# Chapter 12
## Electrical installations

**PART A - GENERAL**

### 12.1 General

12.1.1 Electrical installations should be such that:

.1 all electrical auxiliary services necessary for maintaining the craft in normal operation and habitable conditions will be ensured without recourse to the emergency source of electrical power;

.2 electrical services essential for safety will be ensured under various emergency conditions; and

.3 the safety of passengers, crew and craft from electrical hazards will be ensured.

The FMEA should include the electrical system, taking into account the effects of electrical failure on the systems being supplied. In cases where faults can occur without being detected during routine checks on the installations, the analysis should take into account the possibility of faults occurring simultaneously or consecutively.

*Surveyors should ensure that the details and arrangements comply with the Regulations and the Code, and that workmanship is in all respects satisfactory. In addition to IEC Standards, the Regulations for the Electrical and Electronic Equipment of Ships with Recommended Practice for their Implementation published by the Institution of Electrical Engineers, may be used for guidance.*

*The FMEA should comply with the requirements of Annexes 3 and 4. Normally compliance will be achieved by provision of redundant systems as detailed in 4.5 of Annex 4, and numerical assessment will not be required. Consideration should be given to the independence of redundant systems as required by 4.5.2 of Annex 4. The effect of complete or partial failure of the electrical installation should be assessed against the definitions of Effects contained in 2.3 of Annex 3, taking into account craft handling under reduced propulsion and the variety of circumstances in which such failure may occur throughout the operational life of the craft. As guidance, complete failure of propulsion may result in a hazardous or catastrophic effect under adverse circumstances of weather and location, which should be given due weight in any numerical assessment of probability. It is recommended that FMEA's should be forwarded to HQ for advice, particularly those which comply by means of numerical assessment.*

12.1.2 The electrical system should be designed and installed so that the probability of the craft being at risk of failure of a service is extremely remote.

*This requirement should be adequately covered within the FMEA, although the use of the term 'extremely remote' should not be taken in the context of numerical probabilities described in Annex 3.*

12.1.3 Where loss of particular essential service would cause serious risk to the craft, the service should be fed by at least two independent circuits fed in such a way that no single failure in the electrical supply or distribution systems would affect both supplies.

*Normally compliance will be achieved by provision of redundant systems as detailed in 4.5 of Annex 4.*

12.1.4 The securing arrangements for heavy items, i.e. accumulator batteries, should, as far as practicable, prevent excessive movement during the accelerations due to grounding or collision.

*See section 4.3.*

12.1.5 Precautions should be taken to minimise risk of supplies to essential and emergency services being interrupted by the inadvertent or accidental opening of switches or circuit breakers.

## 12.2 Main Source of electrical power

12.2.1 A main source of electrical power of sufficient capacity to supply all those services mentioned in 12.1.1 should be provided. The main source of electrical power should consist of at least two generating sets.

*Regulation 12.2.1 requires at least two main generating sets which together can supply the power for maintaining all normal operational and habitable conditions, that is to say the full design load including non-essential consumers. These generators should be available for duty at all times when the craft is at sea, or is about to put to sea or is under way. Where these services are intended to be supplied by a single generator in operation, the main generators should be arranged so that another selected machine is automatically started and connected to the main switchboard if the generator in operation is overloaded or fails.*

*Generators, motors and transforming equipment, intended for services in connection with propulsion and safety of the ship, are to be inspected during construction and the works and shipboard tests are to be witnessed. Machines and transforming equipment of less than 100kW may be accepted, without survey at the Manufacturing Works, if satisfactory maker's test certificates are supplied certifying the results of tests to determine the operating characteristics, temperature rise, insulation resistance and dielectric strength.*

12.2.2 The capacity of these generating sets should be such that in the event of any one generating set being stopped or failing it will still be possible to supply those services necessary to provide the normal operational conditions of propulsion and safety. Minimum comfortable conditions of habitability should also be ensured which include at least adequate services for cooking, heating domestic refrigeration, mechanical ventilation, sanitary and fresh water.

12.2.3 The arrangements of the craft's main source of electrical power should be such that the services referred to in 12.1.1.1 can be maintained regardless of the speed and direction of the propulsion machinery or shafting.

12.2.4 In addition, the generating sets should be such as to ensure that with any one generator or its primary source of power out of operation, the remaining generating set

should be capable of providing the electrical services necessary to start the main propulsion plant from dead craft condition. The emergency source of electrical power may be used for the purpose of starting from a dead craft condition if its capability either alone or combined with that of any other source electrical power is sufficient to provide at the same time those services required to be provided by 12.7.3.1 to 12.7.3.3 or 12.7.4.1 to 12.7.4.4 or 12.8.2.1 to 12.8.2.4.1, as appropriate.

12.2.5 Where transformers constitute an essential part of the electrical supply system required by this section, the system should be so arranged as to ensure the same continuity of supply as is stated in 12.2.

12.2.6 A main electric lighting system which should provide illumination throughout those parts of the craft normally accessible to and used by passengers and crew should be supplied from the main source of electrical power.

12.2.7 The arrangement of the main electric lighting system should be such that a fire or other casualty in spaces containing the emergency source of electrical power, associated transforming equipment, if any, the emergency switchboard and the emergency lighting switchboard will not render inoperative the main electric lighting systems required by 12.2.6.

