

Dolski Rejestr Statków

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF HIGH-SPEED CRAFT

PART VII ELECTRICAL INSTALLATIONS AND CONTROL SYSTEMS

2014



GDAŃSK

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF HIGH-SPEED CRAFT developed and issued by Polski Rejestr Statków S.A., further referred to as PRS, consist of the following Parts:

- Part I – Classification Regulations
- Part II – Hull
- Part III – Hull Equipment
- Part IV – Stability and Subdivision
- Part V – Fire Protection
- Part VI – Machinery and Associated Systems
- Part VII – Electrical Installations and Control Systems

With respect to materials and welding, the requirements specified in the *Rules for the Classification and Construction of Sea-Going Ships, Part IX – Materials and Welding*, apply.

Part VII – Electrical Installations and Control Systems – 2014 was approved by PRS Board on 15 October 2014 and enters into force on 20 October 2014.

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1 GENERAL

1.1 Application

Requirements of this *Part – Electrical Installations and Control Systems* (further referred to as the Rules), apply to high-speed craft, defined in *Part I - Classification Regulations*.

1.2 Definitions and Explanations

General definitions and explanations are given in *Part I – Classification Regulations* and *Part VI - Machinery and Associated Systems*.

1.3 Technical Documentation of the Craft

Prior to the commencement of craft construction, documentation listed in 1.4 of the *Rules for the Classification and Construction of Sea-going Ships, Part VIII – Electrical Installations and Control Systems* shall be submitted to the PRS Head Office for consideration and approval.

1.4 Scope of Survey

The general provisions relating to the survey during manufacture and installation of the electrical equipment items on the craft are given in 1.3 of the *Rules for the Classification and Construction of Sea-going Ships, Part VIII – Electrical Installations and Control Systems*.

1.5 General Requirements

1.5.1 Electrical installations shall be such that:

- .1** all electrical auxiliary services necessary for maintaining the craft in normal operation and habitable conditions will be ensured without 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.

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

1.5.3 The electrical system shall be designed and installed so that the probability of the craft being at risk of failure of a service is minimised.

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

1.5.5 Precautions shall 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.

1.5.6 Separation and duplication of electrical supply shall 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 shall be capable of being separated by removable links or other approved means. Each bus section shall be able to supply all equipment necessary to maintain the control of propulsion, steering, stabilization, navigation, lighting and ventilation, and allow starting of the largest essential electric motor at any load. However, partial reduction in the supply 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.

2 DIRECTIONAL CONTROL SYSTEMS

- 2.1** Craft shall be provided with at least two independent appliances and devices to enable directional control (control systems) in all possible craft operational conditions.
- 2.2** Craft directional control may be ensured by any steering device.
- 2.3** The possibility of simultaneous failure of all directional control systems shall be avoided.
- 2.4** Where the craft is not fitted with at least two independent directional control systems, appropriate additional devices ensuring control at failure of essential components of the system shall be provided.
- 2.5** The secondary directional control device may be manually driven when PRS is satisfied that this is adequate, bearing in mind the necessity of ensuring appropriate manoeuvring/movement characteristics of the craft.
- 2.6** The directional control systems shall be constructed so that a single failure will not hazard the craft safety. PRS may allow a short period of time to permit the connection of a secondary control device when such delay will not hazard the craft.
- 2.7** A failure mode and effect analysis shall include the directional control system.
- 2.8** A break in operation of craft control devices shall not exceed 5 seconds. If necessary, back-up power sources and associated systems shall be provided.
- 2.9** All directional control systems shall provide complete control of the craft from the main operating station.
- 2.10** If directional control systems are also operated from other positions, then internal communication shall be arranged between the craft main operating station and these other positions.
- 2.11** Adequate indications shall be provided at the craft to provide verification of the correct response of commands/ruder angle set, and also to indicate any abnormal response or malfunction of propulsion and steering devices. The indications of steering response or rudder angle indicator shall be independent of the system for directional control.

