PART II RULES FOR THE CONSTRUCTION AND CLASSIFICATION OF MOBILE OFFSHORE DRILLING UNITS

TITLE MOBILE OFFSHORE DRILLING UNITS

SECTION 7 ELECTRICITY

CHAPTERS

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APPROACH

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Guidance

Reminder:

"Rules" mean the Rules for the Construction and Classification of Mobile Offshore Drilling Units"

"Ship Rules" mean the Rules for the Construction and Classification of Sea Going Ships".

End of guidance

A1. APPLICATION

100. Scope

101. The following requirements apply to electrical equipment essential to the safe operation of the unit. They do not apply to electrical equipment and systems used solely for the drilling operation except in so far as safety is concerned. Attention shall, however, be given to any relevant statutory regulation of the National Authority of the country in which the unit is to be registered.

102. **Alternative design and arrangements**: When alternative design or arrangements deviate from the prescriptive provisions of the Rules, an engineering analysis, evaluation and approval of the design and arrangements shall be carried out in accordance with SOLAS regulation II-1/55 based on the guidelines developed by the Organization. (*)

(*) Refer to the Guidelines on alternative design and arrangements for SOLAS chapters II-1 and III (MSC.1/Circ.1212).

200. Installation types

201. The electric installations are to be such that:

a. all electrical services necessary for maintaining the unit in normal operational and habitable conditions will be assured without recourse to the emergency source of power;

b. electrical services essential for safety will be assured in case of failure of the main source of electrical power;

c. electromagnetic compatibility of electrical and electronic equipment is assured (*) ; and

(*) Refer to General requirements for electromagnetic compatibility for all electrical and electronic equipment, adopted by the Organization by resolution A.813(19).

d. the safety of personnel and unit from electrical hazards will be assured.

A2. DEFINITIONS

100. Terms

101. The terms employed in the present Section have the following definitions:

102**. Category A machinery spaces:** Machinery spaces of category A are those spaces and trunks to such spaces which contain:

- internal combustion machinery used for main propulsion;

- internal combustion machinery used for purposes other than main propulsion where such machinery has in the aggregate a total power output of not less than 375 kW; or

- any oil-fired boiler or oil fuel unit.

103**. Control stations** are those spaces in which the unit's radio or main navigating equipment or the emergency source of power is located or where the fire recording or fire control equipment or the dynamic positioning control system is centralized or where a fire-extinguishing system serving various locations is situated. In the case of column-stabilized units a centralized ballast control station is a "control station". However, for purposes of the application of fire safety, the space where the emergency source of power is located is not considered as being a control station.

104. **Dangerous goods:** are thoselisted in the Chapter VII of the SOLAS 1974, as amended.

105. **Dead ship condition**: The condition under which the main propulsion plant, boilers and auxiliaries are not in operation due to the absence of power.

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Dead ship condition is a condition in which the entire machinery installation, including the power supply, is out of operation and the auxiliary services such as compressed air, starting current from batteries etc., for bringing the main

propulsion into operation and for the restoration of the main power supply are not available.

End of guidance

106. **Earthing**connecting device to the hull or other structure permanently attached, used as an arbitrary zero potential in such a manner as will ensure at all times an immediate discharge of electrical energy without danger, in order to protect the individual against hazardous contacts with accidentally energized metal parts, which can cause injuries during a phase-earth fault.

107. **Equipotential bonding** is aprovision of electric connections between conductive parts, intended to achieve equipotentiallity.
[IEC 61892-6]

108. **Emergency condition** is a condition under which any services needed for normal operational and habitable conditions are not in working order due to failure of the main source of electrical power.

109. **Emergency consumers** are mandatory consumers which, after breakdown of the main energy supply, shall be fed by the emergency energy supply.

110. **Emergency services** mean services required to be put into operation for the safety of the unit under an emergency condition.

111. **Emergency source of electrical power** is a source of electrical power, intended to supply the necessary services in the event of a failure of the supply from the main source of electrical power.

112. **Emergency switchboard** is a switchboard which in the event of failure of the main electrical power supply system is directly supplied by the emergency source of electrical power and/or the transitional source of emergency power and is intended to distribute electrical energy to the emergency services.

113. **Essential services**: mean services required to be in continuous condition of operation to maintain the safety of the unit and to generate the power supply necessary to meet the operational demand of the unit. Operational power demands are to be specified by the party applying for classification.Services to ensure minimum comfortable conditions of habitability are those services such as defined below.

a. **Primary Essential Services** are those services which need to be in continuous operation to maintain propulsion and steering. Examples of equipment for primary essential services are indicated in E5.200.

b. **Secondary Essential** Services are those services which need not necessarily be in continuous operation to maintain propulsion and steering but which are necessary for maintaining the unit's safety. Examples of equipment for secondary essential services are indicated in E5.300.

c. **Services for habitability** are those services which need to be in operation for maintaining the unit's minimum comfort conditions for the crew. Examples of equipment for maintaining conditions of habitability are indicated in E5.400.

114. **Hazardous areas** are all those areas where, due to the possible presence of a flammable atmosphere arising from the drilling operations, the use without proper consideration of machinery or electrical equipment may lead to fire hazard or explosion. Hazardous areas are subdivided into Zones 0, 1 or 2, the definitions of each category being as follows:

a. Zone 0 an area in which an explosive gas-air mixture is continuously present or present for long periods.

b. Zone 1 an area in which an explosive gas-air mixture is likely to occur in normal operating conditions.

c. Zone 2 an area in which an explosive gas-air mixture is not likely to occur, and if it occurs, it will only exist for a short time.

115. **High voltage:** high voltage circuits are those with more than 1000 V rms. for alternating current and at least 1500 V for direct current.

116. **Hull return:** a system in which insulated conductors are effectively connected to the mass of the unit for earthing.

117. **Low-voltage systems:** Are systems operating with rated voltages of more than 50 V rms. up to 1000 V rms. inclusive and with rated frequencies of 50 Hz or 60 Hz, or direct-current systems where the maximum instantaneous value of the voltage under rated operating conditions is greater than 50 V and not exceeding 1500 V.

118. **Machinery spaces**: all machinery spaces of category A and all other spaces containing propelling machinery, boilers, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air conditioning machinery, and similar spaces, and trunks to such spaces.