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

*In general, the location of the main generators in relation to the main switchboard, as referenced by the term "one space" means the same main fire zone and watertight compartment. Where main generators are located in two separate spaces such that a fire or casualty in either space will not affect supply from the other, and the installed capacity in each space being sufficient to meet the requirements of 12.2.1, the main switchboard may be located in a third space provided that it complies with the intent of 12.2.9.*

12.2.9 The main busbars should normally be subdivided into at least two parts which should be connected by a circuit-breaker or other approved means. So far as is practicable, the connection of generating sets and any other duplicated equipment should be equally divided between the parts. Equivalent arrangements may be permitted to the satisfaction of the Administration.

*Circuit breakers or fuses of suitable rating and characteristics could be accepted as a suitable means for subdivision of switchboards.*

## 12.3 Emergency source of electrical power

12.3.1 A self-contained emergency source of electrical power should be provided.

*See alternative means of compliance under 12.7.2 and 12.8.2. The generators, batteries, transformers, switchgear etc, forming the emergency source of power should be sited so that flames, heat or smoke issuing from doors or other openings in the event of a fire in the machinery space, will not impede the safe operation of the equipment or render the space inaccessible or uninhabitable to necessary personnel.*

12.3.2 The emergency source of electrical power, associated transforming equipment, if any, transitional source of electrical power, emergency switchboard and emergency lighting switchboard should be located above the waterline in the final condition of damage as referred to in Chapter 2, operable in that condition and readily accessible.

12.3.3 The location of the emergency source of electrical power and associated transforming equipment, if any, the transitional source of emergency power, the emergency switchboard and the emergency electrical lighting switchboards in relation to the main source of electrical power, associated transforming equipment if any, and the main switchboard should be such as to ensure that a fire or other casualty in spaces containing the main source of electrical power, associated transforming equipment, if any, and main switchboard or in any machinery space will not interfere with the supply, control, and distribution of emergency electrical power. As far as practicable, the space containing the emergency source of electrical power, associated transforming equipment, if any, the transitional source of emergency electrical power and the emergency switchboard should not be contiguous to the boundaries of the main machinery spaces or those spaces containing the main source of electrical power, associated transforming equipment, if any, or the main switchboard.

12.3.4 Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances, the emergency generator, if provided, may be used exceptionally, and for short periods, to supply non emergency circuits.

*The primary intent of this relaxation is to allow the use of the emergency source of power when starting the craft's plant from the 'dead ship' condition. Arrangements which would require the emergency generator set to be operated for purposes other than supplying emergency services or testing or the purpose mentioned above, should not normally be accepted.*

12.3.5 Distribution systems should be so arranged that the feeders from the main and emergency sources are separated both vertically and horizontally as widely as practicable.

12.3.6 The emergency source of electrical power may be either a generator or an accumulator battery, which should comply with the following:

.1 Where the emergency source of electrical power is a generator it should be:

.1.1 driven by a suitable prime mover with an independent supply of fuel having a flashpoint which meets the requirements of 7.1.2.2;

.1.2 started automatically upon failure of the electrical supply from the main source of electrical power and should be automatically connected to the emergency switchboard. Those services referred to in 12.7.5 or 12.8.3 should then be transferred to the emergency generating set. The automatic starting system and the characteristic of the prime mover should be such as to permit the emergency

generator to carry its full rated load as quickly as is safe and practicable, subject to a maximum of 45 seconds; and

*A sign should be clearly displayed adjacent to the generating set warning that it is arranged for automatic starting.*

.1.3 provided with a transitional source of emergency electrical power according to 12.7.5 or 12.8.3.

*The charging arrangements provided for the transitional source of emergency electrical power, together with any independent battery provided should be supplied from the emergency switchboard.*

.2 Where the emergency source of electrical power is an accumulator battery, it should be capable of:

.2.1 carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage;

*Surveyors should be satisfied that the capacity is sufficient to ensure performance of the required duty. A Certificate of Inspection by a battery maker of repute, or his agent, regarding the satisfactory condition of the battery, may be accepted. Such Certificates should be supplied to the ship.*

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

.2.3 immediately supplying at least those services specified in 12.7.5 or 12.8.3.

*To ensure that the means provided for periodically testing the emergency source of power are fully effective, the arrangements should include facilities for putting the source of power on load by supplying the emergency services. In the case of highly rated turbo charged generating sets, the load should be sufficient to prevent an excessive build up of carbon in the prime mover, which may occur due to operation at light load.*

12.3.7 The emergency switchboard should be installed as near as is practicable to the emergency source of electrical power.

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

*An environmental enclosure within the main boundaries of the space does not provide separation between the emergency generator and the emergency switchboard.*

12.3.9 No accumulator battery fitted in accordance with this section should be installed in the same space as the emergency switchboard. An indicator should be mounted in a suitable space at the craft's operating compartment to indicate when the batteries constituting either the emergency source of electrical power or the transitional source of emergency electrical power referred to in 12.3.6.1.3 are being discharged.

12.3.10 The emergency switchboard should be supplied during normal operation from the main switchboard by an interconnector feeder which should be adequately protected at the main switchboard against overload and short circuit and which should be disconnected automatically at the emergency switchboard upon failure of the main source of electrical power. Where the system is arranged for feedback operation, the interconnector feeder should also be protected at the emergency switchboard at least against short circuit. Failure of the emergency switchboard when being used in other than an emergency should not put at risk the operation of the craft.