3 REMOTE CONTROL, ALARM AND SAFETY SYSTEMS

3.1 General

- 3.1.1** Failure of any remote or automatic control systems shall initiate an audible and visual alarm and shall not prevent normal manual control.
- 3.1.2** Basic and emergency controls shall permit the operating crew to perform the duties for which they are responsible in correct manner without difficulty, fatigue or excessive concentration.
- 3.1.3** Where control of propulsion or manoeuvring is provided at stations beyond the operating compartment, the transfer of control shall only be possible from the station which takes charge of control. Two-way voice communication shall be provided between all stations from which control functions may be exercised and between each such station and the look-out position. Failure of the operating control system or of transfer of control shall bring the craft to low speed without hazarding passengers or the craft.

3.2 Emergency Controls

- 3.2.1** The station or stations in the operating compartment from which control of craft manoeuvring and/or of its main machinery is exercised shall be provided, within easy reach of the crew member at that station, with controls for use in an emergency to:
- activate fixed fire-extinguishing systems;

- close ventilation openings and stop ventilating machinery supplying spaces covered by fixed fire-extinguishing systems;
- shut off fuel supplies to machinery in main and auxiliary machinery spaces;
- disconnect all electrical power sources from the normal power distribution system (the operating control shall be guarded to reduce the risk of inadvertent or careless operation); and
- stop main and auxiliary engines.

3.2.2 Where control of main propulsion and manoeuvring is provided at additional stations outside the operating compartment, such stations shall have direct communication with the continuously manned control station.

3.3 Alarm Systems

3.3.1 Alarm systems shall be provided which announce at the craft's control position, by visual and audible means, malfunctions or unsafe conditions. Alarms shall be maintained until they are acknowledged and the visual indications of individual alarms shall remain until the fault has been corrected, then the alarm system shall automatically set back to the normal operating condition. If an alarm has been acknowledged and a second fault occurs before the first is corrected, the audible and visual alarm shall operate again. Alarm system shall include means to test its operation.

3.3.2 Emergency alarms giving indication of conditions requiring immediate action shall be distinctive and in full view of all crew members in the operating compartment, and shall be provided for the following:

- activation of a fire-detection system;
- total loss of normal electrical supply;
- overspeed of main engines; and;
- thermal runaway of any permanently installed nickel-cadmium battery.

3.3.3 Alarms with a visual display shall indicate conditions requiring action to prevent degradation to an unsafe condition. These shall be provided for at least the following:

- exceeding the limiting value of any craft, machinery or system parameter, other than engine overspeed;
- failure of normal power supply to powered directional or trim control devices;
- operation of any automatic bilge pump;
- high bilge level in any watertight compartment below design waterline;
- failure of compass system;
- low level of a fuel tank contents;
- fuel oil tank overflow;
- extinction of side, masthead or stern navigation lights;
- low level of contents of any fluid reservoir the contents of which are essential for normal craft operation;
- failure of any connected electrical power source;
- failure of any ventilation fan installed for ventilating spaces in which inflammable vapours may accumulate; and
- diesel engine fuel line failure.

3.3.4 All warnings shall be provided at all stations at which control functions may be exercised.

3.3.5 The alarm system shall meet appropriate design and operational requirements for required alarms.

3.3.6 Equipment monitoring the passenger, cargo and machinery spaces for fire and flooding shall, so far as is practicable, form an integrated sub-system incorporating monitoring and activation control for all emergency situations. This sub-system may require feedback instrumentation to indicate that actions initiated have been fully implemented.

3.4 Safety Systems

3.4.1 Where arrangements are fitted for overriding any automatic shutdown system for the main propulsion machinery, they shall be such as to preclude unintentional operation. When a shutdown system is activated, an audible and visual alarm shall be given at the control station. Means shall be provided to override the automatic shutdown except in cases where there is a risk of complete breakdown or explosion.

4 ELECTRICAL INSTALLATIONS

4.1 Main Source of Electrical Power

4.1.1 A main source of electrical power of sufficient capacity to supply all those services mentioned in 1.3.1 shall be provided. The main source of electrical power shall consist of at least two generating sets.

4.1.2 The capacity of these generating sets shall 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 shall also be ensured.