119. **Main source of electrical power** is a source intended to supply all services necessary for maintaining the unit in normal operational and habitable conditions.

120. **Main switchboard** is a switchboard which is directly supplied by the main source of electrical power and is intended to distribute electrical energy to the unit's services.

121. **Mode of operation** means a condition or manner in which a unit may operate or function while on location or in

transit. The modes of operation of a unit include the following:

- **Operating conditions** – conditions wherein a unit is on location for the purpose of conducting drilling operations, and combined environmental and operational loadings are within the appropriate design limits established for such operations. The unit may be either afloat or supported on the seabed, as applicable.

- **Severe storm conditions** – conditions wherein a unit may be subjected to the most severe environmental loading for which the unit is designed. Drilling operations are assumed to have been discontinued due to the severity of the environmental loading. The unit may be either afloat or supported on the seabed, as applicable.

- **Transit conditions** – conditions wherein a unit is moving from one geographical location to another.

122. **Normal operational and habitable conditions** means conditions under which the unit as a whole, its machinery, services, means and aids ensuring safe navigation when underway, safety when in the industrial mode, fire and flooding safety, internal and external communications and signals, means of escape and winches for rescue boats, as well as the means of ensuring the minimum comfortable conditions of habitability, are in working order and functioning normally; and drilling operations.

123. **Oil fuel unit**is the equipment used for the preparation of oil fuel for delivery to an oil-fired boiler, or equipment used for the preparation for delivery of heated oil to an internal combustion engine, and includes any oil pressure pumps, filters and heaters dealing with oil at a pressure more than 0.18 N/mm^2. Oil transfer pumps are not considered oil fuel units.

124. **Transient source of emergency power:** accumulator batteries with sufficient capacity to supply automatically power for the emergency switchboard in the event of failure of either the main or the emergency power source.

CHAPTER B
DOCUMENTS, REGULATIONS AND STANDARDS

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B1. DOCUMENTATION TO THE RBNA

100. Submission of documents

101. Drawings and documents are to be submitted to the approval of the RBNA in triplicate.

200. Control and monitoring Documents

201. The documents to be submitted are to be in accordance with Part I, Title 01, Section 2, Chapter C of the Rules.

B2. REGULATIONS

100. Statutory requirements

101. The following National and International regulations are to be complied with:

- NORMAM 01 Chapter 9
- IMO MODU Code

B3. STANDARDS AND UNITS

100. Standards

101. The electrical installations and all the equipment and materials to be employed on units covered by these Rules are to be designed, constructed and tested according to the latest revisions of the applicable Standards of the following organizations, in addition to the requirements laid down in these Rules:

- INMETRO: National Institute of Metrology,Standardization and Industrial Quality;

- ABNT: Brazilian Association of Technical Standards;

- IEC: InternationalElectrotechnical Commission;
- ANSI: American National Standards Institute;
- NEMA: National Electrical Manufactures Association;
- IEEE: Institute of Electrical and Electronics Engineers;
- API – American Petroleum Institute
- IACS – International Association of Classification Societies

200. Units

201. Drawings and documents to be submitted to the RBNA are to have all the dimensions given in the InternationalSystem. Consecrated dimensionsin other systems of units shall have indications of the corresponding values in the International System.

CHAPTER C
MATERIALS ANDMANUFACTURE

CHAPTER CONTENTS

C1. SELECTION

100. General Conditions

101. The materials and equipment for the electrical systems of essential services of classifiedunitsare constructed, installed and tested under the supervision of the RBNA, in accordance with the procedures for specific classification or type approval homologation.

102. Materials with characteristics other than those listed here may be used, provided that its specification is subject to approval of the RBNA along with the design of the facility to which the material is intended.

103. Bolts, nuts, washers, pins, terminals, springs and all other small parts are to be manufactured from anti-corrosion or corrosion-protected material.

104. Electrical installation components that have a certificate of origin, considered satisfactory by RBNA and at its discretion, may be exempted, in whole or in part of the tests and inspections at the manufacturer.

200. Electrical components

201 In principle and unless they are especially protected and are approved by the RBNA, the electrical equipment and components shallconsist ofnon-hygroscopic materials, resistant to saline contamination, corrosion, moisture and of the flame-retardant type.

300. Wires and Cables

301. The conductors of cables and wires for use in units covered by these Rules are to be consisted of bare or tinned electrolytic copper, depending on the type of insulation.

302. Cables are to be of a type approved by the RBNA. All the electrical cables and wiring external to equipment are to be at least flame-retardant type and installed so that their original flame retardant properties are not harmed. Where necessary for certain applications, the RBNA may

permit the use of special types, such as radio frequency cables.

303. Cables manufactured in accordance with the relevant recommendations of IEC Publication 61892-4, 60092-350, 51, 60092-352, 60092-353, 60092-354, 60092-360, 60092-373, 60092-374, 60092-375 and 60092-376 will be accepted by the RBNA provided that they are tested to its satisfaction.

304. Cables manufactured and tested to standards other than those specified in C1.303 will be accepted provided they are in accordance with an acceptable and relevant international or national standard.

400. Insulation and covering

401. The materials for use as conductor insulation and sheathing for cables shall be selected according to IEC Publication 60092-360.

500. Lighting fixtures

501. The lighting fixtures shall be of galvanized steel, cast aluminium or alloys, flame-retardant, not hygroscopic and properly protected from the effects of heat produced with inner conductors and bases of live parts of anti-flame material.

502. The lighting fixtures installed in spaces where there is a risk of mechanical damage are to be of reinforced construction and properly protected by grilles.

600. Cable trays

601. Electrical continuity shall be maintained at splices between sections of cable ladder, rack or tray by the use of splice plates. Additional bonding is not required, unless cable ladder, rack or tray is insulated from the unit structure or hull to prevent galvanic corrosion. In these cases bonding shall be carried out as required in G5.200.

700. Cable pipes

701. Cables that are carried in the same pipe shall be of such construction that they cannot cause damage to each other.

702. The pipes shall be suitably smooth on the interior and protected against corrosion. The ends shall be shaped or bushed in such a way that the cable covering is not damaged.

703. The pipes shall be fitted with drain holes.

704. When cable pipes are installed vertically due attention shall be paid to the cable's mechanical self-carrying capacity. For longer pipes, suitable installation methods shall be used, e. g. sandfilling.

