c. generators

a) Generators not operated in parallel, except single-phase generators smaller than 2 kVA, are to be provided:

- 1 voltmeter
- 1 ammeter in each phase or one ammeter with a selector switch which enables to read the current in each phase
- 1 frequency meter for generators rated more than 15 kVA

b) In addition to the above, generators for parallel operation are to be provided with at least:

- 1 wattmeter capable of indicating reverse power up to 15% of the rated full load of the generator
- 1 ammeter in each phase conductor (or one ammeter with a selector switch to permit the measurement of current in each phase)

For paralleling purpose, the following are to be provided:

- 2 voltmeters
- 2 frequency meters
- 1 synchronising device comprising either a synchronoscope and lamps, or an equivalent arrangement.

One voltmeter and one frequency meter are to be connected to the busbars; the other voltmeter and frequency meter are to have a selector switch to permit measurement of the voltage and frequency of any generator.

Note 1: When generators are running in parallel in installations with the neutral earthed, it is necessary to ensure that the equalising current caused by harmonics does not exceed harmful values. Reference is to be made to guidance from generator manufacturer.

2.3.4 Each secondary distribution system is to be provided with one voltmeter.

2.3.5 Switchboards are to be fitted with means for monitoring the insulation level of insulated distribution systems as stipulated in Ch 2, Sec 2, [3.2.2] and Ch 2, Sec 2, [3.2.3].

2.3.6 The main switchboard is to be fitted with a voltmeter or signal lamp indicating that the cable between the shore-connection to main switchboard is energised (see Ch 2, Sec 2, [3.6.7]).

2.3.7 For each d.c. power source (e.g. convertors, rectifiers and batteries), one voltmeter and one ammeter are to be provided, except for d.c. power sources for starting devices.

2.4 Testing

2.4.1 Switchboards are normally to be subjected to the tests specified in this section prior installation on board.

The manufacturer is to issue the relative test reports providing information concerning the construction, serial number and technical data relevant to the switchboard, as well as results of the tests required.

a) High voltage test

The main and auxiliary circuits are to be tested with a.c. voltage given in Tab 2 and 3, at a frequency between 25 and 100Hz of approximately sinusoidal form.

The test voltage is to be applied between all live parts connected together and earth or between each polarity and all the other polarities connected to earth for the tests.

During this test, all interrupting and protective devices are to be closed; measuring instruments and relays may however be disconnected.

b) Measurement of the insulation resistance

Immediately after completion of the high voltage test, the insulation resistance is to be measured using a device with a direct current voltage of at least 500 VDC. The insulation resistance between all current carrying parts and earth or between each polarity and the other polarities is to be at least equal to 1 mega ohm.

Table 2 : Testing voltages for main circuits

Insulation rated voltage, in V	AC test voltage (rms), in V
Ui ≤ 60	1000
60 < Ui ≤ 300	2000
300 < Ui ≤ 660	2500
660 < Ui ≤ 800	3000
800 < Ui ≤ 1000	3500

Table 3 : Testing voltages for auxiliary circuits

Insulation rated voltage, in V	AC test voltage (rms), in V
Ui ≤ 12	250
12 < Ui ≤ 60	500
Ui > 60	2 Ui + 1000 with a minimum of 1500

3 Rotating electrical machines

3.1 General

3.1.1 Rotating machines used for essential services are to be manufactured according to recognized international or national standards.

3.2 D.C. generators

3.2.1 D.c. generators are generally alternators with integral rectifiers and regulators fitted to the propulsion machinery.

3.2.2 The voltage regulation is to be ensured with, if necessary, the use of an automatic voltage regulator, particularly in the case of generator driven by a propulsion engine.

For generators of a power higher than 20 kW and less than 50 kW, the regulation is at least such that, in case of sudden removal of half the rated load, the speed remaining constant, the voltage increase remains lower than 8% in the case of shunt wound generators and 4% in the case of compound wound generators.

3.3 A.C. generators

3.3.1 An a.c. generator may be driven by its own prime mover, be powered from propulsion machinery, or be a shaft generator.

Electrical machines, including shaft generators and/or static converter/inverters are to comply with the relevant requirements of IEC Publication 60092-301.

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

3.3.3 Each generator is to be provided with automatic means of voltage regulation.

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

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

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

3.3.7 The combined prime mover, transmission system and generator are to be designed to withstand without damage the effects of the most onerous short-circuit condition at the generator terminals when running at rated voltage and speed.

3.4 Prime movers, speed control

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

3.4.2 When generators are to operate in parallel, the characteristics of speed governors are to comply with above requirements.

3.4.3 The generators driven by the propulsion engine, by a geared shaft or by an auxiliary set intended for another purpose, are to be designed with consideration of the modifications of the number of revolutions which may occur in service.