4.1.3 The arrangements of the craft's main source of electrical power shall be such that the services referred to in 1.3.1.1 can be maintained regardless of the speed and direction of the propulsion machinery or shafting.

4.1.4 Means shall be provided to restore operation of essential machinery from dead craft condition without external aid. Dead ship condition is a condition under which the main propulsion plant and auxiliaries are not in operation and no power source is available to start and operate the main propulsion, basic power sources and essential auxiliaries. In addition, it shall be assumed that starting the emergency generating set or one of primary generating sets located in accordance with 5.1.2 is constantly ensured.

If the emergency generating set complying with 4.3 or primary generating set complying with 5.1.2 is used as emergency source of electric power, it shall be assumed that means are provided to start the set and the set may subsequently be used to restore the operation of the main propulsion and associated essential auxiliaries, if any power sources necessary for the operation of main engine have the same protection degree as starting arrangements.

If no emergency generating set is installed onboard the craft or the set does not comply with the requirements of 4.3, means to ensure restoring operation of main and essential auxiliary machinery shall ensure charging the air receivers or charging starting batteries without external aid. Where an emergency compressor or generator is necessary for this purpose, it shall be driven by manually activated internal combustion engine or shall be manually operated itself (e.g. a manual compressor). Means to restore the operation of main and essential auxiliary machinery shall have such capacity that the energy accumulated for starting and supplying the main engine auxiliaries is available within 30 minutes from occurring the dead ship condition.

Where transformers constitute an essential part of the electrical supply system required by this chapter, the system shall be so arranged as to ensure the same continuity of supply as is stated in 4.1.

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

4.1.6 The arrangement of the main electric lighting system shall 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 4.1.6.

4.1.7 The main switchboard shall be so placed relative to the main generating station that, as far as practicable, the integrity of the normal electrical supply may be affected by a fire or other casualty in one space, only. 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, shall not be considered as separating the switchboards from the generators.

4.1.8 The main busbars shall be divided into at least two sections connected by a switch or other approved means. So far as is practicable, the connection of generating sets and any other duplicated equipment shall be equally divided between the sections.

4.2 Emergency Source of Electrical Power

4.2.1 A self-contained emergency source of electrical power shall be provided on the craft.

4.2.2 The emergency source of electrical power, associated transforming equipment, if any, transitional source of emergency electrical power, emergency switchboard and emergency lighting switchboard shall be located above the waterline in the final damage condition as referred to in *Part IV – Stability and Subdivision* and shall be operable in that condition and readily accessible.

4.2.3 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 and the main switchboard shall be such as to ensure that a fire or other casualty in spaces containing the main source of electrical power, associated transforming equipment, and the main switchboard will not interfere with the supply, control, and distribution of emergency electrical power. The space containing the emergency source of electrical power, associated transforming equipment, the transitional source of emergency electrical power and the emergency switchboard shall not be contiguous to the boundaries of the main machinery spaces or those spaces containing the main source of electrical power, associated transforming equipment, or the main switchboard.

4.2.4 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.

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

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

4.2.6.1 Where the emergency source of electrical power is a generator, it shall be:

- .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 of the *HSC Code*;
- .2** started automatically upon failure of the electrical supply from the main source of electrical power and shall be automatically connected to the emergency switchboard. Those services referred to in 5.1.5 or 6.1.3 shall then be transferred to the emergency generating set. The automatic starting system and the characteristics of the prime mover shall 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 s; and
- .3** provided with a transitional source of emergency electrical power according to 5.1.5 or 6.1.3.

4.2.6.2 Where the emergency source of electrical power is an accumulator battery, it shall be capable of:

- .1** carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12% above or below its nominal voltage;
- .2** automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and
- .3** immediately supplying at least those services specified in 5.1.5 and 6.1.3.

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

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

4.2.9 No accumulator battery shall be installed in the same space as the emergency switchboard. An indicator shall 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 4.2.6.1.3 are being discharged.

4.2.10 The emergency switchboard shall be supplied during normal operation from the main switchboard by an interconnector feeder which shall be adequately protected at the main switchboard against overload and short circuit and which shall 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 shall also be protected at the emergency switchboard at least against short circuit. Failure of the emergency switchboard, when being used in other purpose than an emergency, shall not put at risk the operation of the craft.