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

12.3.12 The emergency generator and its prime mover and any emergency accumulator battery should be so designed and arranged as to ensure that they will function at full rated power when the craft is upright and when the craft has a list or trimming accordance with 9.1.12 including any damage cases considered in Chapter 2, or is in any combination of angles within those limits.

12.3.13 Where accumulator batteries are installed to supply emergency services, provisions should be made to charge them in situ from a reliable on-board supply. Charging facilities should be so designed to permit the supply of services, regardless of whether battery is on charge or not. Means should be provided to minimise the risk of overcharging or overheating the batteries. Means for efficient air ventilation should be provided.

*Access to battery compartments should, wherever practicable, be arranged from the open deck. Electrical equipment in compartments for the normal "vented type" battery should comply with the IEE Regulations. Where all batteries in the compartment are of the "sealed type", the alternative arrangements described in the IEE Regulations 1990 edition as amended may be accepted, provided all such requirements are met. Ventilation should always be provided for the space where the batteries are located, to the standard described in the IEE Regulations 1990 edition as amended.*

## 12.4 Starting arrangements for emergency generating sets

12.4.1 Emergency generating sets should be capable of being readily started in their cold condition at a temperature of $0^0$C. If this is impracticable, or if lower temperatures are likely to be encountered, provisions should be made for heating arrangements to ensure ready starting of the generating sets.

12.4.2 Each emergency generating set should be equipped with starting devices with a stored energy capability of at least three consecutive starts. The source of stored energy should be protected to preclude critical depletion by the automatic starting system, unless a second independent means of starting is provided. A second source of energy should be provided for an additional three starts within 30 min, unless manual starting can be demonstrated to be effective.

*Where both the sources of stored energy are accumulator batteries, a single common starter motor and associated switch can be accepted. The arrangements should ensure that only one battery at a time can be brought into service. Separate charging arrangements, supplied by the emergency switchboard, should be provided for each battery.*

12.4.3 The stored energy should be maintained at all times, as follows:

.1 electrical and hydraulic starting systems should be maintained from the emergency switchboard;

.2 compressed air starting systems may be maintained by the main or auxiliary compressed air receivers through a suitable non-return valve or by an emergency air compressor which, if electrically driven, is supplied from the emergency switchboard

.3 all of these starting, charging and energy storing devices should be located in the emergency generator space. These devices should not be used for any purpose other than the operation of the emergency generating set. This does not preclude the supply to the air receiver of the emergency generating set from the main or auxiliary compresses air system through the non return valve fitted in the emergency generator space.

## 12.5 Steering and stabilisation

12.5.1 Where steering and/or stabilisation of a craft is essentially dependent on one device as with a single rudder or pylon, which is itself dependent on the continuous availability of electric power, it should be served by at least two independent circuits, one of which should be fed either from the emergency source of electric power or from an independent power source located in such a position as to be unaffected by fire or flooding affecting the main source of power. Failure of either supply should not cause any risk to the craft or passengers during switching to the alternative supply and such switching arrangements should meet the requirements in 5.2.5. These circuits should be provided with short circuit protection and an overload alarm.

*The control circuits of electrically controlled devices should be connected to the power circuit supplying the device.*

12.5.2 Protection against excess current may be provided, in which case it should be for not less than twice the full load current of the motor or circuit so protected, and should be arranged to accept the appropriate starting current with a reasonable margin. Where three-phase supply is used an alarm should be provided in a readily observed position in the craft's operating compartment that will indicate failure of any one of the phases.

*If switching arrangements are such that more than one steering and/or stabilisation device can be connected to one feeder, its over-current protection is to be similarly based on at least 200% of the sum of the rated currents of all the devices that can be connected to the feeder.*

12.5.3 Where such systems are not essentially dependent on the continuous availability of electric power but at least one alternative system, not dependent on the electric supply is installed, then the electrically powered or controlled system may be fed by a single circuit protected in accordance with 12.5.2.

12.5.4 The requirements of Chapter 5 and 16 for power supply of the directional control system and stabilising system of the craft should be met.

## 12.6 Precautions against shock, fire and other hazards of electrical origin

12.6.1.1 Exposed metal parts of electrical machines or equipment which are not intended to be live but which are liable under fault conditions to become live should be earthed unless the machines or equipment are:

.1 supplied at a voltage not exceeding 55V direct current or 55V, root mean square between conductors; auto-transformers should not be used for the purpose of achieving this voltage; or

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

.3 constructed in accordance with the principle of double insulation.

12.6.1.2 The Administration may require additional precautions for portable electrical equipment for use in confined or exceptionally damp spaces where particular risks due to conductivity may exist.