705. Cable pipes shall not include expansion elements.

706. Cable pipe material – cablepipes shall be made of steel or type tested non-metallic materials.

707. The cable pipe material shall not have less resistance against fire than required from the cable itself.

708. Aluminium cable pipes may be used if fixed to aluminium structures.

709. Wall thickness of cable pipes–steelcable pipes on deck, through cargo holds, in keel ducts, pump rooms and similar wet spaces, and in water and fuel oil tanks shall be internally and externally galvanised, or shall have an equivalent effective corrosion protection.

710. Condensation in cable pipes– cablepipes with connection and draw boxes shall be arranged so that condensed water is drained out of the system.

711. Bending radius of pipes– thebending radius of cable pipes shall be sufficiently large so that “drawing-in” of the cables does not cause damage to the cables, and in no case less than:

- the minimum bending radius of the cables according to Tables T.B2.206.1 and T.B2.206.2;

- twice the internal diameter of the pipe.

712. Filling of cable pipes - the sum of the cables' total cross section, based on the cables' external diameter, shall not exceed 40% of the pipe's internal cross section. This does not apply to a single cable in a pipe.

713. Connection and draw boxes - connection and draw boxes shall have at least the same wall thickness as required for the pipes, and shall be of steel, with exemption for aluminium alloy pipes, where galvanised cast iron or aluminium alloy shall be used.

714. All connection and draw boxes shall be accessible. Connection boxes may be accepted installed behind panels in dry accommodation spaces provided that they are accessible through a hinged panel or similar arrangement.

C2. CLASSIFICATION OF INPUTS

100. Definition

101. The term "input", when mentioned in the Rules, refers to materials, machinery, equipment and manufactured components of the electrical installation for essential service of classified units. They are subject to special supervision ofRBNA in accordance with the following procedures.

200. Type approval

201. Type approval tests on electrical components covered by the Rules are to be carried out in the presence of the surveyors of the RBNA at the manufacturers' premises. Product certificates issued by manufacturers will be accepted from companies homologated by RBNA.

202. The procedures for specific classification ormanufacturers' type approval are considered as minimum requirements applicable to units classified under special supervision of the RBNA. Alternative procedures for specific classification of products may be accepted at the discretion of the RBNA, if requested in advance by the manufacturer, depending on the particularities of the products and regional peculiarities.

203. These procedures for specific classification or homologation of type approval apply to products manufactured by continuous or semi-continuous processes under controlled conditions and capable of producing homogeneous products in accordance with the requirements laid down in the quality system.

204. The classification framed as type approval comprises the supervision of manufacturing and of all the tests, which are witnessed by the Surveyor per unit of product, in accordance with the requirements of the Rules of the RBNA. The parts considered in accordance with the Rules will be marked individually on visible place with the signet of the RBNA.

205. The following electrical components are to be classified by the type approval procedure:

- electrical cables;
- accessories for cable splicing;
- protection, connection and disconnection devices;
- electronic protection devices, panel alarms, sensors, equipment of remote and automatic controls and actuators;
- safety devices for essential service installations of propulsion machinery, steering system, controllable pitch propellers, electronic speed regulators and shutdown of the main and auxiliary machinery;
- alarm systems for opening and closing devices, monitoring and supervision systems and flooding detection systems.

300. Homologation

301. The homologation of a manufacturerincludes a satisfactory demonstration of the manufacturer's experience with the technology employed, complexity to the type of product and establishment of procedures appropriate to the manufacture of each product in type test of prototype.

C3. MATERIALS

100. Design and assembly

101. The material for the electrical installation is to be sufficiently protected against mechanical damage and manufactured in corrosion resistant materials.

102. Portable appliances are to be equipped with means for protection of cables of connections against mechanical stress.

103. Terminals, bolts, nuts, etc. are to be of bronze.

CHAPTER D
PRINCIPLES OF CONSTRUCTION

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D1. INSTALLATIONS ON BOARD

100. Design andconstruction

101. Every unit is to be provided with a main source of electrical power which is to include at least two generators.

102. Electrical propelling machinery and associated equipmenttogether with auxiliary services essential for the safety of the unit are to be constructed and installed in accordance with the relevant requirements of the Rules and as specified herein.

103. The design and installation of other equipment including that used for drilling operations is to be such that there is minimal risk of fire due to its failure. It must, as a minimum, comply with an acceptable specification, standard or code, revised where necessary, for ambient conditions.

104. Essential lighting shall be supplied from at least two final sub-circuits in such a way that failure of any one of the circuits does not leave the space in darkness. For lightingin hazardous areas or spaces, switches are to be of the two-pole type and, wherever practicable, located in a non-hazardous area.

105. All the electrical components are to be manufactured for operation in harsh environments and installed so as not to cause injury when handled or touched in normal operating conditions.

105. All the electrical materials intended for use in units covered by these Rules are to be resistant to saline and/or industrial contamination and adequate to installation in highly favourable corrosion environment.

106. All the electrical equipment shall be designed and manufactured so that live parts cannot be accidentally touched, unless if supplied with a low safety voltage, and isolated by means of gangways, protections or other adequate device in such a way as to avoid the risk of staff injured in service.

107. Electrical equipment exposed to the weather or installed in areas subject to salt contamination, spills or other moisture are to be watertight or effectively protected by watertight enclosure, without this procedure implying the submission of the equipment to temperatures higher than those for which they were designed.

108. In principle, the rotating machinery is to be installed horizontally with its rotation shaft along the longitudinal direction of the unit. When impractical, if installed across or vertically the designis to ensure that the bearings are adequate to operate satisfactorily in the specified rotation and the lubrication system able to absorb shocks or vibration under any operating condition.

109. The design and assembly of electrical equipment on board shall take into account the accessibility of the parts that need maintenance, repair and inspection.

110. Live parts are to be effectively protected to prevent injury from contact in the case of nominal voltage ≥ 250 V DC or≥ 150 V AC.

111. Insulation materials and insulation of windings are to be resistant to moisture, salt contamination and oily fumes unless effective precautions are taken for protection against these agents.

112. All the bolts and nuts applied in energized connections or working parts are to be effectively locked or wire locked to avoid loosing or giving off when subjected to vibrations.

