

## **PART 7**

### **ELECTRICAL EQUIPMENT AND INSTALLATIONS**

#### **7.1 Initial Survey**

7.1.1 Surveyors should ensure that the details and arrangements comply with the statutory Regulations and with the requirements of the edition relevant to the year of build of the IEE Regulations for the Electrical and Electronic Equipment of ships or the equivalent standards listed in Merchant Shipping Notice No. M1672.

7.1.2 Generators, motors and transforming equipment, intended for services in connection with the propulsion and safety of the ship, are to be inspected during construction. 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 detailing the results of tests to determine the operating characteristics, temperature rise, insulation resistance and dielectric strength.

#### **7.2 Number and Availability of Main Generators**

7.2.1 Regulation 54(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 use at all times when the ship is at sea, or is about to put to sea. Regulations 54(3, 4, 5 and 6) present the requirements for ships built after 1st September 1984 where one of the generating sets is out of action. Ships built before the 1st of September 1984 shall be provided with at least two generating sets whereby if one set is out of service the remaining set or sets will be capable of supplying those services essential for the propulsion and safety of the vessel after load shedding. See also paragraph 7.6 of these Instructions

7.2.2 Where the services required by Regulation 53(3) 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.

7.2.3 Shaft generators which are not in accordance with the operational requirements of Regulation 54(3) (i.e. cannot maintain services regardless of the speed and direction of rotation of the propulsion machinery or shafting) may be used to supply the main switchboard at sea, provided they are additional to those generators forming the main source of electrical power which are in conformity. The arrangements should be such that the additional generators can easily be disconnected from the main switchboard, without loss of normal supply, as might be necessary when entering and leaving port and in areas where navigation demands special caution.

### **7.3 Safeguarding Generators etc. Against Flooding**

Where reasonably practicable, installations and equipment should be designed and located such that services which are essential for the propulsion and safety of the ship will not fail in the event of partial flooding of the ship's machinery space. Due consideration should be given to space limitations and the intended service of the ship.

### **7.4 Transforming Equipment**

7.4.1 Any transforming equipment supplying an electrical system referred to in Regulation 54 should be arranged to ensure the same continuity of supply as that required for generating sets by that regulation.

7.4.2 When transformers, rectifiers, etc. are used to supply the services required by Regulation 54, alternative supplies should be available by:-

7.4.2.1 an alternative supply from another working transformer/rectifier or generator;

7.4.2.2 the provision of a spare transformer/rectifier;

7.4.2.3 in three phase circuits, the provision of a spare single phase unit if single phase transformers/rectifiers are used; or

7.2.2.4 in three phase circuits, the provision of single phase transformer/rectifier units connected and of such capacity that the required load can be met with one unit out of service (Open delta connection).

### **7.5 Protection**

Short circuit protection must be provided in the primary circuit. Overload protection should also be provided for the primary circuit but the overload device may be located in the secondary circuit of transformers having only one secondary winding.

### **7.6 Load Shedding**

The load shedding, or other arrangements provided, should not interfere with the supply to electrical services which are essential for the propulsion and safety of the ship and which must be maintained after shedding non-essential loads. The essential services include those auxiliaries necessary for propulsion, bilge and fire pumping, navigation lights, essential lighting, steering gear, navigational aids required by the Merchant Shipping Regulations, communication and alarm systems required for safety, watertight doors and engine and boiler room ventilation. The order in which non-essential services are disconnected may be arranged to suit the owner's convenience. Circuits supplying Bow/Stern thrusters should not normally be included in the load shedding arrangements.

## **7.7 Main Generators**

7.7.1 In general, the location of the main generators in relation to the main switchboard, as referenced by the "same space" referred to in Regulation 54(2) means the same main fire zone and watertight compartment.

7.7.2 An environmental enclosure or a subdivision bulkhead or other division which is not required by the regulations, is not to be considered as separating the equipment.

## **7.8 Protection**

Where the distance between the generator and associated circuit breaker is larger than usual and in all cases where the generator capacity is large (1500 kW approx), it is recommended that protection is provided which will de-excite the generator in the event of a severe internal fault or of a fault between the generator and its circuit breaker.

## **7.9 Main Switchboard**

Circuit breakers or fuses of suitable rating and characteristics could be accepted as a suitable means for subdivision of switchboards required by Regulation 54(6). The advantages of such an arrangement should also be taken into consideration in the design of switchboards where the installed electrical power of the generating sets is less than 3 megawatts.

## **7.10 Emergency and Transitional Source of Electrical Power (Regulation 56)**

### **7.10.1 Location**

The generators, batteries, transformers, switchgear etc, forming the emergency source of power should be sited as per Schedule 7 to Merchant Shipping Notice MSN 1698 (M) so that flames, heat or smoke issuing from skylights, 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. Additional requirements for battery compartments are given in paragraph 7.13.3 of these Instructions.

