SECTION 4 INSTALLATION

1 General

1.1 Protection against injury or damage caused by electrical equipment

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

1.1.2 All electrical equipment is to be installed in such a way that live parts cannot be inadvertently touched, unless supplied at a safety voltage.

1.1.3 For protective earthing as a precaution against indirect contact, see [2].

1.1.4 Equipment is to be installed so as not to cause, or at least so as to reduce to a minimum, electromagnetic interference.

1.2 Protection against damage to electrical equipment

1.2.1 Electrical equipment is to be so placed that as far as practicable it is not exposed to risk of damage from water, oil or oil vapours.

1.2.2 Equipment is to be so mounted that its enclosing arrangements and the functioning of the built-in equipment will not be affected by distortions, vibrations and movements of the yacht's structure or by other damage liable to occur during normal operation of the yacht.

1.2.3 If electrical fittings are attached to structures of another metal, for instance aluminium, suitable provision is to be made to prevent galvanic corrosion.

1.3 Accessibility

1.3.1 Equipment is to be so installed that sufficient space is available for inspection and maintenance as required for all its parts.

2 Earthing of non-current carrying parts

2.1 General

2.1.1 The purpose of earthing and bonding of non-current-carrying parts of an electrical system is to reduce the danger of shock to personnel and to minimise damage to equipment from the effects of earth currents. These can occur from failures of insulation of live conductors, induced voltages and currents.

2.2 Parts which are to be earthed

2.2.1 All exposed non-current carrying conductive parts of both fixed and portable electrical machines or equipment which are liable under fault conditions to become live and similar parts inside non-metallic enclosures are to be connected to earth unless the machines or equipment are:

a) supplied at a voltage not exceeding 50 V direct current or 50 V root mean square between conductors, achieved without the use of auto-transformers (safety voltage); or

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

c) constructed in accordance with the principle of double insulation (Class II) as per IEC 60536 or equivalent insulation intended to prevent the appearance of dangerous voltages on accessible parts due to a fault in the basic insulation.

2.3 Earthing connection

2.3.1 Non-current carrying conductive parts are to be connected to earth either via the protective conductors or by direct connection to the hull for steel yacht.

2.3.2 The nominal cross-sectional area of bonding and protective conductors is to be not less than that required in Tab 1.

Note 1: Precautions are to be taken for design of cross sectional area of protective conductors for components producing harmonic distortion.

2.4 Earthed distribution system

2.4.1 The a.c. protective conductor(s) are to be provided with a final connection to the hull for metallic hull yachts or to the external main earthing plate required in [2.4.2] for yachts with non metallic hull. Connection is to be effected at one point only by means independent of any earthing arrangements of non-current carrying parts.

A main earth conductor bar may be used to connect all protective conductors at one location before the final connection is made.

2.4.2 Earthing of non metallic hull yachts is to be made by an external earthing plate of copper or other conducting material compatible with sea water, and having a surface area of not less than 0.25 m^2. This plate is to be secured to the outside of the hull in an area reserved for this purpose and located below the light-load water line so that it is immersed under all conditions of heel.

Note 1: For metallic yachts, and particularly those of aluminium alloy, control systems of internal combustion engines are to be insulated from engine earth.

Table 1 : Cross-sectional area of protective and bonding conductors

Type of earthing connection		Cross-sectional area of associated current carrying conductor	Minimum cross-sectional area of copper earthing connection
1	Protective conductor in flexible cable or flexible cord	any	Same as current carrying conductor up to and including 16 mm² and one half above 16 mm² but at least 16 mm²
2	Protective conductor incorporated in fixed multicore cable	any	a) a cross-section equal to that of the main conductors if the latter is less than or equal to 16 mm², but minimum of 1,5 mm² b) a cross-section of not less than 50% of the cross-section of the main conductor when the latter is more than 16 mm², but at least 16 mm²
3	Protective conductor provided by single core cable	any	a) a cross-section equal to that of the current carrying conductor if the latter is less than or equal to 16 mm² b) a cross-section of not less than 50% of the cross-section of the current carrying conductor if the latter is more than 16 mm², but at least 16 mm²
4	Separate fixed bonding conductor	> 1,5 mm² but ≤ 120 mm²	One half the cross-sectional area of the current carrying conductor, subjected to a minimum of 4 mm²
		> 120 mm²	70 mm²

2.4.3 The earthing connection is to be made at a location above any anticipated water accumulation in an accessible position where it may readily be inspected and disconnected for insulation testing.