113. Soldered terminals are to have length equal to, at least 1.5 times the diameter of the conductor.

200. Spacing tolerances

201. The spacing between live parts and between live parts and earthed metallic parts are to be adequate to the working voltage, taking into consideration the nature of the insulation material and transient over-voltage developed by switches and abnormal failure conditions.

202 The minimum clearanceand creepagedistances between exposed metal parts and internal leakage current to the terminals' box of rotating machinesare to be measured.

203. The minimum clearance and creepage distances between main distribution bars and main and emergency electrical and non-isolated metal parts, as well as exposed conductive parts are to be measured.

D2. FACILITIES

100. Location of switchboards

101. Switchgear and controlgear assemblies shall be installed in easily accessible and well-ventilated locations where high humidity, combustible gases, acid vapours or

similar do not occur, and shall be located well clear of heat sources such as boilers, heated oil tanks, steam exhaust pipes or other heated pipes.

102. Power distribution switchgear assemblies shall have enough free space above to allow hot gasses expansion from arc generated by short-circuit or circuit-breaker opening, according to manufacturer's recommendation. In this space the installation of HVAC ducts, cable ladders and any other obstructions shall be avoided.

103. All switchgear and control gear assemblies shall be so installed that no pipes or tanks are above them within the same space or at their rear. Where this is unavoidable, pipes shall be continuous and without openings in such locations. In addition a drip pan shall be installed for protection of the switchgear and control gear.

104. Where switchgear and control gear assemblies are located in dedicated rooms, pipes or conduits for water, steam, gas, oil, etc., which are not related to the electrical equipment, are not permitted.

105. The main switchboard is to be installed in ventilated, dry place and out of areas with risk of explosion or near steam, water and oil pipes. There must be at least 900 mm of free and unobstructed area in front. When needed access and maintenance by the rear, this shall have a minimum clearance of 600 mm from adjacent areas or 450 mm from structure stiffeners (stanchions and frames). For nominal voltages exceeding 600 V, it is recommended to increase this space. In the case of the vicinity of oil or heated tanks, these distances will be reviewed particularly by the RBNA.

106. Passageways and corridors formed between switchboards line-ups should have escape way at both ends when longer than 6 m.

107. An unobstructed passageway extending not less than 1 m wide from the furthest projection shall be provided in front of any assemblies.

108. When an assembly contains withdrawable equipment, for example circuit-breaker and starter chassis, the unobstructed passageway shall not be less than 400mm wide with this equipment in its fully withdrawn position.

109. For small units, the unobstructed passageway may be reduced subject to agreement by the RBNA.

110. Separation of the parts that conduct earthing currents shall be provided. Unit structures with contact withdrawal of circuit breakers exposed to the air less than 300 mm are to have insulating barriers.

111. In front and behind of the electrical panel is to be placed carpet or isolated platform, extending along the length and width depending of the workspace.

112. Trays are to be installed on switchboards or where better located, when there is the possibility of damage due to leaks or falling objects.

113. When the voltage exceeds the extra-low voltage an insulating mat or grating shall be provided in front of switchgear and control gear assemblies and also at the rear, if accessible.

114. The insulating mat or grating shall be oil-resistant and non-slip.

115. If an assembly contains withdrawable equipment, the insulating mat or grating shall be provided in front of and on both sides of the equipment in its fully withdrawn position.

116. Removable mats for use only during repair and maintenance should be considered.

117. This requirement does not apply when the floor is made of an insulating layer.

118 Doors to rooms containing high-voltage switchboards shall be marked with suitable warning signs.

119. Doors to high voltage rooms shall be lockable. They shall open outwards from the room. They should be equipped with a manual panic device that can be opened at all time from the interior, e.g. a vertical bar or push-button operated device that is operable from inside the room by the use of the knee, elbow or other part of the body, also by a person who is crawling.

120. In accommodation spaces where open-type assemblies of section and distribution boards are surrounded by combustible material, a fire barrier of incombustible material shall be provided.

200. Cable installation

201. The cables are to be individually attached to beds or cable holders through straps of galvanized steel, copper, brass or anti-flame plastic.

202. The cables are to be installed and fixed in such a way that the mechanical stresses that may occur are kept within allowed limits. This concern is to be taken particularly for cables of conductor of small cross section, installed in long vertical stretches.

203. Conductors for electrical power circuits for essential or emergency service, lighting, internal communications or signals shall so far as possible, pass the farthest possible from galleys, laundries, machinery spaces of category A and of their ceilings or other high risk fire areas.

204. The installation of cables in conduits shall be avoided as much as possible. However, if conduits are required for

cable protection against mechanical damage, the following must be observed:

a. conduits and ducts are to be installed with enough trim and hole for drainage;

b. the cables can occupy a maximum of 40% internal section of conduit, and cable area, for this verification, calculated from the outer diameters of the cables;

c. long stretches in conduits are to be avoided and if necessary cable-passingboxes are to be installed.

205. Cables for high voltage, low voltage, control and instrumentation shall not be installed on the same cable ladders or trays. Where insufficient space makes this impossible, cables for low voltage, control and instrumentation may be installed on the same tray, but not in the same cable bunch.

206. A partition separator made of the same material as the cable tray should be installed on the tray or ladder if different types of cables are installed on the same tray or ladder.

207. Cable ladders installed horizontally shall have sufficient space to facilitate cable pulling and cleating/strapping, minimum 300 mm free space between top of one ladder edge to bottom of next ladder edge, and from top ladder edge to roof.

208. Trunking or conduits may be used for special mechanical protection of single field routed cables for shorter distances (maximum 5 m). Where conduits are used, they shall be installed with open ends.

209. Access for maintenance and an orderly layout shall be ensured. This is also valid when cables are installed below raised floor.

210. Once a cable has been cut, a protective cap/sealing shall be applied on the end, when being exposed to humid atmosphere.

211. All cable entries to equipment located outdoors, or in areas subject to fire fighting by water and in wash down areas shall be from below. Side entry may be used provided the cable is installed with a drip nose.

212. Sufficient cable spare length shall be provided for equipment that needs future adjustments (floodlights, loudspeakers, etc.) or where equipment has to be dismounted for maintenance and calibration without disconnecting the cable.

213. Single core cables for three-phase AC shall run in trefoil formation. All cables shall have the same length. The length of lay is to be equal for all cables. The braided armour shall be earthed in one end only. For equipment installed in hazardous areas, the braid shall be earthed at the hazardous end. When using single core cables, additional cables for earthing have to be installed.