### **7.11 Capacity and Services Supplied**

7.11.1 An emergency generator provided in compliance with Regulation 56 should be of sufficient capacity to supply, simultaneously, those services stipulated in Schedule 7 to Merchant Shipping Notice MSN 1698 (M) as appropriate together with the drencher pump when required by the MS (Fire Protection) Regulations 1998, including starting currents.

7.11.2 Paragraph 4 of Schedule 7 to Merchant Shipping Notice MSN 1698 (M) states that emergency generating sets may be used to supply services other than emergency supplies exceptionally for short periods. The primary intent of this

relaxation is to allow the use of the emergency source of power when starting the ship's plant from the dead ship condition.

7.11.3 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.

## **7.12 Periodic Testing**

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.

## **7.13 Batteries**

### **7.13.1 Emergency batteries**

7.13.1.1 Batteries should be sized according to the maximum design load, in ampere-hours, for which they are required to maintain an emergency supply in compliance with paragraph 13 of Schedule 7 of Merchant Shipping Notice MSN 1698 (M).

7.13.1.2 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.

7.13.1.3 Discharge of any independent accumulator batteries provided in compliance with paragraph 13(3) of Schedule 7 of Merchant Shipping Notice MSN 1698 (M) should be indicated at the appropriate control station.

### **7.13.2 Transitional source of emergency electrical power**

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.

### **7.13.3 Battery compartments**

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. Some ventilation should always be provided for the space where the batteries are located.

## **7.14 Electrical Protection of Cables**

In some circumstances it may be impracticable to provide overload and short circuit protection for cables connected to batteries e.g. within battery compartments and in engine starting circuits. Unprotected cable runs should be kept as short as possible and the cables should be "Short Circuit Proof", e.g. single core with a sheath or additional insulated sleeve over the insulation of each core.

## **7.15 Inverters**

Where central inverters (from dc to ac irrespective of size) are used to supply a number of emergency loads, particular attention should be paid to reliability. Equipment of proven design in the marine environment should be selected wherever practicable. Works tests of completed equipment should be witnessed.

## **7.16 Emergency Switchboard**

7.16.1 For the purposes of paragraph 9 of Schedule 7 of Merchant Shipping Notice MSN 1698 (M) an environmental enclosure within the main boundaries of the space does not provide separation between the emergency generator and the emergency switchboard.

7.16.2 Circuits should be arranged so that the emergency lighting is of the maintained type, i.e. is continuously supplied and forms part of the normal lighting system. Because difficulties can be experienced with the start of certain lamp types (e.g. fluorescent tubes) at low temperatures, lamps connected to emergency circuits should normally be of the filament type. Evidence should be provided to confirm that the performance of other types will be satisfactory down to -15°C. Supplementary emergency lighting required for Ro-Ro ships should normally be supplied from the emergency switchboard and the light fittings should be approved in accordance with paragraph 10.3 of these Instructions.

## **7.17 Protection of Non-Emergency Services**

The automatic disconnection of non-emergency circuits from the emergency switchboard required by paragraph 11 of Schedule 7 of Merchant Shipping Notice MSN 1698 (M) should be provided where the capacity of the emergency source of power is insufficient to supply the connected emergency and non-emergency services simultaneously. Load shedding or an arrangement interlocked with the interconnector feeder required by Schedule 7 of Merchant Shipping Notice MSN 1698 (M) would be acceptable.

## **7.18 Interconnector to Main Switchboard**

The interconnector feeder arrangements required by regulation should be of sufficient capacity to supply all the emergency services and all the non-emergency services which can be simultaneously connected to the emergency switchboard. Clear instructions for manual operation of the emergency source of power and emergency switchboard should be displayed.

## **7.19 Starting Arrangements for Emergency Generating Sets**

7.19.1 Where both the sources of stored energy required by paragraph 12 of Schedule 7 to Merchant Shipping Notice MSN 1698 (M) 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.

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

## **7.20 Safeguarding of Essential and Emergency Services**

### 7.20.1 Essential and emergency services

Where remote control is provided, local control should be unaffected by a fault, including a cable fault, when local control is selected.

### 7.20.2 Emergency services

Where changeover facilities which affect the operation of emergency services are provided (e.g. battery isolating switch), the arrangement should be such as to minimise the risk of the devices being left in a position which would prevent the emergency services being supplied when required, e.g. locking facilities.

### 7.20.3 Computerised equipment or programmable electronic systems

7.20.3.1 If the failure of one particular hardware or software channel could cause the installation to fail in a dangerous way likely to lead to an accident, then at least one additional method of achieving the required safety level following a single failure should be provided.

7.20.3.2 The most usual means of satisfying this requirement is the provision of additional/diversified hardware/software or the addition of non-programmable hardware, e.g. a "hard wired" circuit.