2.5 Bonding conductors

2.5.1 Every earthing conductor is to be made of copper or other corrosion-resistant material and is to be securely installed and protected, where necessary, against damage and electrolytic corrosion.

2.5.2 The earth bonding is to be such as to give substantially equal potential and sufficiently low earth fault loop impedance to ensure correct operation of protective devices.

2.5.3 Extraneous conductive parts which are connected to hull of a steel yacht by permanent and reliable metal to metal joints of negligible impedance need not be bonded by separate earthing conductors.

2.5.4 All bonding conductors for a.c. and d.c. installations are to be identified by green, or green with a yellow stripe insulation or may be uninsulated. Conductors with green, or green with yellow stripe insulation are not to be used for current-carrying conductors.

2.5.5 Metal used for earth or earth bond terminal studs, nuts and washers are to be corrosion-resistant and galvanically compatible with the conductor and terminal. Aluminium and unplated steel are not to be used for studs, nuts and washers in electrical circuits. No more than four conductors are to be secured to one earth or earth bond one terminal stud.

2.5.6 Where possible, the means of bonding is to be separate from that provided at the yachts hull for radio, radar and communication circuits to minimise possible interference.

3 Converters - Transformers

3.1 Semiconductor power converters

3.1.1 Converters/inverters are to be installed such that the circulation of air around them is not impeded and so that the air temperature at their cooling inlet air does not exceed the ambient temperature.

3.1.2 Converters/inverters are not to be mounted near sources of heat such as engine exhaust pipes.

3.2 Transformers

3.2.1 Transformers are to be installed in well-ventilated locations. Their connections are to be protected against mechanical damages, condensation and corrosion as may be reasonably expected.

4 Storage batteries

4.1 General

4.1.1 Batteries are to be located where they are not exposed to excessive heat, extreme cold, spray, steam or other conditions which would impair performance or accelerate deterioration. They are to be installed in such a way that no damage may be caused to surrounding appliances by the vapours generated.

4.1.2 Batteries are to be secured against movements and inclinations occurring during yacht operation and are to be protected against falling objects.

On sailing yachts, and small motor yachts, batteries are to be secured sufficiently to prevent them from breaking free in the event of a complete capsize (i.e. inversion).

4.1.3 Storage batteries are to be suitably housed in compartment (containers or boxes) properly constructed for their accommodation and efficiently ventilated so as to prevent accumulation of flammable gas.

4.1.4 The interior of vented battery compartments (containers, boxes) including all metal parts subject to the electrolyte is to be protected against the deteriorating effect of the latter by electrolyte-resistant coating or other equivalent means, unless corrosion-resistant materials are used.

4.1.5 Starter batteries are to be located as close as practicable to the engine or engines served.

4.1.6 Lead-acid batteries and alkaline batteries are not to be placed in the same cabinet or container or in close vicinity to each other.

4.1.7 Batteries are not to be installed directly above or below a fuel tank or fuel filter and any other metallic component of the fuel system. A clear distance of 300 mm above the battery top is to be provided as a minimum.

4.1.8 Switches and fuses or other equipment, which may generate sparks are not to be placed in battery compartments or containers.

4.1.9 Batteries are not to be located in sleeping quarters except where hermetically sealed to the satisfaction of the Society.

4.2 Ventilation

4.2.1 Whatever the type of battery, areas in which batteries are stowed is to be provided with adequate ventilation to free air to prevent an accumulation of flammable gas.