214. Single core cables shall not be installed separately through openings surrounded by magnetic materials. Non-magnetic stainless steel separation walls and stay plates shall be used in multi cable transits utilised for single core cables.

215. All cables shall be marked for easy identification, at least on each end. The marking should indicate type of cable, i.e. high voltage, low voltage, control/instrumentation and consumer.

216. Cable-runs shall be selected so as to avoid action from condensed moisture or dripping water.

217. Cables shall, as far as possible, be routed out of, or far away from fire risk zone or fire risk equipment, be remote from sources of heat and protected from avoidable risks of mechanical damage.

218. In the case of essential electrical equipment for which it is mandatory to have at least two supplies, the supply and any associated control cables shall follow different routes, which shall be separated both vertically and horizontally as far as practical.

219. Cable-runs subject to green water (seawater waves boarding on the deck) shall be securely protected by pipes or equivalent.

220. Cable cleating and strapping – stainlesssteel straps shall be used for all runs outside, in non-ventilated areas, or for horizontal runs in the vertical plane indoors. When cut, no sharp ends shall be left in cutting end.

221. Plastic straps may be used for horizontal runs indoors.

222. Where cables are run on the underside of ladders or trays, or otherwise such that the cables could be released in a fire, stainless steel straps shall be used.

213. For strapping of fibre-optical and coaxial cables, supplier guidelines shall be adhered to.

214. The distance between supports shall be chosen according to the type of cable and the probability of vibration. It shall not exceed 400 mm for a horizontal cable run where the cables are laid on cable supports in the form of tray plates, separate brackets or hanger ladders. The spacing for the cable retention device may be up to 900 mm, provided that there are supports with maximum spacing as specified above.

215. Trefoil cable cleats for single core power cables shall be approved for the potential short circuit stress. Outdoors,

in naturally ventilated areas and wash down areas the cleats shall be made of stainless steel, AISI 316L or AISI 316.

216. The distance between trefoil cleats for single core cables shall be as specified by the cable manufacturer based on the calculated short circuit level.

217. Joints and tappings – cableruns shall not normally include joints (splices). If, in the case of repair or sectional construction of the unit, a joint is necessary, the joint shall be of such a type that electrical continuity, insulation, mechanical strength and protection earthing and fire-resisting or flameretardant characteristics are not less than those required for the cables.

218. Tappings (branch circuits) shall be made in enclosures of such design that the conductors remain adequately insulated and protected appropriate to the current rating.

219. Joints and tappings shall be clearly marked to identify the cable(s) and core(s).

220. For splicing of cables in hazardous areas, see IEC 61892-7.

221. Cable ends - cable glands/blanking and drain plugs shall be of a material which is compatible with the material used in the enclosure.

222. Cables passing through the deck or entering into compartments are not to harm the mechanical strength, watertightness and fire resistance of these areas, and shall be used cable glands that, preferably, will have the body welded to the deck or bulkhead.

300. Installation of accumulator batteries
[IACS UR E18, IACS UR M 61, IEC 61892-6]

301. Accumulator batteries are to be installed in uninhabited spaces, airy and sheltered, where are not exposed to excessive heat, low temperatures, humidity, spray, vapours or other conditions that may affect the performance or accelerate deterioration.They are to be installed, when fixed in decks, with a minimum height of 400 mm from the floor and arranged in such a way as to allow easy access for maintenance, cleaning and recharging.

302. Accumulator batteries are not to be installed in accommodation spaces, except if hermetically sealed and especially approved by the RBNA.

303 Batteries shall not be installed in hazardous area locations, except in rooms considered hazardous are solely by the presence of the batteries themselves. Batteries shall be located so that the vapours generated from the batteries cannot harm surrounding appliances.

304. Secondary cells and batteries connected to a charging device shall be installed dependent on the output power of the device (calculated from the maximum obtainable charging current and the nominal voltage of the battery), as given in Tables T.D2.304.1 and T.D2.304.2.

305. When a dedicated battery room, battery locker or battery box is required, only batteries and related equipment are allowed in the room/locker/box.

306. Secondary cells and batteries (with the exception of valve regulated type batteries with recharging power below 4 kW) shall not be placed in accommodation, office and control room areas.

307. VRLA batteries and alkaline secondary batteries shall not be placed in the same battery box or battery locker. When different electrolyte type batteries are located in the same room, precautions and warning labels shall be installed to avoid mixing of maintenance tools, electrolyte and topping up water.

308. A danger notice shall be permanently secured to doors or covers of battery compartments, lockers and boxes, indicating that any source of ignition in these rooms or in their vicinity is prohibited.

309. Electrical installation in secondary battery compartments –cables,with the exception of those pertaining to the battery or the battery compartment lighting, shall, as far as possible, not be installed in the battery compartments. If, however, such an installation is necessary, the cables shall have a protective covering resistant to the vapours developed by the electrolyte or shall be otherwise protected against these vapours.

310. Due to the risk of corrosion only equipment essential for the use of the battery room shall be installed inside the room, when a separate battery room is used. For requirements with respect to explosion protection of equipment inside the room, see IEC Publication 61892-7.

311. Valve regulated lead acid (VRLA) type batteries shall be designed for operation in a nominal ambient temperature of 25 °C.

312. VRLA type batteries should be installed in conditioned rooms with recommended average temperature between 20 °C to 25 °C, except for short periods of time operating in a different temperature range, to avoid lifetime shortening and thermal avalanche effect.

313. VRLA batteries shall have a charger with cell temperature compensation floating charge and shall not have boosting charge mode.

314. VRLA battery chargers shall have less than 1 % current ripple.

315. Sealed or VRLA type batteries should not be used for Diesel engine starting, like emergency generators or fire pumps.

316. The VRLA type of batteries is not suitable for rapid, high cycle discharging and recharging.

317. Protection against electric shock –measuresshall be taken in stationary battery installations for protection against direct contact and indirect contact or both. Battery assemblies shall have insulated caps for each pole and connector.