*The voltage of electrical supplies to portable and transportable electrical apparatus in all such spaces, should be as low as is practicable for the application. General guidance is given in Appendix B of the IEE Regulations 1990. Attention is particularly drawn to the recommendation that 24 volts is used for hand lamps. Where the supply exceeds 55 volts the use of Class I appliances is recommended in preference to Class II. (Class I appliances are provided with facilities for earthing non-current carrying parts.) (Class II appliances have double insulation and/or reinforced insulation throughout and are without provision for earthing.) It is recognised that the limits of voltage recommended in the IEE Regulations are not always practicable for portable and transportable apparatus such as submersible pumps, refrigerated containers etc. In these cases, where 3 phase supplies up to 500 volts may be involved, the additional precautions in (a) and (b) below or a combination are recommended:*

*(a) circuits which monitor the continuity of the earthed connections and automatically disconnect supply on loss of earth continuity. This arrangement will not, however, be effective when Class II apparatus is used;*

*(b) each socket outlet or group of socket outlets supplied through a high sensitivity residual current circuit breaker (RCCB) (formerly termed high sensitivity current operated earth leakage circuit breaker). For this method to be fully effective the supply must be earthed at one point. In craft with unearthed systems double wound isolating transformers with one point of the secondary winding solidly earthed should be used. Particular attention is drawn to the need to select an RCCB which is resistant to the marine environment eg vibration, salt atmosphere etc.*

*The supply arrangements to refrigerated containers etc should ensure that all wandering leads are kept clear of the vehicle decks and the need for extension leads is eliminated.*

12.6.1.3 All electrical apparatus should be constructed and so installed as not to cause injury when handled or touched in the normal manner.

12.6.2 Main and emergency switchboards should be so arranged as to give easy access as may be needed to apparatus and equipment, without danger to personnel. The sides and the rear and, where necessary, the front of switchboards should be suitably guarded. Exposed live parts having voltages, to earth exceeding a voltage to be specified by the Administration should not be installed on the front of such switchboards. Where necessary, non-conducting mats or gratings should be provided at the front and rear of the switchboard.

*The voltage referred to should be taken as 55V. Platforms at the front and rear of switchboard must have non-slip surfaces. Where access to live parts within switchboard is normally possible, the surfaces must, in addition be insulated by non-conducting mat or gratings.*

12.6.3 When a distribution system, whether primary or secondary, for power, heating or lighting, with non-connection to earth is used, a device capable of continuously monitoring the insulation level to earth and of giving an audible or visual indication of abnormally low insulation values should be provided. For limited secondary distribution systems the Administration may accept a device for manual checking of the insulation level.

*Where visual indication only is provided, it shall be in a position where it will be included in routine checks or will be apparent to the crew within 24 hours.*

**2.6.4 Cables and wiring**

12.6.4.1 Except as permitted by the Administration in exceptional circumstances, all metal sheaths and armour of cables should be electrically continuous and should be earthed.

*Relaxation is permitted for limited instrumentation circuits where the manufacturers of the devices require cable sheaths not to be earthed.*

12.6.4.2 All electric cables and wiring external to equipment should be at least of a flame-retardant type and should be so installed as not to impair their original flame-retarding properties. Where necessary for particular applications the Administration may permit the use of special types of cables such as radio frequency cables, which do not comply with the foregoing.

*To meet flame retardant characteristics cables should be at least in accordance with BS 4066 : Pt 1 : 1995, or IEC 332-1 : 1993. Consideration should be given to the arrangements of bunched cable runs to ensure that their flame retarding characteristics are not impaired. Note: The use of unsuitable paints, trunking, casings, etc may significantly affect the fire propagation characteristics of cables. Builders proposals for fire stops in long runs of bunched cables should be considered, unless the cables are totally enclosed in cable trunks. Long cable runs may, as a guidance figure, be taken as those over 6m vertical, 14m horizontal. Where cables are installed in totally enclosed cable trunks, derating may be necessary due to lack of ventilation*

12.6.4.3 Cables and wiring serving essential or emergency power, lighting, internal communications or signals should so far as practicable be routed clear of machinery spaces and their casings and other high fire risk areas. Where practicable all such cables should be run in such a manner as to preclude their being rendered unserviceable by heating of the bulkheads that may be caused by a fire in an adjacent space.

*Cable runs should, as far as practicable, avoid routes which pass over or near the top of diesel engines and oil-fired equipment, or near to hot surfaces e.g. diesel engine exhaust systems. Where there is no alternative route, cables should be protected from heat and fire damage. Such fire protection may be in the form of a steel plate or trunk, due account being taken of the effects on cable rating, if appropriate.*

12.6.4.4 Where cables which are installed in hazardous areas introduce the risk of fire or explosion in the event of an electrical fault in such areas, special precautions against such risks should be taken to the satisfaction of the Administration.

*Intrinsically safe circuits should not be run in the same multicore cable as non-intrinsically safe circuits. Different intrinsically safe circuits should not be run in the same cable without special consideration. The electrical parameters (capacitance, inductance and resistance) of cables for intrinsically safe circuits should comply with the certification documents. Cables for intrinsically safe circuits in new craft should be segregated from all non-intrinsically safe cables by at least 50mm throughout their length. In existing craft, arrangements without cable segregation can be accepted provided that either the intrinsically safe cables or the non-intrinsically safe cables are armoured (wire, braid or tape) or metal sheathed.*

*Cable for non-intrinsically safe circuits in the hazardous areas should be either:*

*.1 of the mineral insulated metal covered type or*

*.2 protected by electrically continuous metal sheathing or metallic wire armour, braid or tape or*

*.3 enclosed in screwed heavy gauge steel solid drawn or seam welded and galvanised conduit. The conduit should be made gas tight with respect to hazardous areas.*

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

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

12.6.5.1 Each separate circuit should be protected against short circuit and against overload, except as permitted in 12.5 or where the Administration may exceptionally otherwise permit.