4.2.2 Where batteries are installed in a separate closed compartment (containers or boxes) reserved for batteries, a vent system or other means are to be provided to permit the discharge from the yacht of gasses released by battery when under charge.

4.2.3 The minimum rate of air expelled (by natural or forced ventilation) for battery compartment is to be as given by the following formula:

$Q = 110\ I\ n$

where:

Q : Rate of ventilation, in litres per hour

I : 25% of the maximum obtainable charging current, in amperes

n : Number of cells in series.

4.2.4 The ventilation rate for compartment containing valve-regulated sealed batteries may be reduced to 25 per cent of that given in [4.2.3].

4.2.5 Where natural ventilation is impracticable or insufficient, mechanical exhaust ventilation is to be provided.

4.2.6 The air inlet to battery compartments or containers is to be below the level of the battery, and the outlet is to be at the highest point of the compartment or container.

Air inlet may be from the open air or from another space (for example from machinery spaces).

4.2.7 Cable entries to battery compartments or containers are to be gas-tight.

4.2.8 Exhaust ducts of natural ventilation systems:

a) are to be run directly from the top of the compartment to the open air above (they may terminate in the open or in well-ventilated spaces)

b) are to terminate not less than 90 cm above the top of the battery compartment

c) are to have no part more than 45° from the vertical

d) are not to contain appliances (for example flame arrestors) which may impede the free passage of air or gas mixtures.

4.2.9 In mechanical exhaust ventilation systems:

a) electric motors are to be outside the exhaust ducts and battery compartment and are to be of an explosion-proof safe type if installed within 3 m from the exhaust of the ventilation duct

b) fans are to be so constructed and of a material such as to render sparking impossible in the event of the impeller touching the fan casing

c) steel or aluminium impellers are not to be used

d) the system is to be interlocked with the charging device so that the battery cannot be charged without ventilation. A warning signal is to be provided and operate if failure occurs.

5 Switchboards

5.1 General

5.1.1 Switchboards are to be so arranged as to give easy access as may be needed to apparatus and equipment, without danger to personnel.

5.1.2 An unobstructed space is to be left in front of the switchboards wide enough to allow access for operation and maintenance.

5.1.3 When the voltage exceeds the safety voltage, non-conducting mats or gratings are to be provided at the front of the switchboard and also at the rear if access to the rear is provided. The insulated mats or gratings are to be oil-resistant and non-slippery.

5.1.4 Piping and conduits are not to be installed directly above or in the vicinity of switchboards.

Where this is unavoidable, pipes and conduits are to have welded joints only or to be provided with protection against spray from pressurised liquids or dripping.

5.2 Emergency switchboard

5.2.1 When provided, the emergency switchboard is to be installed as near as is practicable to the emergency source of electrical power.

5.2.2 Where the emergency source of electrical power is a generator, the emergency switchboard is to be located in the same space unless the operation of the emergency switchboard would thereby be impaired.

6 Cables

6.1 General

6.1.1 Cables having insulating materials with different maximum permissible conductor temperatures are not to be bunched together. Where this is not practicable, the size of these cables is to be sufficient to ensure that no cable can reach a temperature higher than its rating.

6.1.2 All cables and wiring external to equipment are to be so installed as not to impair their original flame-retarding properties. To this end, only cables which have been tested in accordance with IEC Publication 60332-3 Category A or an equivalent test procedure for installation in bunches are to be used.

6.1.3 Refer to the recommendations of clause 28 of IEC 60092-352 relating to special precautions for single-core cables for a.c. wiring.

6.2 Cable runs

6.2.1 Cable runs are to be as short and direct as possible and selected to avoid areas of fire risk and areas where there is a risk of mechanical damage.

6.2.2 Cables are to be routed away from exhaust pipes and other heat sources which can damage the insulation.

6.2.3 Cables are to be routed above anticipated levels of bilge water and in other areas where water may accumulate, or at least 25 mm above the level at which the automatic bilge-pump switch activates.