318. Protection by obstacles or by placing out of reach is expressly permitted in battery installations. It requires however that batteries with nominal voltages from 60 V DC to 120 V DC between terminals and/or with nominal voltages from 60 V DC to 120 V DC with respect to earth shall be located in boxes or cabinets with restricted access, and batteries with a nominal voltage above 120 V DC shall be located in locked cabinets or rooms with restricted access. Doors to battery rooms and cabinets are regarded as obstacles and shall be marked with the warning labels according with D2.323 to D2.326.

319. If protection by barriers or enclosures is applied, a degree of protection at least IP 2X or IPXXB according to IEC 60529 should at least be used.

320. A nominal touch voltage of 120 V DC should not be exceeded for direct and indirect contact (see IEC 61201).

321. Metallic boxes and metallic fixing supports shall be earthed.

322. Batteries with nominal voltages up to or equal 60 V DC do not require protection against direct contact, as long as the whole installation corresponds to the conditions for SELV (safety extra low voltage) or PELV (protective extra low voltage).

Note - Further guidance is given in IEC 61140.

323. The identification label or marking shall be durably fixed on each battery assembly unit and shall include the information as required in IEC 60896-11 and IEC 60623.

324. Each crate or tray shall be provided with a durable nameplate securely attached, bearing the manufacturer's name, the ampere-hour rating at a specific rate of discharge (preferably the one corresponding to the duty for the specific application), the voltage and the specific gravity of the electrolyte (in the case of a lead acid battery, the specific gravity when the battery is fully charged).

325. The nameplate shall also include reference to the systems supplied by the batteries, e.g. by using cell and battery number, tag number, identifying manufacturer and type, nominal battery voltage, capacity, electrolyte type and other relevant information.

326. At least the positive terminal shall be clearly identified, either by a red washer or by an indented or raised symbol.

TABLE T.D2.304.1 – LOCATION OF BATTERIES VERSUS CHARGING POWER – VENTED CELL TYPE

Charging Power	Location
Power above 2 kW	A dedicated battery room
Power between 0,2 kW and 2 kW	A dedicated battery room or a dedicated battery locker
Power below 0,2 kW	A dedicated battery room or a dedicated battery locker or battery box
When two or more batteries are grouped in the same room, locker or box, the sum of output power of all charging devices shall be considered. For ventilation requirements for battery rooms see IEC Publication 61892-7	

TABLE T.D2.304.2 – LOCATION OF BATTERIES VERSUS CHARGING POWER – VRLA OR SEALED CELL TYPE

Charging Power	Location
Power above 20 kW	A dedicated battery room
Power between 2 kW and 20 kW	A dedicated battery room, a dedicated battery box or open battery stand in an equipment room
Power between 0,2 kW and 2 kW	A separate battery room, a dedicated battery box or a dedicated part of an electrical assembly
Power below 0,2 kW	A dedicated battery room, a dedicated battery box or a dedicated part of and electrical assembly or inside and electrical assembly
When two or more batteries are grouped in the same room, locker, box or inside an electrical assembly, the sum of output power of all charging devices shall be considered. The above criteria are valid when the requirements of D2.311 to D2.316 are complied with. Otherwise, the requirement of Table T.G7.120.1 should be considered. For ventilation requirements for battery rooms see IEC Publication 61892-7	

400. Installation of electrical machinery

401. Generators and rotating machines shall be installed in dry and ventilated spaces out from nearby steam, water and oil pipes. To allow enough space for maintenance and accessibility in the removal of the rotor and, induced, must be mounted with 450 mm minimum clearance between sets and objects of adjacent areas.

402. Generators and motors shall, where practicable, be installed to minimize the effect of motion of the unit.

403.Generators shall be located in well-ventilated spaces where combustible gases cannot accumulate. This requirement does not preclude the installation of generators and prime movers in zone 2, provided sufficient precautions are taken with regard to ventilation and to explosion protection of equipment. For additional requirements for installations in hazardous areas, see Chapter K of this Section and IEC Publication 61892-7.

404. The spaces where electrical equipment is installed must have lighting according to the topic that follows.

500. Lighting installations

501. For dimensioning and uniform distribution of lighting of the spaces must be adopted the luminance values shown in standard ABNT NBR ISO/CIE 8995-1.

502. The spaces where electrical equipment is installed must have minimum luminance of 50 lux. and sufficiently ventilated for at least 2 air changes per hour. This is considered as standard and sufficient for the application, unless more appropriate luminance environment or a forced ventilation system is required.

503. The maximum spacing between luminaire centres must not be greater than 1.5 times the available height of the space and the clearance to the bulkhead of at least 0.75 times this height.

504. The fixtures must be installed so that it is maintained a minimum spacing of 5 mm between the base and the surface that will be fixed in order to allow for air circulation for cooling.

505. Depending on their location, luminaires shall as a minimum have the degree of protection and safety requirements given in IEC 61892-2.

506. Luminaries likely to be exposed to more than the ordinary risk of mechanical damage shall be protected against such shock or be of especially robust construction.

507. Floodlights shall be provided with an extra safeguarding against falling down if the screwed connections loosen.

508. Particular attention should be paid to the mechanical protection of luminaires located in or near landing areas where cranes are operating.

600. Emergency and escape lighting

601. Emergency lights and escape light fixtures shall be marked for easy identification. There shall be a clear difference between the two types.

602. The escape lights should, unless otherwise required, to the extent possible be located at a low level in confined spaces.

CHAPTER E
BASIC PRINCIPLES FOR DIMENSIONING

CHAPTER CONTENTS

E1. OPERATIONAL AND ENVIRONMENTAL CONDITIONS

100. Electric current conditions

101. Electric equipment, cables and accessories must be designed and constructed so to operate correctly under following conditions of electric current:

– maximum variation of a.c. voltage and frequency for distribution systems: see Table T.E4.203.1;

– maximum variation of d.c. voltage for distribution systems: see Table T.E4.203.2;

– maximum variation of voltage for battery systems: see Table T.E4.203.3.

200. Conditions of ambient temperatures

201. The standard ambient temperature to be considered is 40^0C. For machinery spaces and boilers the temperature is 45^0C with relative humidity average of 70% and seawater temperature of 32^0C.

202. For rotating electrical machinery installed in machinery spaces, it will be considered the standard ambient temperature of 50^0C.

203. Units employed in service out of tropical waters, the standard ambient temperature considered will be of 40^0C and seawater temperature of 25^0C.