## **7.21 Public Address System**

7.21.1 A public address system, required by other regulations, (see Merchant Shipping Notices No. M 1386 and No. M 1409), is also a part of the internal communications system required in an emergency by paragraph 13(3)(a) of Schedule 7 of Merchant Shipping Notice MSN 1698 (M). The loudspeaker arrangements should be such that all public spaces including open decks, public rooms, control stations, alleyways and stairways will be served by more than one circuit. The circuits should be as widely separated as practicable and cables should preferably be routed outside the zone (i.e. above deck), but protection should still be provided. The system should include automatic change-over upon fault to a reserve amplifier.

7.21.2 If oscillators or similar electronic means are used to generate emergency warnings and signals at least two oscillators with associated control devices should be provided.

7.21.3 In any system used for emergency signals the oscillator or microphone originating the signal should have facilities to override all other inputs to the system and to override the user volume controls provided. In such systems the circuits to the alarm devices (e.g. bells, loudspeakers, etc) should be protected by fuses or other appropriate means so that damage to one circuit will not prevent operation of the remainder of the system.

7.21.4 Cabling for emergency alarms and public address systems fitted in Ro-Ro passenger ships on or after 1st July 1998 is to be of a type approved by the Administration. The MCA considers that cables manufactured in accordance with the standards set out in paragraph 7.22 of these Instructions or their equivalent, will be acceptable. Such cables and wiring should, as far as is practicable, be routed clear of galleys, laundries, machinery spaces of Category A and their casings and other high fire risk areas unless serving those spaces. Where practicable, all such cables should be run in such a manner so as to preclude their being rendered unserviceable by heating of the bulkheads that may be caused by a fire in an adjacent space. All areas of each fire zone should be served by at least two dedicated loops sufficiently separated throughout their length and supplied by independent amplifiers.

## 7.22 Construction of Cables

7.22.1 To meet the flame retardant characteristics required by Regulation 58 cables should be at least in accordance with BS 4066 : Pt 1 : 1995 or IEC 332-1 : 1979.

7.22.2 To meet the fire resistant characteristics required by Regulation 58 cables should be either of the mineral insulated metal covered type in accordance with BS 6207 : 1995 or of a type which meets test symbols CWZ (950°C for 3 hours) as defined in BS 6387 : 1994 and is suitable for shipboard use. Alternatively, compliance with IEC 331 is acceptable as a minimum standard.

7.22.3 In a ship constructed on or after 1 September 1984 the insulation of any distribution system that is not earthed should be continuously monitored by a system capable of giving audible and visual indication of abnormally low insulation values.

## 7.23 Installation of Cables and Equipment

Main and emergency cable runs and the equipment which they supply should be separated as widely as practicable. Where main and emergency supplies are required for a particular service, e.g. the sprinkler pump, the cables should take differing routes, as far as is practicable.

## **7.24 Precautions Against Fire and Flood**

7.24.1 Emergency cable runs should be arranged so that a fire or flood in one watertight compartment or fire zone does not affect emergency services in other watertight compartments or fire zones.

7.24.2 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.

## **7.25 Precautions Against Fire and High Temperature**

7.25.1 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.

7.25.2 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.

## **7.26 Precaution Against Collision**

All cables and associated equipment supplied from the emergency source of power and, as far as practicable, main runs of cables supplied from the main source of power, should be kept within the B/5 line. Where supplies to emergency services cannot be kept within this line additional precautions, e.g. duplication of supplies, should be taken to protect the services against loss of supply.

## **7.27 Cable Joints**

Joints in cables may be accepted for repair or replacement purposes and also, exceptionally, to facilitate installation in new ships. Details of the jointing system, which should be a well established method, should be specially considered. Cable joints should not normally be accepted in hazardous areas, unless they are part of an intrinsically safe circuit.

## **7.28 Electrical Protection**

7.28.1 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 shipbuilder's calculations, indicating compliance with the foregoing, should be considered.

7.28.2 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.

7.28.3 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.

7.28.4 The arrangements of circuits and protection supplying emergency services should be such that, as far as practicable, a fire or flood or other casualty in one fire zone or one watertight compartment will not affect the emergency services in other compartments. (See also paragraph 7.24 of these Instructions).

7.28.5 An overload alarm should be provided for each circuit where overload protection is omitted.

## **7.29 Steering Gear Circuits**

Cables and motors for steering gears should be protected against overcurrent of not less than a short circuit. This should be interpreted as meaning that protective devices should not operate at less than 200% of rated motor current. If, however, switching arrangements are such that more than one steering gear motor 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 motors that can be connected to the feeder. The control circuits of electrically controlled steering gear should be connected to the power circuit supplying the steering gear.

## **7.30 Electric Lifts**

Arrangements should be made for an inspection of lifts, other than those used exclusively for goods, to be carried out by the lift maker or another competent organisation. Satisfactory certificates or reports should be supplied before acceptance. Such lifts should be provided with acceptable means of escape for the occupants for use in the event of the failure of the primary means of escape. One lamp in each lift car, the emergency lighting in the trunk and the alarm system should be supplied from the emergency source of power. Attention is drawn to Marine Guidance Note MGN 56 (M+F): "Accidents Involving Personnel Lifts".