*Protective devices, either individually or in combination, should be capable of handling the maximum short circuit current that may occur at the point of installation, allowing for all the generators that can be running and connected, and including the contribution from all the motors that can be expected to be running. The builder's calculations indicating compliance*

*with the foregoing should be considered. The operating times of protective devices provided for any circuit should be such that faults will be isolated before the supply cable of the circuit has been permanently damaged. An overload alarm should be provided for each circuit where overload protection is omitted.*

*It is recommended that, where practicable, isolating devices which are not designed to break current should be protected against inadvertent or malicious operation when the circuit is carrying current e.g. by interlocking. As a minimum, a notice warning that the device should not be opened under load should be displayed at the operating position.*

12.6.5.2 The rating or appropriate setting of the overload protective device for each circuit should be permanently indicated at the location of the protective device.

12.6.5.3 When the protective device is a fuse it should be placed on the load side of the disconnect switch serving the protected circuit.

12.6.6 Lighting fittings should be so arranged as to prevent temperature rises which could damage the cables and wiring, and to prevent surrounding material from becoming excessively hot.

12.6.7 All lighting and power circuits terminating in a bunker or cargo space should be provided with a multiple-pole switch outside the space for disconnecting such circuits.

12.6.8.1 Accumulator batteries should be suitably housed, and compartments used primarily for their accommodation should be properly constructed and efficiently ventilated.

*Battery compartments and ventilation should comply with the recommendations of the IEE Regulations.*

12.6.8.2 Electrical or other equipment which may constitute a source of ignition of flammable vapours should not be permitted in these compartments except as permitted in 12.6.9.

12.6.8.3 Accumulator batteries should not be located in crew accommodation.

12.6.9 No electrical equipment should be installed in any space where flammable mixtures are liable to collect including those in compartments assigned principally to accumulator batteries, in paint lockers, acetylene stores or similar spaces, unless the Administration is satisfied that such equipment is:

.1 essential for operational purposes;
.2 of a type which will not ignite the mixture concerned;
.3 appropriate to the space concerned; and
.4 appropriately certified for safe usage on the dusts, vapours or gases likely to be encountered.

*Areas in which flammable mixtures are liable to collect include:*

*(a) those parts of special category spaces where electrical equipment is required by 7.8.7 to be certified for use in explosive petrol/air mixtures. Perforated decks or platforms which are not*

*more that 60% solid and permit penetration of petrol gases downwards are not considered to be decks on which vapour accumulate;*

*(b) ventilation trunks as required by 7.8.7.2*

*(c) battery compartments containing ventilated type batteries;*

*(d) compartments in which gas burning or welding cylinders are stored;*

*(e) compartments in which vapour from heated fuel oil may accumulate in normal circumstances, eg non-mechanically ventilated spaces containing any part of a heated fuel installation, including tanks;*

*(f) other compartments in which substances which might give off flammable vapours or gases are stored such as paint stores.*

*Electrical equipment for use in spaces where flammable mixtures of petrol and heated fuel oil are liable to collect, should be certified to at least apparatus group IIA and temperature class T3 as defined in BS 5345: Pt 1. The following types of equipment may be accepted in these spaces:*

| | | |
|---|---|---|
| *.1* | *Intrinsically safe* | *Ex i* |
| *.2* | *Flameproof* | *Ex d* |
| *.3* | *Increased safety (except Motors)* | *Ex e* |

*Equipment which is required to be enclosed and protected to prevent discharge of sparks by 7.8.7.1, should have a minimum degree of ingress protection IP 55 in accordance with BS EN 60529.*

*It is recommended that electrical equipment and cables should not be installed in the ventilation trunks referred to in 7.8.7.2. Where this cannot be avoided, adequate access for inspection and maintenance should be provided.*

*Electrical equipment for use in the spaces described in (c) should be certified to at least apparatus group IIC, temperature class T1. Equipment should be confined to luminaires of flameproof type Ex d, or increased safety type Ex e and intrinsically safe circuits.*

*Electrical equipment should not be installed in the spaces described in paragraph (d).*

*The appropriate apparatus group, temperature class and degree of ingress protection for electrical equipment for use in spaces described in (f) will depend on the substances to be stored. To ensure that electrical equipment is suitable for use with all the flammable mixtures to which it may be exposed, electrical equipment, certified to the highest standard, (i.e. group IIC, temperature class T6 and degree of ingress protection IP 6X) should be installed. The following types of equipment may be accepted in these spaces:*

| | | |
|---|---|---|
| *.1* | *Intrinsically safe* | *Ex i* |
| *.2* | *Flameproof* | *Ex d* |
| *.3* | *Increased safety (luminaires only)* | *Ex e* |

*Only self-contained battery operated lamps or torches of a type that is certified safe should be provided for use in spaces where flammable mixtures are liable to collect. No facilities for connecting portable electrical equipment should be provided in such spaces.*

12.6.10 The following additional requirements from .1 to .7 should be met, and requirements from .8 to .13 should be met also for non-metallic craft:

.1 The electrical distribution voltages throughout the craft may be either direct current or alternating current and should not exceed:

.1.1 500 v for power, cooking, heating, and other permanently connected equipment; and

.1.2 250 v for lighting, internal communications and receptacle outlets.

The Administration may accept higher voltages for propulsion purposes.

.2 For electrical power distribution, two-wire, three-wire or four-wire insulated systems should be used. Where applicable the requirements for 7.5.6.4 or 7.5.6.5 should also be met.