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

4.2.12 The emergency generator and its prime mover and any emergency accumulator battery shall 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 trim, taking into account any damage cases considered in *Part IV – Stability and Subdivision*.

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

4.3 Starting Arrangements for Emergency Generating Sets

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

4.3.2 Each emergency generating set shall be equipped with starting devices with a stored energy capability of at least three consecutive starts. The source of stored energy shall 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 shall be provided for additional three starts within 30 min, unless manual starting can be demonstrated to be effective.

4.3.3 The stored energy shall be maintained at all times, as follows:

- .1** electrical and hydraulic starting systems shall 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 shall be located in the emergency generator space. These devices shall 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 compressed air system through the non-return valve fitted in the emergency generator space.

4.4 Steering and Stabilization of Craft Direction and Position

4.4.1 Where steering and/or stabilization of a craft are essentially dependent on one device as with a single rudder or steerable propeller, which is itself dependent on the continuous availability of electric power, it shall be served by at least two independent circuits, one of which shall 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 shall not cause any risk to the craft or passengers during switching to the alternative supply. These circuits shall be provided with short-circuit protection and an overload alarm.

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

4.4.3 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 appropriately protected.

4.5 Precautions against Shock and other Hazards of Electrical Origin

4.5.1 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 shall be earthed unless the machines or equipment are:

- .1** supplied at a voltage not exceeding 50V direct current or 50V root-mean square between conductors; auto-transformers shall 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.

4.5.2 PRS may require additional precautions for portable electrical equipment intended for use in confined or exceptionally damp spaces, where particular risks due to conductivity may exist.

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

4.5.4 Main and emergency switchboards shall 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 shall be suitably guarded. Exposed live parts having voltages to earth exceeding a voltage to be specified by PRS shall not be installed on the front of such switchboards. Where necessary, non-conducting mats or gratings shall be provided at the front and rear of the switchboard.

4.5.5 When a distribution system, whether primary or secondary, for power, heating or lighting, with no 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 shall be provided. For limited secondary distribution systems PRS may accept a device for manual checking of the insulation level.

4.6 Cables and Wiring

4.6.1 Except as permitted by PRS in exceptional circumstances, all metal sheaths and armour of cables shall be electrically continuous and shall be earthed.

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

4.6.3 Cables and wiring serving essential or emergency power, lighting, internal communications or signal consumers shall, as far as practicable, be routed clear of machinery spaces and their casings and other areas of major fire risk. Where practicable, all such cables shall 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.

4.6.4 Where cables which are installed in hazardous areas pose the risk of fire or explosion in the event of an electrical fault in such areas, special precautions against such risks shall be taken:

- .1 cables and wiring shall be installed and supported in such manner as to avoid chafing or other damage;
- .2 terminations and joints in all conductors shall be so made as to retain the original electrical, mechanical, flame-retarding and, where necessary, fire-resisting properties of the cable.

4.7 Protection

4.7.1 Each separate circuit shall be protected against short circuit and overload, except as permitted in 4.4 or where PRS may exceptionally otherwise permit.

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

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

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

4.8 Accumulator batteries and Power Distribution Systems

4.8.1 Accumulator batteries shall be located in special ventilated boxes or suitable compartments used exclusively for their accommodation. The compartments shall be properly constructed and efficiently ventilated.

4.8.2 Accumulator batteries shall not be located in crew accommodation.

4.8.3 Accumulator batteries shall be located so as to prevent their movement.

4.8.4 No electrical equipment shall 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 such equipment is:

- .1 essential for the craft 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 in the dusts, vapours or gases likely to be encountered.