## **7.31 Portable and Transportable Electrical Apparatus**

7.31.1 The effect of Regulation 59(2) is to classify all spaces of the ship, except dry areas of accommodation such as public rooms, cabins and alleyways, as spaces where special provision should be made to ensure that the danger of

electric shock is reduced to a minimum. The voltage of electrical supplies to portable and transportable electrical apparatus in all spaces, except dry areas in the accommodation, should be as low as is practicable for the application. General guidance is given in Table 4A and Appendix 2 of the IEE Regulations 1972 and Table 4.1 and Appendix B of the IEE Regulations 1990. Attention is particularly drawn to the recommendation that 24 volts is used for hand lamps.

7.31.2 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.)

7.31.3 It is recognised that the limits of voltage recommended in the relevant Appendices 2 and B of the IEE Regulations 1972 and 1990 respectively are not always practicable for portable and transportable apparatus such as submersible pumps, deck scalers, refrigerated containers etc. In these cases, where 3 phase supplies up to 500 volts may be involved, the additional precautions in 7.31.3.1 and 7.31.3.2 below, or a combination are recommended:-

7.31.3.1 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; and

7.31.3.2 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 ships 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, e.g. vibration, salt atmosphere etc.

7.31.4 The supply arrangements to refrigerated vehicles or containers on a trailer etc should ensure that all wandering leads are kept clear of the vehicle decks and the need for extension leads is eliminated.

7.31.5 Where electric welding apparatus is involved, attention is drawn to Appendix B of the 1990 IEE Regulations.

## **7.32 Supplies to Lifeboats and Similar Craft**

The electrical supply connections, if any, from the ship to any lifeboat or similar craft should be at a voltage not exceeding 55 volts DC or 55 volts RMS AC.

### **7.33 Space Heaters**

7.33.1 When the installation of space heaters is undertaken, it should be ensured that there will be no risk of heat causing burning or scorching to the surrounding or adjacent material.

7.33.2 It is recommended that electric space heaters are provided with thermostats to reduce the risk of overheating.

### **7.34 Special Category Space Ventilation**

Where regulation requires that any loss or reduction of ventilation capacity is indicated on the navigating bridge, systems based on sensing the current drawn by the fan motor are preferred, as the reliability of the flow switches previously used has been found to be unsatisfactory in marine conditions. Means which indicate that the motor is running, for example an auxiliary contact on the fan motor controller, can be accepted as a minimum requirement if open/close indication of the fire dampers in the respective vent trunking is provided near the motor running lights in the wheelhouse.

### **7.35 Electrical Equipment in Hazardous Areas and Spaces**

#### **7.35.1 Definitions**

For the purposes of these Instructions, a hazardous area is defined in Regulation 2(2) and includes:-

7.35.1.1 those parts of special category spaces where electrical equipment is required by Regulation 60(3) to be certified for use in explosive petrol/air mixtures, unless dangerous goods are to be carried, (see below). Decks or platforms with openings of a sufficient size to permit penetration of petrol gases downwards are not considered to be decks on which vapour accumulates;

7.35.1.2 when vehicles are carried on multiple levels in special category spaces, above the bulkhead deck the zones regarded as hazardous will be extended in the vicinity of the deck end and openings as shown at A to F of figure 7.35.1.2. Item B in the figure, shows the arrangement when there is a hole in a solid deck, but where the dimension 'd' is more than  $1.1h + 2$  metres, a mirror image of item A may be used. Uniformly perforated decks from which at least 40 per cent of the area has been removed may, if they are self-draining, be left out of account (item E). Other perforated decks should be considered as item F. For special category spaces situated below the bulkhead deck any electrical equipment, if fitted, is to be of a type suitable and certified safe for use in explosive petrol and air mixtures;

7.35.1.3 cargo spaces as defined in Regulation 60(4);

- 7.35.1.4 ventilation trunks as defined in Regulation 60(5);
- 7.35.1.5 those spaces defined in Regulation 60(6) (Dangerous Goods);
- 7.35.1.6 battery compartments containing ventilated type batteries;
- 7.35.1.7 compartments in which gas burning or welding cylinders are stored;
- 7.35.1.8 compartments in which vapour from heated fuel oil may accumulate in normal circumstances, e.g. non-mechanically ventilated spaces containing any part of a heated fuel installation, including tanks; and
- 7.35.1.9 other compartments in which substances which might give off flammable vapours or gases are stored such as paint stores.

## 7.35.2 Type of equipment

7.35.2.1 Electrical equipment for use in the spaces described in paragraphs 7.35.1.1, 7.35.1.2, 7.35.1.3 and 7.35.1.7 of these Instructions, with respect to petrol and heated fuel oil, should be certified to at least apparatus group IIA and temperature class T3 as defined in BS 5345: Pt 1 : 1989. The following types of equipment may be accepted in these spaces:

- Intrinsically safe            Ex i
- Flameproof                    Ex d
- Increased safety            Ex e  
(except Motors)

7.35.2.2 Equipment which is required to be enclosed and protected to prevent discharge of sparks by Regulation 60(3) should have a minimum degree of ingress protection IP 55 in accordance with BS EN 60529 : 1992. Where this is not practical as with fire detector leads and gas detectors, the equipment should be certified for use in hazardous areas.