.3 Effective means should be provided so that voltage may be cut off from each and every circuit and sub-circuit and from all apparatus as may be necessary to prevent danger.

.4 Electrical equipment should be so designed that the possibility of accidentally touching live parts, rotating or moving parts as well as heated surfaces which might cause burns or initiate fire is minimised.

.5 Electrical equipment should be adequately secured. The probability of fire or dangerous consequences arising from damage to electrical equipment should be reduced to an acceptable minimum.

.6 The rating or appropriate setting of the overload protective device for each circuit should be permanently indicated at the location of the protection device.

.7 Where it is impracticable to provide electrical protective devices for certain cables supplied from batteries, e.g., within battery compartments and in engine starting circuits, unprotected cable runs should be kept as short as possible and special precautions should be taken to minimise risk of faults, e.g., use of single core cables with additional sleeve over the insulation of each core, with shrouded terminals.

.8 In order to minimise the risk of fire, structural damage, electrical shock and radio interference due to lightning strike or electrostatic discharge all metal parts of the craft should be bonded together, in so far as possible in consideration of galvanic corrosion between dissimilar metals, to form a continuous electrical system, suitable for the earth return of electrical equipment and to connect the craft to the water when water-born.

The bonding of isolated components inside the structure is not generally necessary except in fuel tanks.

.9 Each pressure refuelling point should be provided with a means of bonding the fuelling equipment to the craft.

.10 Metallic pipes capable of generating electrostatic discharges, due to the flow of liquids and gases should be bonded so as to be electrically continuous throughout their length and should be adequately earthed.

.11 Primary conductors provided for lightning discharge current should have a minimum cross section of 50 mm2 in copper or equivalent surge carrying capacity in aluminium.

.12 Secondary conductors provided for the equalisation of static discharges, bonding of equipment, etc., but not for carrying lightning discharges should have a minimum cross section of 6.5 mm2 copper of equivalent surge current carrying capacity in aluminium.

.13 The electrical resistance between bonded objects and the basic structure should not exceed 0.05 Ohms except where is can be demonstrated that a higher resistance will not cause a hazard. The bonding path should have sufficient cross-sectional area to carry the maximum current likely to be imposed on it without excessive voltage drop.

## PART B - REQUIREMENTS FOR PASSENGER CRAFTS

### 12.7 General

12.7.1 Separation and duplication of electrical supply should be provided for duplicated consumers of essential services. During normal operation the systems may be connected to the same power-bus, but facilities for easy separation should be provided. Each system should be able to supply all equipment necessary to maintain the control of propulsion, steering, stabilisation, navigation, light and ventilation, and allow starting of the largest essential electric motor at any load. Automatic load-dependent disconnection of non-essential consumers may be allowed.

12.7.2 Emergency source of electrical power

Where the main source of electrical power is located in two or more compartments which are not contiguous, each of which has its own self-contained systems, including power distribution and control systems, completely independent of each other and such that a fire or other casualty in any one of the spaces will not affect the power distribution from the others, or to the services required by 12.7.3 or 12.7.4, the requirement of 12.3.1, 12.3.2 and 12.3.4 may be considered satisfied without an additional emergency source of electrical power, provided that:

.1 there is at least one generating set, meeting the requirements of 12.3.12 and of sufficient capacity to meet the requirements of 12.7.3 or 12.7.4 in each of at least two non-contiguous spaces;

.2 the arrangements required by .1 in each such space are equivalent to those required by 12.3.6.1, 12.3.7 to 12.3.11 and 12.4 so that a source of electrical power is available at all times to the services required by 12.7.3 or 12.7.4.

.3 the generator sets referred to in .1 and their self-contained systems are installed such that one of them remains operable after damage or flooding in any one compartment.

12.7.3 For Category A craft, the emergency source of power should be capable of supplying simultaneously the following services:

.1 or a period of 5 h emergency lighting:
- .1.1 at the stowage positions of life-saving appliances;
- .1.2 at all escape routes, such as alleyways, stairways, exits from accommodation and service spaces, embarkation points, etc;
- .1.3 in the public spaces;
- .1.4 in the machinery spaces and main emergency generating spaces including their control positions;
- .1.5 in control stations;
- .1.6 at the stowage positions for firemen's outfits; and
- .1.7 at the steering gear;

.2 for a period of 5 h;

- .2.1 main navigation lights, except for "not under command" lights;
- .2.2 electrical internal communication equipment for announcements for passengers and crew required during evacuation;
- .2.3 fire detection and general alarm system and manual fire alarms; and
- .2.4 remote control devices of fire-extinguishing systems, if electrical;

.3 for a period of 4 h of intermittent operation:

- .3.1 the daylight signalling lamps, if they have no independent supply from their own accumulator battery; and
- .3.2 the craft's whistle, if electrically driven;

.4 for a period of 5 h;

- .4.1 craft radio facilities and other loads as set out in 14.12.2.
- .4.2 essential electrically powered instruments and controls for propulsions machinery, if alternate sources of power are not available for such devices; and

.5 for a period of 12 h: the "not under command" lights; and

.6 for a period of 10 min:

.6.1 power drives for directional control devices including those required to direct thrust forward and astern, unless there is a manual alternative acceptable to the Administration as complying with 5.2.3.