6.2.4 Cables and wiring serving essential or emergency power, lighting, internal communications or signals are, so far as is practicable, to be routed clear of high fire risk areas (e.g. galleys, machinery spaces), except for supplying equipment in those spaces.

6.2.5 For the installation of cables in the vicinity of radio equipment or of cables belonging to electronic control and monitoring systems, steps are to be taken in order to limit the effects of unwanted electromagnetic interference (screening and/or twisted pairs, separation).

All cables between antennas and transmitters are to be separated from the cables of all other circuits.

6.2.6 In the case of essential services requiring a duplicate supply (e.g. steering gear circuits), the supply and associated control cables are to follow different routes which are to be as far apart as practicable, separated both vertically and horizontally.

6.3 Radius of bend

6.3.1 The internal radius of bend for the installation of cables is to be chosen according to the type of cable as recommended by the manufacturer.

6.4 Cable support and protection

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

6.4.2 Cables exposed to risk of mechanical damage are to be protected by metal casing, profiles, pipes or other equivalent means, unless the cable covering (e.g. sheath or armour) provides adequate mechanical protection.

6.4.3 Cables are to be supported throughout their length in conduits, cable trunking or trays, or by individual supports at maximum intervals of 450 mm.

6.4.4 The supports (tray plates, separate support brackets or hanger ladders) and the corresponding accessories are to be of robust construction and of corrosion-resistant material or suitably treated before erection to resist corrosion.

When cables are installed directly on aluminium structures, fixing devices of aluminium or suitably treated steel are to be used.

6.4.5 With the exception of cables installed in pipes, conduits, trunkings or special casings, cables are to be fixed by means of clips, saddles or straps of suitable material, in order to tighten the cables without their coverings being damaged.

6.4.6 Cable clips or straps made from a material other than metal are to be manufactured of a flame-retardant material.

6.5 Penetration of bulkheads and decks

6.5.1 If cables and conductors have to pass without adequate support through non-watertight bulkheads and generally through holes drilled in sheets of structural steel, these holes are to be fitted with glands or bushings. Materials used for glands and bushings are to be resistant to corrosion and are not to damage the cable or the yacht's structure.

6.5.2 Cable penetrations are not to impair the effectiveness of fire protection, watertightness or gas-tight of decks and bulkhead.

6.6 Earthing and continuity of metal coverings of cables

6.6.1 All metal coverings of cables are to be earthed at both ends. Earthing at one end is admitted where it is required for technical or safety reasons.

6.6.2 The electrical continuity of all metal coverings of cables throughout the length of the latter, particularly at joints and tappings, is to be ensured.

6.7 Earthing and continuity of metal pipes, conduits and trunking or casings

6.7.1 Metal casings, conduits and trunking are to be effectively earthed.

6.8 Cable trays/protective casings/conduits made of plastics materials

6.8.1 Cable trays, protective casings or conduits made of plastics materials (thermoplastic or thermosetting plastic material) are to be type tested.

6.8.2 Non-metallic cable trays or protective casings or conduits made are to be flame retardant. We used on open deck, they are to be protected against U.V. light.

6.8.3 The load on the non-metallic cable trays is to be as recommended by the manufacturer.

7 Cabling and wiring

7.1 Cable terminations

7.1.1 Terminations in all conductors are to be so made as to retain the original electrical, mechanical, flame-retarding properties of the cable.

7.1.2 The dimensions and design of cable sockets and clamps are to be such that the maximum current likely to flow through them will not cause the rated operating temperature of the cable insulation to be exceeded.

7.1.3 The means of fixing of conductors and terminals are to be capable of withstanding the thermal and dynamic effects of short-circuits.

7.1.4 Screw-clamp or screwless terminals are to conform to IEC 60947-7-1. Other terminals are to be of the ring or captive-spade type, not dependent on screw or nut tightness alone for retention on the screw or stud. Captive-spade terminals are to be of the self-locking type.