7.35.2.3 It is recommended that electrical equipment and cables should not be installed in the ventilation trunks referred to in paragraph 7.35.1.4 of these Instructions. Where this cannot be avoided, adequate access for inspection and maintenance should be provided.

7.35.2.4 The appropriate apparatus group, temperature class and degree of ingress protection for electrical equipment for use in spaces described in paragraphs 7.35.1.5 and 7.35.1.9 of these Instructions will depend on the substances to be carried as cargo or stored respectively. To ensure that electrical equipment is suitable for use with all the flammable dusts, gases or vapours to which it may be exposed, electrical equipment, certified to the highest standard, (i.e. group IIC, temperature

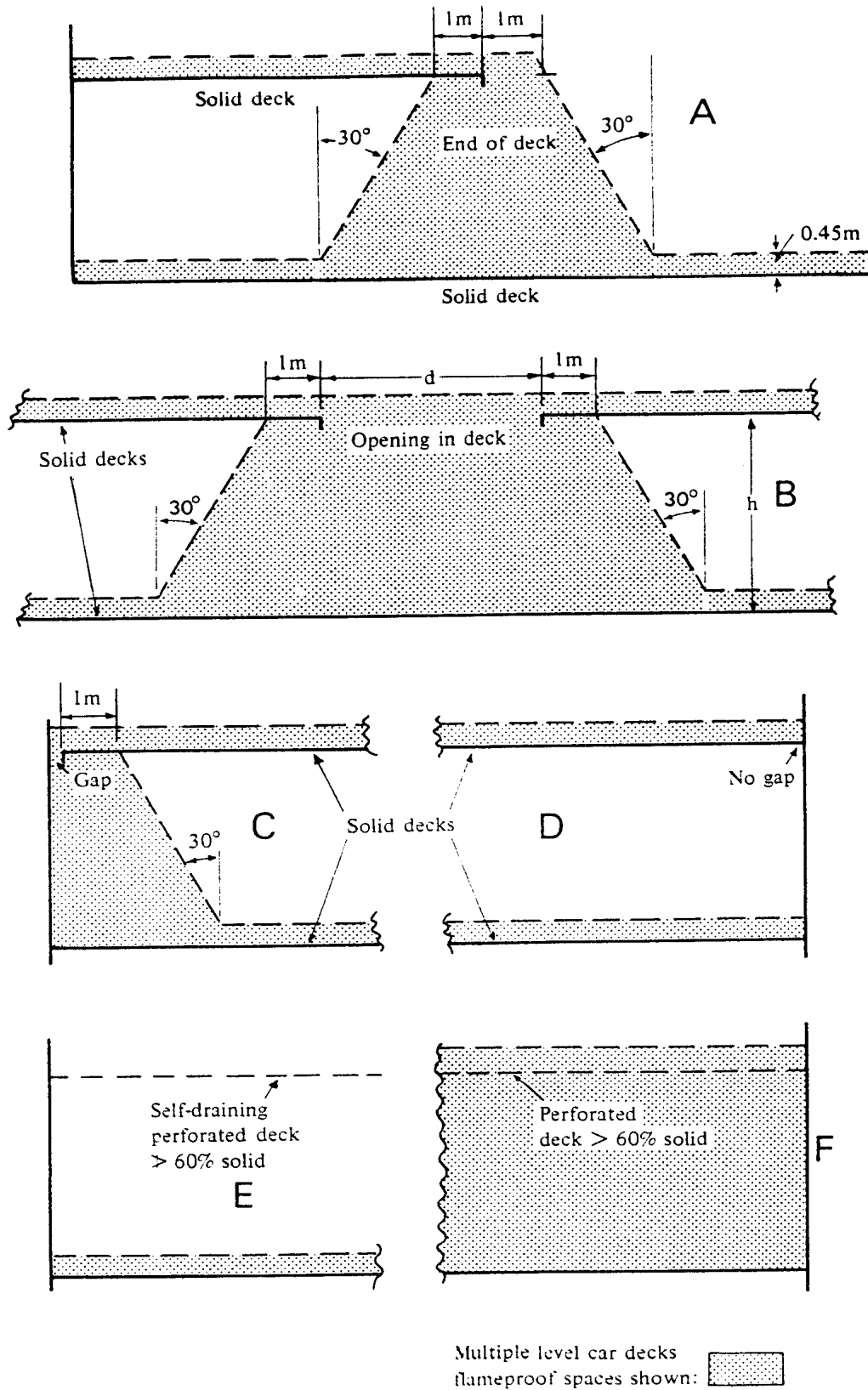


figure 7.35.1.2

class T6 and degree of ingress protection IP 6X) should be installed. The following types of equipment may be accepted in these spaces:

- Intrinsically safe           Ex i
- Flameproof                   Ex d
- Increased safety           Ex e  
(luminaires only)

7.35.2.5 Attention is drawn to the special requirements for the carriage of dangerous goods in Regulation 103 of the Merchant Shipping (Fire Protection) Regulations 1998; SI 1998/1012. Electrical equipment in the whole of the space in which the goods are carried, together with the associated ventilation trunks, will normally need to be certified to the highest standards mentioned above, unless the equipment and associated cables are capable of being electrically isolated by the removal of links or the operation of lockable switches.