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

- .1 the electrical distribution voltages throughout the craft may be either direct current or alternating current and shall not exceed:
 - .1.1 500 V for cooking, heating and other permanently connected equipment; and
 - .1.2 250 V for lighting, internal communications and receptacle outlets.
PRS may accept higher voltages for main propulsion purposes;
- .2 for electrical power distribution, two-wire or three-wire systems shall be used. Four-wire systems with neutral earthed but without hull return may also be used. Where applicable, the requirements of 7.5.6.4 or 7.5.6.5 of *HSC Code* shall also be met;
- .3 effective means shall be provided so that voltage may be cut off from each and every circuit and sub-circuit and from all apparatus;

- .4 electrical equipment shall be so designed that the possibility of accidental touching live parts, rotating or moving parts as well as heated surfaces which might cause burns or initiate fire is minimized;
- .5 electrical equipment shall be adequately secured. The probability of fire or dangerous consequences arising from damage to electrical equipment shall be reduced to an acceptable minimum;
- .6 the rating or appropriate setting of the overload protective device for each circuit shall 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 combustion engine starting circuits, unprotected cable runs shall be kept as short as possible. Special precautions, e.g. the use of singlecore cables with additional sleeve over the insulation of each core, with shrouded terminals, shall also be taken to minimize risk of faults;
- .8 in order to minimize the risk of fire, structural damage, electrical shock and radio interference due to lightning strike or electrostatic discharge, all metal parts of the craft shall 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-borne. The bonding of isolated components inside the structure is not generally necessary, except in fuel tanks;
- .9 each pressure refuelling point shall be provided with a means of electrical bonding the fuelling equipment to the craft;
- .10 metallic pipes capable of generating electrostatic discharges, due to the flow of liquids and gases, shall be bonded so as to be electrically continuous throughout their length and shall be adequately earthed;
- .11 primary conductors provided for lightning discharge currents shall have a minimum cross-section of 50 mm² in copper or equivalent surge-carrying capacity in aluminium;
- .12 secondary conductors provided for the equalization of static discharges, bonding of equipment, etc., but not for carrying lightning discharges shall have a minimum cross-section of 5 mm² in copper or equivalent surge current carrying capacity in aluminium;
- .13 the electrical resistance between bonded objects and the basic structure shall not exceed 0.05 Ohm, except where it can be demonstrated that a higher resistance will not cause a hazard. The bonding path shall have sufficient cross-sectional area to carry the maximum current likely to be imposed on it without excessive voltage drop.

5 ADDITIONAL REQUIREMENTS

5.1 Passenger Craft – Mark PASSENGER

5.1.1 Separation and duplication of electrical supply shall be provided for duplicated consumers of essential services. During normal operation the systems may be connected to the same power-bus, but means for their easy separation shall be provided. Each bus section shall be able to supply all equipment necessary to maintain the control of propulsion, steering, stabilization, navigation, lighting and ventilation, and allow starting of the largest essential electric motor under any load. Automatic load-dependent disconnection of non-essential consumers may be allowed.

5.1.2 Distribution systems shall 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.

5.1.3 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 5.1.3 or

5.1.4, the requirements of 4.2.1, 4.2 and 4.2.3 may be considered satisfied without an additional emergency source of electrical power, provided that:

- .1 there is at least one generating set in each of at least two non-contiguous spaces, meeting the requirements of 4.2.12 and of sufficient capacity to meet the requirements of 5.1.3 or 5.1.4;
- .2 the arrangements required by .1 in each such space are equivalent to those required by 4.2.6.1, 4.2.7 to 4.2.11 and 4.3 so that a source of electrical power is available at all times to the services required by 5.1.3 or 5.1.4; and
- .3 the generating 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.

5.1.4 The transitional source of emergency electrical power required by 4.2.6.1.3 may consist of an accumulator battery suitably located for use in an emergency which shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12% 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 consumers specified in 5.1.3.1, .2 and .3 or in 5.1.4.1, .2 and .3 and
- .2 with respect to the watertight doors:
 - .2.1 to provide power to operate the watertight doors, but not necessarily simultaneously, unless an independent temporary source of stored energy is provided. The power source shall have sufficient capacity to operate each door at least three times, i.e. closed-open-closed, against an adverse list of 15°; and
 - .2.2 to provide power to the control, indication and alarm circuits for the watertight doors for half an hour.

5.1.5 The requirements of 5.1.4 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 main propulsion and direction systems shall be uninterruptible.