204. In the case of ambient temperatures higher than the specified values, the temperature increase of the engine or equipment installed in the space will be reduced by the equivalent average excess temperature.

300. Ambient temperature for electrical equipment installed in environmentally controlled spaces [IACS UR E19]

301. Where electrical equipment is installed within environmentally controlled spaces the ambient temperature for which the equipment is to be suitable may be reduced from 45°C and maintained at a value not less than 35°C provided:

a. the equipment is not for use for emergency services.

b. temperature control is achieved by at least two cooling units so arranged that in the event of loss of one cooling unit, for any reason, the remaining unit(s) is capable of satisfactorily maintaining the design temperature.

302. In accepting a lesser ambient temperature than 45°C, it is to be ensured that electrical cables for their entire length are adequately rated for the maximum ambient temperature to which they are exposed along their length.

303. The equipment used for cooling and maintaining the lesser ambient temperature is to be classified as a secondary essential service, in accordance with IACS UI SC 134 and to be subject tosurvey in accordance with the requirements of RBNA.

400. Position conditions

401. All machinery, equipment and essential service devicesare to be designed and installed in such a way as to operate satisfactorily in permanent maximum inclinationsof:

- for column-stabilized units: 15º in any direction;

- for self-elevating units: 10º in any direction; or

- for surface units: 15º athwartships and 5º trimmed by bow or stern.

402. Inclining angles of roll or trim are to be considered which could occur simultaneously in most unfavourable combination of operation of the installation.

500. VibrationConditions

501. The natural frequencies of equipment and their foundations are to be kept within the permissible values. Where it is not possible to fix the vibrations by means of adequate construction techniques, the equipment is to be transferred to avoid unnecessary amplitudes.

E2. DEGREES OF PROTECTIONS

100. General conditions

101. Electrical equipment, cables and accessories are to be designed and built for services in the respective locations of installation, with adequate degree of protection of the enclosure against accidental contact, ingress of solid objects and harmful ingress of water, in accordance with the standard ABNT NBR IEC 60529. The minimum requirements are shown in RBNA Rules for the Construction and Classification of Ships, Table T.E2.101.1. –Minimum degrees of protection for electrical equipment enclosures.

102. Metallic enclosures, housings and all and any metal parts that can be touched and whose method of installation does not ensure a perfect grounding are to be earthed through specially installed conductors aimed to grounding and adequately protected against mechanical accidents that might interrupt this connection.

103. Depending on the application the RBNA may require that electrical equipment is to be protected against bad weather, being added the letter W to letters IP.

E3. CLASSES OF INSULATION

100. Characteristics

101. The definition of insulation classes and their respective temperature limits follows the Standard ABNT NBR 17094. They are the following.

a. **Insulation Class A:**Materials or combinations of materials such as cotton, silk and paper, when properly impregnated or covered or immersed in dielectric liquids such as oil. Other materials or combination of materials can be included in this class if they demonstrate operate continuously, through tests, at the temperature of 105^0 C.

b. **Insulation Class E:** materials or combination of materials that are able to demonstrate to operate continuously, through tests, at the temperature of 120^0 C.

c. I**nsulation Class B**: materials or combinations of materials such as mica, fiberglass, asbestos or other appropriate substances. Other materials or combination of materials can be included in this class if they demonstrate operate continuously, through tests, at the temperature of 130^0 C.

d. **Insulation class F**: materials or combinations of materials such as mica, fiberglass, asbestos or other appropriate substances. Other materials or combination of materials can be included in this class if they demonstrate operate continuously, through tests, at the temperature of 155^0 C

e. **Insulation class H:** materials or combinations of materials such as elastomeric compounds, mica, fiberglass, asbestos with binding substances as appropriate silicone resins. Other materials or combination of materials can be included in this class if they demonstrate operate continuously, through tests, at the temperature of 180^0 C.

200. Performance

201. The difference between the warmest and the average temperature of the electrical equipment in relation to the insulation class, considering the ambient temperature of 40°C, is not exceed the following values:

- insulation Class A: 5^0 C
- insulation Class E: 5^0 C
- insulation Class B: 10^0 C
- insulation Class F: 15^0 C**,**

E4. DISTRIBUTION SYSTEMS, VOLTAGES AND FREQUENCIES

100. Types of distribution systems

101. AC power: The following distribution systems can be used (for exemptions see E4.104):

a. three-phase three-wire with high-resistance earthed neutral

b. three-phase three-wire with low-resistance earthed neutral

c. three-phase three-wire with directly earthed neutral

d. three-phase three-wire with insulated neutral.

102. In addition for all voltages up to and including 500 V AC:

a. three-phase four-wire with neutral earthed, but without hull return

b. single-phase two-wire with insulated neutral

c. single-phase two-wire with one phase earthed at the power source, but without hull return.

103. DC power: The following distribution systems can be used (for exemptions see E4.104):

a. two-wire insulated

b. two-wire with one pole earthed at the power source (without hull return)

c. single-wire with hull return as accepted in E4.104.

104. Hull return systems

a. The hull return system of distribution shall not be used, except as stated in b) and c). [IEC61892-2 Item 6.1.1]

b. Provided that any possible resulting current does not flow directly through any gas hazardous spaces, the requirements of a) does not preclude the use of:

i. impressed current cathodic protective systems

ii. limited and locally earthed systems

iii. insulation level monitoring devices provided the circulation current does not exceed 30 mA under the most unfavourable conditions

iv. intrinsically safe circuits.

c. Where the hull return system is used for distribution of DC power, one of the busbars of the distribution board shall be connected to the hull. Outgoing final sub circuits i.e. all circuits fitted after the last protective device shall be with insulated two-wires or two-core cable.

200. Voltage and frequency variations
[IACS UR E5]

201. The voltage and frequency variations for a.c. / d.c. shall be measured.

202. All electrical appliances supplied from the main or emergency systems are to be so designed and manufactured that they are capable of operating satisfactorily under the normally occurring variations in voltage and frequency.

203. Unless otherwise stated in the national or international standards, all equipment shall operate satisfactorily with the variations from its rated value shown in the Tables T.E4.203.1, T.E4.203.2 and T.E4.203.3on the following conditions.

a. For alternative current components, voltage and frequency variations shown in the Table T.E4.203.1 are to be assumed.

b. For direct current components supplied by d.c. generators or converted by rectifiers, voltage variations shown in the Table T.E4.203.2 are to be assumed.

c. For direct current components supplied by electrical batteries, voltage variations shown in the Table T.E4.203.3 are to be assumed.