7.35.2.6 Electrical equipment for use in the spaces described in paragraph 7.35.1.5 of these Instructions 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.

7.35.2.7 In order to comply with Regulation 83, electrical equipment should not be installed in the spaces described in paragraph 7.35.1.7 of these Instructions.

7.35.2.8 Only self-contained battery operated lamps or torches of a type that is certified for use in the flammable dusts, gases or vapours to which they may be subjected should be provided for use in hazardous areas and spaces. No facilities for connecting portable electrical equipment should be provided in hazardous areas and spaces.

### 7.35.3 Cables

7.35.3.1 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.

7.35.3.2 Cables for intrinsically safe circuits in new ships should be segregated from all non-intrinsically safe cables by at least 50 mm throughout their length. In existing ships, 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.

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

- (i) of the mineral insulated metal covered type;
- (ii) protected by electrically continuous metal sheathing or metallic wire armour, braid or tape; or
- (iii) 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.

## **7.36 Approval - Electrical Installations**

The following aspects should be considered for inclusion in any approval programme:-

### **7.36.1 Cables**

- 7.36.1.1 Specifications, including flame retardant standard.
- 7.36.1.2 Location of principal runs of main cables.
- 7.36.1.3 Location of all emergency cable runs.
- 7.36.1.4 Details of fire stops in bunched cable runs over 6m vertical; over 14m horizontal in length.
- 7.36.1.5 Detail arrangements including segregation and marking of High Voltage cables (where applicable).
- 7.36.1.6 Details of cable transits for watertight and for fire resisting bulkhead penetrations.

### **7.36.2 Load Schedules**

- 7.36.2.1 Main system, indicating essential services and operational mode (i.e. at sea, manoeuvring, harbour, etc). Emergency system, indicating required services and any non-statutory services.
- 7.36.2.2 Starting conditions for motors more than 25% of the generator rating are to be stated. Arrangements for the disconnection of non-essential services from the main switchboard and, where applicable, non-emergency services from the emergency switchboard.

### **7.36.3 Generation and distribution systems (main and emergency)**

- 7.36.3.1 Fault level calculations.
- 7.36.3.2 Short circuit capacity of circuit breakers, fuses and bus-bars.

7.36.3.3 Type and rating of circuit breakers and fuses.

7.36.3.4 Details of protection-overload, reverse power, preference tripping and short circuit.

7.36.3.5 Generator paralleling arrangements.

7.36.3.6 Generator control. AVR and metering details.

7.36.3.7 Earth indication system details.

7.36.3.8 Earthing of current transformer secondary windings.

7.36.3.9 Interlocking arrangements.

7.36.3.10 Switchboard construction (dead front if above 250 volts DC or 55 volts AC).

#### 7.36.4 Emergency stops

7.36.4.1 Means and location of stops for ventilating fans, oil pumps and overboard discharges in way of lifeboat lowering positions.

7.36.4.2 Interconnection arrangements between main and emergency switchboards.

#### 7.36.5 Main generators

7.36.5.1 Arrangement drawings showing outline and detail of construction including AVR and exciter, if fitted.

7.36.5.2 Position in ship with regard to flooding level.

7.36.5.3 Location with respect to switchboard, fire zones and watertight bulkheads.

#### 7.36.6 Emergency generators

7.36.6.1 Arrangement drawings showing outline and details of construction including AVR and exciter.

7.36.6.2 Position in ship (uppermost continuous deck and access from open deck) and with respect to the emergency switchboard and main machinery spaces.

7.36.6.3 Auto-start arrangements.

#### 7.36.7 Batteries for essential and emergency services.

7.36.7.1 Battery type, manufacturer, service and rating.

7.36.7.2 Indication of discharge at main switchboard or in the machinery control room.

7.36.7.3 Separation of alkali and acid types.

7.36.7.4 Instrumentation and charging arrangements.

### 7.36.8 Steering gear

Details of supply, control circuits and cable runs.

### 7.36.9 Drencher pump, sprinkler pump

Motor power supply, cable runs and protection arrangements.