7.1.5 The ends of every conductor are to be securely terminated by a means which contains all the strands of the conductor.

7.1.6 All conductors attached to stud or screw connection are to be fitted with suitable terminals (i.e. no bare wires attached to stud or screw connections).

7.1.7 The number of wires terminated in the same cable socket or clamp is not to exceed the maximum number recommended by the accessory manufacturer.

7.1.8 Exposed shanks of terminals are to be protected against accidental shorting by the use of insulating barriers or sleeves, except those in the protective conductor system.

7.2 D.c. and a.c. segregation

7.2.1 A d.c. circuit is not to be contained in the same wiring system as an a.c. circuit, unless one of the following methods of separation is used:

a) For a multicore cable or cord, the cores of the d.c. circuit are separated from the cores of the a.c. circuit by an earthed metal screen of equivalent current-carrying capacity to that of the largest core in either circuit

b) The cables are insulated for their system voltage and installed in separate compartments of a cable ducting or trunking system

c) The cables are installed on a tray or ladder where physical separation is provided by a partition

d) Physically separate conduit, duct, trunking or routing systems are used for d.c. and a.c. systems

e) The d.c. and a.c. conductors are fixed directly to a surface and separated by at least 100 mm.

7.3 Conductor identification

7.3.1 Requirements mentioned in this Article are applicable to yachts of length less than 24 metres.

7.3.2 Each electrical conductor that is part of the electrical system is to have a means to identify its function in the system, except for conductors include in packaged system (e.g engine) and bonding conductors.

7.3.3 All d.c. negative conductors are to be identified by black or yellow insulation.

7.3.4 If the yacht is equipped with a.c. and d.c. electrical system using both black conductor insulation, yellow insulation is to be used for negative conductors of the d.c. system. Black or yellow insulation are not to be used for d.c. positive conductors.

7.3.5 Means of identification other than colour for d.c. positive conductors is permitted if properly identified on the wiring diagram of the electrical system(s) of the yacht.

7.3.6 Conductor identification for a.c. system is to be in accordance with IEC 60446.

- live conductors: black or brown
- neutral conductors: white or light blue
- protective conductors: green and yellow.

Note 1: A colour stripe or number may be added to the conductor insulation for identification in the system.

Note 2: yachts with an a.c. and d.c. systems should avoid the use of a brown, white or light blue insulation colour in the d.c. system unless clearly separated from the a.c. conductors and identified.

8 Various appliances

8.1 Lighting fittings

8.1.1 Lighting fittings are to be so arranged as to prevent temperature rises which could damage the cables and wiring.

8.1.2 Lighting fittings are to be so arranged as to prevent surrounding material from becoming excessively hot.

8.1.3 Lighting fittings are to be secured in place such that they cannot be displaced by the motion of the yacht.

8.2 Heating appliances

8.2.1 Space heaters are to be so installed that clothing, bedding and other flammable material cannot come in contact with them in such a manner as to cause risk of fire.

Note 1: To this end, for example, hooks or other devices for hanging garments are not to be fitted above space heaters or, where appropriate, a perforated plate of incombustible material is to be mounted above each heater, slanted to prevent hanging anything on the heater itself.

8.2.2 Space heaters are to be so installed that there is no risk of excessive heating of the bulkheads or decks on which or next to which they are mounted.

8.2.3 Combustible materials in the vicinity of space heaters are to be protected by suitable incombustible and thermal-insulating materials.

8.3 Magnetic compass

8.3.1 Cables and equipment are to be placed at a such distance from the compass, or are to be so screened, that the interfering external magnetic field is negligible, causing a compass deviation of no more than 30' when the circuits are switched on or off under maximum load.

8.4 Socket-outlets

8.4.1 Socket-outlets provided for the galley area are to be located so that the appliance cords may be plugged in without crossing above a galley stove or sink or across a traffic area.