.7 As 12.7.4.4.4

12.7.4 For Category B craft, the electrical power available should be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously. The emergency source of electrical power should be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the following services for the periods specified hereinafter, if they depend upon an electrical source for their operation.

.1 for a period of 12 h, emergency lighting:

.1.1 at the stowage positions of life-saving appliances;
.1.2 at all escape routes, such as alleyways, stairways, exits from accommodation and service spaces, embarkation points, etc;
.1.3 in the passenger compartments;
.1.4 in the machinery spaces and main emergency generating spaces including their control positions;
.1.5 in control stations;
.1.6 at the stowage positions for firemen's outfits; and
.1.7 at the steering gear;

.2 for a period of 12 h;

.2.1 the navigation lights, and other lights required by International Regulations for Preventing Collisions at Sea in force;
.2.2 electrical internal communication equipment for announcements for passengers and crew required during evacuation;
.2.3 fire detection and general alarm system and manual fire alarms; and
.2.4 remote control devices of fire-extinguishing systems, if electrical;

.3 for a period of 4 h on intermittent operation:

.3.1 the daylight signalling lamps, if they have no independent supply from their own accumulator battery; and
.3.2 the craft's whistle, if electrically driven;

.4 for a period of 12 h;

.4.1 the navigational equipment as required in Chapter 13 where such provision is unreasonable or impracticable the Administration may waive this requirement for craft of less than 5,000 tons gross tonnage;
.4.2 essential electrically powered instruments and controls for propulsion machinery, if alternate sources of power not available for such devices;
.4.3 one of the fire pumps required by 7.7.8.1;
.4.4 the sprinkler pump and drencher pump, if fitted;

.4.5 the emergency bilge pump and all the equipment essential for the operation of electrically powered remote controlled bilge valves as required by Chapter 10; and,

.4.6 craft radio facilities and other loads as set out in 14.12.2.

.5 For a period of 30 min, any watertight doors required by Chapter 2 to be power operated together with their indicators and warning signals.

.6 for a period of 10 min, power drives for directional control devices including those required to direct thrust forward and astern, unless there is a manual alternative acceptable to the Administration as complying with 5.2.3.

**12.7.5 Transitional source of emergency electrical power**

The transitional source of emergency electrical power required by paragraph 12.3.6.1.3 may consist of an accumulator battery suitably located for use in an emergency which should operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage and be of sufficient capacity and so arranged as to supply automatically in the event of failure of either the main or emergency source of electrical power at least the following services, if they depend upon an electrical source for their operation:

.1 for a period of 30 min, the load specified in 12.7.3.1, .2 and .3, or in 12.7.4.1, .2 and .3; and

.2 with respect to the watertight doors:

.2.1 power to operate the watertight doors but not necessarily simultaneously, unless an independent temporary source of stored energy is provided. The power source should have sufficient capacity to operate each door at least three times, i.e. closed-open-closed, against an adverse list of 15ø;

.2.2 power to the control, indication and alarm circuits for the watertight doors for half an hour.

12.7.6 The requirements of 12.7.5 may be considered satisfied without the installation of a transitional source of emergency electrical power if each of the services required by that paragraph have independent supplies for the period specified from accumulator batteries suitably located for use in an emergency. The supply of emergency power to the instruments and controls of the propulsion and direction systems should be interruptible.

*An indicator shall be provided in the operating compartment to indicate when such independent batteries are being discharged (see 12.3.9).*

12.7.7 In category A craft having limited public spaces, emergency lighting fittings of the type described in 12.7.9.1 as meeting the requirements of 12.7.3.1 and 12.7.5.1 may be accepted, provided that an adequate standard of safety would be attained.

12.7.8 Provisions should be made for the periodic testing of the complete emergency system including the emergency consumers required by 12.7.3. 12.7.4 and 12.7.5, and should include the testing of automatic starting arrangements.

*To ensure that the means provided for periodically testing the emergency source of power are fully effective, the arrangements should include facilities for putting the source of power on load by supplying the emergency services. In the case of highly rated turbo charged generating sets, the load should be sufficient to prevent an excessive build up of carbon in the prime mover, which may occur due to operation at light load.*

12.7.9 In addition to the emergency lighting required by paragraph 12.7.3.1, 12.7.4.1 and 12.7.5.1 on every craft with special category spaces:

.1 All passenger public spaces and alleyways should be provided with supplementary electric lighting that can operate for at least three hours when all other sources of electric power have failed and under any condition of heel. The illumination provided should be such that the approach to the means of escape can be readily seen. The source of power for the supplementary lighting should consist of accumulator batteries located within the lighting units that are continuously charged, where practicable, from the emergency switchboard. Alternatively, any other means of lighting which is at least as effective may be accepted by the Administration.

The supplementary lighting should be such that any failure of the lamp will be immediately apparent. Any accumulator battery provided should be replaced at intervals having regard to the specified service life in the ambient condition that it is subject to in service; and

.2 A portable rechargeable battery operated lamp should be provided in every crew space alleyway, recreational space and every working space which is normally occupied unless supplementary emergency lighting, as required by .1, is provided.

12.7.10 Distribution systems should be so arranged that fire in any main vertical zone will not interfere with services essential for safety in any other such zone. This requirement will be met if main and emergency feeders passing through any such zone are separated both vertically and horizontally as widely as is practicable.