### 7.36.10 Main and emergency lighting

7.36.10.1 Position and rating of luminaires

7.36.10.2 Provision of at least two separate circuits in each fire zone, main propelling machinery space, saloons, etc.

7.36.10.3 Provision of illuminated signs.

7.36.10.4 Emergency lighting of maintained type.

7.36.10.5 Emergency lighting at boat stations.

7.36.10.6 Details of any proposal to use fluorescent luminaires for outside emergency lighting (should normally be of filament type).

7.36.10.7 Arrangements of dimming circuits in public rooms etc, if fitted.

7.36.10.8 Type, disposition and supply arrangements of supplementary emergency lighting required by Regulation for Ro-Ro ships and which should be in accordance with 10.3.

7.36.10.9 Type, disposition and supply arrangements (if applicable) of low location lighting required by Regulation for passenger ships carrying more than 36 passengers and which should be in accordance with the requirements set out in Survey of Fire Protection in Ships - Instructions for the guidance of surveyors.

### 7.36.11 Navigation lights, access opening indicator lights.

7.36.11.1 Supply arrangements including control and alarm panel for navigation lights.

7.36.11.2 Arrangements (including details of circuits), limit switches and indicator panel for the access opening indicator lights required by Regulation 86 for Ro-Ro ships.

### 7.36.12 Lifts

7.36.12.1 Automatic decking arrangements (except those for goods only).

7.36.12.2 Emergency escape arrangements (including safety interlocking).

7.36.12.3 Supplies to lighting in lift car and trunk (main and emergency) and to alarm.

### 7.36.13 Shore supply

Location and details of connection box(es).

### 7.36.14 Transformers

7.36.14.1 Protection (electrical) of primary windings.

7.36.14.2 Redundancy of transformers for power and lighting.

### 7.36.15 Plugs and sockets

7.36.15.1 Voltage of sockets for portable and transportable equipment.

7.36.15.2 Different socket arrangements for each different voltage.

7.36.15.3 Supply arrangements to refrigerated containers etc. where applicable.

### 7.36.16 Converters

Details of converters (rectifiers and inverters) where used for emergency supply purposes.

### 7.36.17 Automation

Details of power management system for generation and associated auxiliaries (where fitted).

### 7.36.18 Hazardous areas

7.36.18.1 All electrical equipment in hazardous areas to be listed with details of explosion protection and ingress protection, (IP).

7.36.18.2 Copies of certification documents for all such equipment.

7.36.18.3 Full details of all cables in hazardous areas and the separation of intrinsically safe cables from all other cables.

7.36.18.4 For ventilation fans, details of "sparkproof" construction and details of access to fan and motor for inspection and maintenance.

### 7.36.19 Public address and alarm systems

7.36.19.1 Location of loudspeakers, alarm bells, etc.

7.36.19.2 Power supply arrangements for each system.

7.36.19.3 Distribution circuit arrangements for each system.

7.36.19.4 Redundancy of amplifiers, oscillators, controls etc.

### 7.36.20 Spares and tools

Lists in sufficient detail to confirm that Regulation 61 will be complied with.

## 7.37 **Re-Survey - Electrical Installations**

### 7.37.1 General

7.37.1.1 Surveyors should satisfy themselves that routine testing and servicing of the installation and equipment has been carried out and in particular on essential and emergency services.

7.37.1.2 Casualty investigations have shown that insufficient attention is paid to ensuring that connections and securing devices are tight. Shipowners should check connections at regular intervals so that any wear or other deterioration which could lead to loose parts, overheating or disintegration, is detected and corrected before any serious consequences arise. It is recommended that all current carrying parts and connections should be so constructed and secured as to ensure their continued effectiveness when subject to vibration. Screws and nuts securing current carrying parts should be effectively locked so that they cannot work loose under vibration. Where connections cannot be checked, e.g. because of the need to maintain supplies to essential services, shipowners and surveyors are recommended to consider the use of thermographic imaging equipment to detect poor connections by means of generated heat.

7.37.1.3 It should be established that the necessary spare gear is on board and in good condition.

### 7.37.2 Insulation resistance

Surveyors should be satisfied that the insulation resistance value of all cables, switchgear, generators, motors, heaters, other electrical apparatus in power circuits and all lighting circuits (including lighting fittings), are not less than the values given below. Values for essential power and all emergency services should be measured annually and the remainder of the installation within 5 years. Readings presented by the ship's engineers may be accepted at the surveyor's discretion. When it is necessary for values to be measured, they should be taken between all insulated poles and earth. The installation may be sub-divided to any desired extent.

Nominal Voltage of Circuit	Minimum Insulation Resistance In Megohms
Below 50V	0.3
50V to 440V	1.0
Greater than 440V	$\frac{\text{Nominal voltage} + 1}{1000}$

Note: Insulation resistance of intrinsically safe circuits should not normally be measured.

### 7.37.3 Motors and generators for essential and emergency services

The condition of stators, rotors and their windings and the electrical connections, commutators, slip rings etc. should be satisfactory. Main and emergency generators should be seen under working conditions each year.