3.5 Testing

3.5.1 All machines are to be tested by the manufacturers. The manufacturer is to issue a test reports giving, inter alia, information concerning the construction, type, serial number, insulation class and all other technical data relevant to the machine, as well as the results of the tests required.

Such test reports are to be provided to the Society, for machine intended for essential services. For other machines, these test reports are to be made available upon request of the Society.

3.5.2 Machines of 100 kW and over, intended for essential services are to be surveyed by the Society during testing in compliance with an approved procedure.

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

4 Transformers

4.1 General

4.1.1 Transformers are to be manufactured according to recognized international or national standards.

4.2 Construction

4.2.1 Transformers used for power, lighting and as static convertors, starting transformers, static balancers, saturable reactors and transductors, including single-phase transformers rated at less than 1kVA, and three-phase transformers rated at less than 5 kVA, are to comply with IEC 60092-303.

4.2.2 Transformers with liquids containing polychlorinated biphenyl's (PCB) are not to be used.

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

4.2.4 Transformers are normally to be of the dry, air cooled type. When a forced air cooling system is used, an alarm is to be activated in the event of its failure.

4.2.5 Transformers are to have enclosures with a degree of protection in accordance with Ch 2, Sec 2, Tab 2.

4.3 Testing

4.3.1 All transformers intended for essential services are to be tested by the manufacturers. The manufacturer is to issue a test reports giving, inter alia, information concerning the construction, type, serial number, insulation class and all other technical data relevant to the transformer, as well as the results of the tests required.

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

4.3.2 Tests of transformers of 100 kW and over (60 kVA when single phase) intended for essential services are to be attended by a Surveyor of the Society in accordance with an approved procedure.

4.3.3 Tests are to be carried out according to the requirements of IEC 60076 and 60726.

5 Converters/inverters

5.1 General

5.1.1 Converters/inverters are to be manufactured and tested according to recognized international or national standards.

5.2 Construction

5.2.1 Natural air-cooling units are to be designed with sufficient ventilation openings, or with sufficient cooling surface to dissipate the heat so that totally enclosed equipment operates within the design temperature limits.

5.2.2 Converters/inverters are to be so constructed that they may be removed without dismantling the complete unit.

6 Storage batteries and chargers

6.1 Constructional requirement for batteries

6.1.1 The requirements of this Article apply to permanently installed storage batteries (not portable batteries).

6.1.2 Vented batteries are to be constructed to withstand the movement of the yacht and the atmosphere (e.g. salt mist) to which they may be exposed. No spillage of electrolyte is to occur at any inclination angle up to 45° from the vertical.

6.1.3 Battery terminal connectors which depend on spring tension for mechanical connection to the terminal are not to be used.

6.2 Constructional requirement for chargers

6.2.1 Chargers are to be adequate for the batteries for which they are intended.

6.2.2 Chargers are to incorporate a voltage regulator, a protection against overcharging and a charge indicator.

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

6.2.4 The charging facilities for batteries are to be such that the completely discharged battery may be charged to 80% charge within a period of 10 hours without exceeding the maximum permissible charging current.

6.2.5 Charge regulators used with a wind generator or photo-voltaic cells are to be specially designed for use in such systems. When used to charge battery installations, they are to be set so that the gassing voltage of the battery to which they are connected is not exceeded.

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

7 Acessories

7.1 Plugs and socket-outlets

7.1.1 Where earthed system is used, plug and socket outlets of the earthing type are to be arranged with a terminal provided for the protective conductor in accordance with IEC 60309.

7.1.2 Socket-outlets rated over 16 A are to be normally provided with a switch.

7.1.3 Where socket-outlets are supplied at different voltages, the socket-outlets and plugs are to be designed in a such a way that an incorrect connection cannot be made.

7.1.4 Socket outlets and matching plugs used on a.c. systems are not to be interchangeable with those used in d.c. system on the yacht.

7.2 Lighting fittings

7.2.1 Lighting fittings are to comply with IEC Publications 60092-306. Lighting fittings complying with other standards are to be specially considered by the Society.

7.2.2 Lighting fittings likely to be exposed to risk of mechanical damage are to be either protected against such damage or to be specially robust construction. The construction and installation of luminaires are to be appropriate to their location and environment.

7.3 Heating and cooking appliances

7.3.1 Electrical heating and cooking appliances are to comply with the relevant requirements of IEC 60092-307.

7.3.2 The casing or enclosure of space heaters is to be so designed that clothing or other flammable material cannot be placed on them.

7.3.3 The temperature of the external surface of space heaters is not to exceed 60°C.

7.3.4 Space heaters are to be provided with a temperature limiting device without automatic reconnection which automatically trips all poles or phases not connected to earth when the temperature exceeds the maximum permissible value.