*Cable penetrations through bulkheads which are required to be fire resistant and/or watertight should be made using cable transits which have been approved for this purpose.*

## PART C _ REQUIREMENTS FOR CARGO CRAFT

### 12.8 General

12.8.1 Separation and duplication of electrical supply should be provided for duplicated consumers of essential services. During normal operation these consumers may be connected to the same power-bus directly or via distribution boards or group starters, but should be separated by removable links or other approved means. Each power-bus should be able to supply all equipment necessary to maintain the control of propulsion, steering, stabilisation,

navigation, lighting and ventilation, and allow starting of the largest essential electric motor at any load. However, having regard to 12.1.2, partial reduction in the capability from normal operation may be accepted. Non-duplicated consumers of essential services connected to the emergency switchboard directly or via distribution boards may be accepted. Automatic load-dependent disconnection of non-essential consumers may be allowed.

12.8.2 Emergency source of electrical power

12.8.2.1 Where the main source of electrical power is located in two or more compartments which are not contiguous, each of which has its own self-contained systems, including power distribution and control systems, completely independent of each other and such that a fire or other casualty in any one of the spaces will not affect the power distribution from the others, or to the services required by 12.8.2.2, the requirements of 12.3.1, 12.3.2 and 12.3.4 may be considered satisfied without an additional emergency source of electrical power, provided that:

.1 there is at least one generating set meeting the requirements of 12.3.12 and each of sufficient capacity to meet the requirements of 12.8.2.2, in each of at least two non-contiguous spaces;

.2 the arrangements required by .1 in each such space are equivalent to those required by 12.3.6.1, 12.3.7 to 12.3.11 and 12.4 so that a source of electrical power is available at all times to the services required by 12.8.2; and

.3 the generator sets are referred to in .1 and their self-contained systems are installed in accordance with 12.3.2.

12.8.2.2 The electrical power available should be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously. The emergency source of electrical power should be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the following services for the periods specified hereinafter, if they depend upon an electrical source for their operation;

.1 for a period of 12 h, emergency lighting;

.1.1 at the stowage positions of life-saving appliances;
.1.2 at all escape routes, such as alleyways, stairways, exits from accommodation and service spaces, embarkation points, etc.;
.1.3 in public spaces, if any;
.1.4 in the machinery spaces, and main emergency generating spaces including their control positions;
.1.5 in control stations;
.1.6 at the stowage positions for fireman's outfits; and
.1.7 at the steering gear;

.2 for a period of 12 h;

.2.1 the navigation lights, and other lights required by the International Regulations for Preventing Collisions at Sea in force;

.2.2 electrical internal communication equipment for announcements during evacuation;

.2.3 fire detection and general alarm system and manual fire alarms; and

.2.4 remote control devices of fire-extinguishing systems, if electrical;

.3 for a period of 4 h of intermittent operation;

.3.1 the daylight signalling lamps, if they have no independent supply from their own accumulator battery; and

.3.2 the craft's whistle, if electrically driven;

.4 for a period of 12 h;

.4.1 the navigational equipment as required by Chapter 13; where such provision is unreasonable or impracticable, the Administration may waive this requirement for craft of less than 5,000 tons gross tonnage;

.4.2 essential electrically powered instruments and controls for propulsion machinery, if alternate sources of power are not available for such devices;

.4.3 one of the fire pumps required by 7.7.8.1;

.4.4 the sprinkler pump and drencher pump, if fitted;

.4.5 the emergency bilge pump and all the equipment essential for the operation of electrically powered remote controlled bilge valves as required by Chapter 10;

.4.6 craft radio facilities and other loads as set out in 14.12.2.

.5 for a period of 10 min:

.5.1 power drives for directional control devices including those required to direct thrust forward and astern, unless there is a manual alternative acceptable to the Administration as complying with 5.2.3.

12.8.2.3 Provision should be made for the periodic testing of the complete emergency system including the emergency consumers required by 12.8.2.2 and should include the testing of automatic starting arrangements.

*To ensure that the means provided for periodically testing the emergency source of power are fully effective, the arrangements should include facilities for putting the source of power on load by supplying the emergency services. In the case of highly rated turbo charged generating sets, the load should be sufficient to prevent an excessive build up of carbon in the prime mover, which may occur due to operation at light load.*

12.8.2.4 Where the emergency source of electrical power is a generator, a transitional source of emergency power should be provided according to paragraph 12.8.3 unless the automatic starting system, and the characteristics of the prime mover should be such as to prevent the emergency generator to carry its full rated load as quickly as is safe and practicable, subject to a maximum of 45 s.

12.8.3 Transitional source of emergency electrical power

The transitional source of emergency electrical power required by paragraph 12.8.2.4 may consist of an accumulator battery suitably located for use in an emergency which should operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage and be of sufficient capacity and so arranged as to supply automatically in the event of failure of either the main or emergency source of electrical power at least the following services, if they depend upon an electrical source for their operation:

.1 for a period of 30 min, the load specified in 12.8.2.2(a), (b) and (c);

.2 with respect to watertight doors:

.2.1 power to operate the watertight doors, but not necessarily simultaneously, unless an independent temporary source of stored energy is provided. The power source should have sufficient capacity to operate each door at least three times, i.e. closed-open-closed, against an adverse list of 15ø; and

.2.2 power to the control, indication and alarm circuits for the watertight doors for half an hour.