### 7.37.4 Switchboards, distribution boards and motor control gear

7.37.4.1 It should be established that all switchgear is clean and circuit breaker contacts are in good condition. Sealed contacts, which are used in some high voltage circuit breakers, e.g. vacuum and sulphur hexafluoride (SF6), need little maintenance and should only be maintained in accordance with the manufacturer's instructions. The settings of protective devices and fuse ratings should be satisfactory, e.g. not excessively high. See also paragraph headed Electrical Protection below. Particular attention should be paid to ensure that there are no loose connections and parts. Reference is made to 7.37.1.2.

7.37.4.2 In addition, it is recommended that the main and emergency generator circuit breakers should be tested at least every five years. The tests should, as far as is practicable, check the settings of protective devices including over-current, reverse power and preference trips. Simulation by current injection may be accepted.

7.37.4.3 Where circuit breakers are used to control equipment requiring frequent switching operations, e.g. the main generators and bow thrust motors of cross channel ferries, their condition is likely to deteriorate more quickly and a more frequent programme of inspection/maintenance may be required. Consequently, annual inspection and test of these circuit breakers is appropriate and should include the mechanical linkages etc. of units with sealed contacts, e.g. vacuum.

### 7.37.5 Electrical protection

7.37.5.1 It may be appropriate to carry out random checks on the electrical protection devices, e.g. fuse rating, MCB setting, overload setting in motor starters etc.

7.37.5.2 Electric welding plant should be in accordance with Appendix B of the 1990 IEE Regulations.

### 7.37.6 Transforming equipment

7.37.6.1 Where transformers, rectifiers etc are used to supply essential or emergency services the surveyor should satisfy himself regarding their general condition with particular reference to cleanliness and the tightness of connections and parts.

7.37.6.2 Where liquid immersed equipment is installed, an up to date certificate from a competent test authority testifying that the electrical characteristics of the liquid are satisfactory for the condition of service should be available to the surveyor at least every 5 years.

### 7.37.7 Electrical equipment incorporating liquid cooling

7.37.7.1 Where water circulated air coolers are fitted they should be examined and if necessary subjected to a suitable hydraulic test. Where liquid is in contact with live conductors an up to date certificate from a competent test authority testifying that the electrical characteristics of the liquid are satisfactory for the conditions of service should be available to the surveyor at least every 5 years. Where suitable test equipment for determining the electrical characteristics of the cooling medium is provided on board, these results may be accepted at the discretion of the surveyor.

7.37.7.2 The alarm and indicators provided, e.g. temperature, flow etc, should be tested as far as is practicable.

### 7.37.8 Emergency services

7.37.8.1 It should be established that the operation of equipment for automatically starting and connecting the emergency generator to the emergency switchboard is satisfactory.

7.37.8.2 The emergency services required by the Regulations e.g. lighting, pumps, miscellaneous services etc, should be seen under operating conditions each year.

### 7.37.9 Emergency batteries

7.37.9.1 It should be established each year that the battery and associated compartment or container is clean and in good condition and that ventilation arrangements are in good order.

7.37.9.2 Any battery cell suspected of being defective should be tested for capacity and if it fails to give 80% of its rated capacity it should be considered unfit for further service. A Certificate of Inspection by a battery maker of repute regarding the satisfactory condition of the battery may be accepted by the surveyor. Such certificates should be supplied for inclusion in the records of the ship.

7.37.9.3 The arrangements for automatic change-over from mains supply to battery supply required by the Regulations should be checked each year.

#### 7.37.10 Cables

It may be appropriate, depending on the age and condition of the installation to examine a sample of cables to ascertain the general condition of the whole installation. Opening up of trunks etc should not normally be necessary unless examination or unsatisfactory insulation resistance readings indicate that it is required for further investigation. Particular attention should be paid to cables in areas of high ambient temperatures, e.g. near exhaust systems of diesel engines.

#### 7.37.11 Electric lifts

7.37.11.1 Surveyors should be satisfied that electric lifts are maintained in good condition.

7.37.11.2 Inspection and maintenance of lifts should be carried out by the lift makers or other competent organisations every six months and certificates or reports made available to the surveyor. If such a certificate or report is produced or some equally satisfactory arrangement is made, surveyors need not insist on the opening up of working parts or dismantling of safety devices etc, for inspection. Attention is drawn to Marine Guidance Note MGN 56 (M+F) "Accidents involving Personnel Lifts".

#### 7.37.12 Hazardous areas and spaces

The condition of cabling and equipment within hazardous areas and spaces should be examined each year to ensure that it is in a satisfactory condition and that no unauthorised alterations have been made. Particular attention should be paid to the insulation resistance values and electrical protection devices. Intrinsically safe circuits should not normally be subjected to an insulation resistance test.

#### 7.37.13 High voltage equipment

Where electrical equipment operating at above 1000 volts is installed any arrangements which are provided to guard against unauthorised entry of personnel should be checked each year to ensure that they are satisfactory.

#### 7.37.14 Electric propulsion machinery

The electrical equipment should be surveyed as described above.