5.2 Passenger Craft of Category A – Mark PASSENGER CATEGORY A

5.2.1 For category A passenger craft, the emergency source of power shall be capable of supplying simultaneously, within the below time periods, the following services:

- .1 for a period of 5 h emergency lighting:
 - .1.1 at the stowage, preparation, launching and deployed positions of survival craft and equipment for embarkation into those craft;
 - .1.2 at all escape routes, such as alleyways, stairways, exits from accommodation and service spaces, life-saving appliances embarkation points, etc.;
 - .1.3 in the public spaces;
 - .1.4 in the machinery spaces and main emergency generator spaces, including their control positions;
 - .1.5 in steering and 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 consumers as set out in 14.13.2 of *HSC Code*; and
 - .4.2 essential electrically powered instruments and controls for propulsion machinery, if alternate sources of power are not available for such devices;
- .5 for a period of 12 h, the "not under command" lights; and
- .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 PRS.

5.2.2 In category passenger A craft having limited public spaces, emergency lighting fittings of the type described in 5.1.9.1 as meeting the requirements of 5.1.3.1 and 5.1.5.1 may be accepted, provided that an adequate standard of safety is ensured.

5.2.3 Provisions shall be made for the periodic testing of the complete emergency system, including the emergency consumers required by 5.1.3 or 5.1.4 and 5.1.5, and it shall include the testing of automatic starting arrangements.

5.3 Passenger Craft of Category B – Mark PASSENGER CATEGORY B

5.3.1 In addition to the requirements of subchapter 3.1, for category B passenger craft, remote control systems for propulsion machinery and directional control shall be equipped with back-up systems controllable from the operating compartment.

5.3.2 In addition to the requirements of subchapter 3.2, for category B passenger craft control of propulsion and manoeuvring as well as emergency functions shall be provided in a station outside the operating compartment. Such stations shall have direct communication with the operating compartment, which shall be a continuously manned control station.

5.3.3 In addition to the requirement of 4.1.8, for passenger craft of category B each part of the main busbars with its associated generators shall be arranged in separate compartments.

5.3.4 For category B passenger craft, the electrical power available shall 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 shall 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, preparation, launching and deployed positions of survival craft and equipment for embarkation into those craft;
 - .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 set 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 required navigational equipment. Where such provision is unreasonable or impracticable, the Administration may waive this requirement for craft of less than 5,000 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 *Part V – Fire Protection*;
 - .4.4 the sprinkler pumps and drencher pumps, 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 *Part VI – Machinery and Associated Systems*, and
 - .4.6 craft radio facilities and other additional consumers;
- .5 for a period of 30 min, any watertight doors, required 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 PRS.

5.4 Ro-ro Craft – Mark RO-RO

5.4.1 In addition to the emergency lighting required by paragraphs 5.1.3.1, 5.1.4.1 and 5.1.5.1 on every craft with ro-ro spaces:

- .1 all passenger public spaces and alleyways shall be provided with supplementary electric lighting that can operate for at least 3 h when all other sources of electric power have failed and under any condition of heel. The illumination provided shall be such that the approach to the means of escape can be readily seen. The source of power for the supplementary lighting shall consist of two 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 PRS. The supplementary lighting shall be such that any failure of the lamp will be immediately apparent. Any accumulator battery provided shall 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 shall 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.

5.5 Vessels Designed to Transport Offshore Support Personnel – Mark CREW BOAT

5.5.1 Electrical equipment shall operate properly in the following conditions:

- .1 at permanent heel of 15°;
- .2 at ambient temperature +45°C;
- .3 at voltage variations $\pm 0.2U_n$ (for 1.5 seconds);
- .4 at frequency variations $\pm 0.1f_n$ (for 3 seconds).

where:

U_n – rated voltage, [V],

f_n – rated frequency, [Hz].

5.5.2 The electrical equipment shall be provided with housings of protection degree in accordance with table 5.6.1.2.

5.5.3 Electric Power Distribution

5.5.3.1 Basic Requirements

5.5.3.1.1 In insulated power distribution systems, continuous insulation resistance measurement shall be provided with appropriate alarm given in case of value drop below (exceeding) inadmissible level.

5.5.3.1.2 The terminal for power supply from an external source of electric power, with voltage exceeding 50 V, is to be provided with clamps for earthing the neutral run. The design of the terminal shall be such as to ensure connection of earthing clamp before connecting other clamps.

Table 5.5.3.1

Item	Location of electrical appliance	Location conditions	Housing protection degree
1	Dry accommodation spaces Dry control stations	Danger of touching live parts	IP20
2	Rooms on the bridge Engine and boiler rooms above floor	Danger of dripping liquid and/or minor mechanical damage	IP22
	Steering gear rooms Refrigerating machinery rooms (excluding ammonia plant) Emergency machinery rooms General store-rooms Pantries Provision rooms	Increased danger of liquid occurrence and mechanical damage	IP44
3	Rooms intended for fish processing Shaft or pipe tunnels in double bottom Holds	Danger of liquid spraying, cargo dust presence, serious mechanical damage, aggressive fumes	IP55
4	Open decks	Danger of occurrence of liquids in large quantities	IP56

5.5.3.1.3 For three-phase alternating current systems, a control device for phase polarity or sequence shall be provided.

5.5.3.1.4 Craft provided with two main engines with electric start shall have two separate starting batteries, one for each engine. Each battery shall be capable of being so switched that start of any engine is possible by any battery.

5.5.3.2 Navigation Lights

5.5.3.2.1 A separate navigation lights switchboard shall be provided, to supply only the navigation lights. The navigation lights switchboard shall be supplied from the main switchboard and, by secondary circuit, from an emergency source. Manual change-over of electric supply from the main to emergency source shall be provided.

5.5.3.2.2 Where the navigation lights are not capable of being controlled from the navigation bridge, control systems for lights operation shall be provided.

5.5.3.3 Electric Drives for Steering Gear

5.5.3.3.1 The electric or electrohydraulic steering gear comprising two electric motors shall be supplied directly from the main switchboard by two separate circuits. Cables of the circuits shall be laid as apart of each other as possible.

5.5.3.3.2 Steering gear motors and control systems shall be protected only against short-circuit.

5.5.3.3.3 The main control station shall be provided with: indicators of steering gear motors operation, rudder angle, and alarm signal in case of failure (stoppage) and overload of the steering gear motor.

5.5.3.4 Electric Driver for Fans and Pumps

5.5.3.4.1 The electric motors of fans and fuel pumps shall be provided with remote switching devices situated outside the spaces in which the equipment is located.

5.5.4 Alarm Systems and Communication

5.5.4.1 The craft shall be provided with general alarm system, capable of being activated from the navigation bridge.

5.5.4.2 The craft shall be provided with devices ensuring possibility of transferring announcements to accommodation spaces, public spaces and machinery control positions.

5.5.4.3 The craft of a length L above 12 m shall have an additional independent system for transferring announcements and alarm signals, operating in the case of emergency, to ensure safe abandoning the craft.

5.5.4.4 An engine room telegraph and an other independent means for transferring commands to machinery control station shall be fitted on the navigation bridge. If the installation of the above devices does not satisfy the needs, having regard to the size/structure of the craft, only two-way voice communication arrangement may be provided.

5.5.4.5 Local control stations, located directly at propulsion machinery shall be provided with at least one engine room telegraph. If the installation of the above devices does not satisfy the needs, having regard to the size/structure of the craft, arrangements for two-way voice communication with the local control station of steering gear, propulsion machinery compartment and service spaces shall be provided.

5.5.4.6 The craft shall be provided with arrangements for voice communication with crew accommodation personnel, unless the spaces are adjacent and the announcements may be communicated directly.

5.5.4.7 The high liquid level alarm for engine room situated below the highest damage waterline shall be fitted in navigation bridge.

5.5.4.8 All bilges and bilge wells shall be fitted with alarm signals.

5.5.5 Electric Machines

The craft electric machines shall comply with the requirements of Chapter 10, *Part VIII* of the *Rules for the Classification and Construction of Sea-going Ships*.