204. Any special system, e.g. electronic circuits, whose function cannot operate satisfactorily within the limits shown in the Tableshall not be supplied directly from the system but by alternative means, e.g. through stabilized supply.

TABLE T.E4.203.1: VOLTAGE AND FREQUENCY VARIATIONS FOR A.C. DISTRIBUTION SYSTEMS

Quantity in Operation	Variations	
	Permanent	Transient
Frequency	±5%	±10% (recovery time: 5 sec)
Voltage	+6%, -10%	±20% (recovery time: 1,5 sec)

TABLE T.E4.203.2: VOLTAGE VARIATIONS FOR D.C. DISTRIBUTION SYSTEMS

Parameters	Variations
Voltage tolerance (continuous)	±10%
Voltage cyclic variation deviation	5%
Voltage ripple (a.c. r.m.s. over steady d.c. voltage)	10%

TABLE T.E4.203.3: VOLTAGE VARIATIONS FOR BATTERY SYSTEMS

Systems	Variations
Components connected to the battery during charging (see Note)	+30%, -25%
Components not connected to the battery during charging	+20%, -25%
Note: Different voltage variations as determined by the charging/discharging characteristics, including ripple voltage from the charging device, may be considered.	

300. Primary and secondary systems

301. Primary systems are those powered directly by generators and secondary systems are powered by transformers or converters.

400. Harmonic distortion

401. The tolerance on the voltage waveform is not to exceed the following percentage values of harmonic distortion:

- simple harmonic distortion: 3%;
- total harmonic distortion: 5%.

E5. ESSENTIAL SERVICES

Guidance

IMO MSC/Circ.1176 represents a revised version of IACS UI SC134 ***Essential Services and Arrangements of Sources of Power, Supply, Control and Monitoring to the different Categories of Essential Services*** *(SOLAS Regulations II-1/40 & 41) which is shown in the present Part II, Title 11, Section 7, Chapter E, sub chapter E5.*

End of guidance

100. Classification of electrical services

101. Essential Services are those services essential for propulsion and steering, and safety of the unit, which are made up of "Primary Essential Services" and "Secondary Essential Services". Definitions and examples of such services are given in E5.200 and E5.300 below.

102. Services to ensure minimum comfortable conditions of habitability are those services such as defined in E5.400 below.

200. Primary Essential Services

201. Primary Essential Services are those services which need to be in continuous operation to maintain propulsion and steering. Examples of equipment for primary essential services are as follows:

- Steering gears
- Pumps for controllable pitch propellers
- Scavenging air blower, fuel oil supply pumps, fuel valve cooling pumps, lubricating oil pumps and cooling water pumps for main and auxiliary engines and turbines necessary for propulsion
- Forced draught fans, feed water pumps, water circulating pumps, vacuum pumps and condensate pumps for steam plants on steam turbine units, and also for auxiliary boilers on units where steam is used for equipment supplying primary essential services
- Oil burning installations for steam plants on steam turbine units and for auxiliary boilers where steam is used for equipment supplying primary essential services
- Azimuth thrusters which are the sole means for propulsion/steering with lubricating oil pumps, cooling water pumps
- Electrical equipment for electric propulsion plant with lubricating oil pumps and cooling water pumps

- Electric generators and associated power sources supplying the above equipment
- Hydraulic pumps supplying the above equipment
- Viscosity control equipment for heavy fuel oil
- Control, monitoring and safety devices/systems for equipment to primary essential services.
- Emergency shut down (ESD) system of an offshore unit.
- Fire pumps and other fire extinguishing medium pumps

300. Secondary Essential Services

301. Secondary Essential Services are those services which need not necessarily be in continuous operation to maintain propulsion and steering but which are necessary for maintaining the unit's safety. Examples of equipment for secondary essential services are as follows:

- Windlass
- Fuel oil transfer pumps and fuel oil treatment equipment
- Lubrication oil transfer pumps and lubrication oil treatment equipment
- Pre-heaters for heavy fuel oil
- Starting air and control air compressors
- Bilge, ballast and heeling pumps
- Fire pumps and other fire extinguishing medium pumps
- Ventilating fans for engine and boiler rooms
- Services considered necessary to maintain dangerous spaces in a safe condition
- Navigation lights, aids and signals
- Internal safety communication equipment
- Fire detection and alarm system
- Lighting system
- Electrical Equipment for watertight closing appliances
- Electric generators and associated power sources supplying the above equipment
- Hydraulic pumps supplying the above equipment
- Control, monitoring and safety systems for cargo containment systems
- Control, monitoring and safety devices/systems for equipment to secondary essential services.
- Jacking motors
- Water ingress detection and alarm system

400. Services for Habitability

401. Services for habitability are those services which need to be in operation for maintaining the unit's minimum comfort conditions for the crew. Examples of equipment for maintaining conditions of habitability are as follows:

- Cooking
- Heating
- Domestic refrigeration
- Mechanical ventilation
- Sanitary and fresh water
- Electric generators and associated power sources supplying the above equipment

500. SOLAS Regulations

501. Regulation II-1/40.1.1 and Regulation II-1/41.1.1 – Forthe purposes of these regulations, the services as included in items E5.200 to E5.400 are to be considered.

502. Regulation II-1/40.1.2 - For the purposes of this regulation, the services as included in items E5.200 and E5.300 and the services in the Regulation II-1/42 or II-1/43, as applicable, are to be considered.

503. Regulation II-1/41.1.2 - For the purposes of this regulation, the services as included in 4 items E5.200 to E5.400, are tobe considered.

504. Regulation II-1/41.1.5 - For the purposes of this regulation, the services as included in items E5.200, E5.300 and E5.400 are to be considered. See also IACS UI SC83.

505. Regulation II-1/41.5.1.2 - For the purposes of this regulation, the following interpretations are applicable.

1. Services in item E5.200 are not to be included in any load shedding or other equivalent arrangements.

2. Services in item E5.300 may be included in the automatic load shedding or other equivalent arrangement provided disconnection will not:

a.Cause immediate disruption of systems required for safety, e.g.:

- Lighting systems,
- Navigation lights, aids and signals,
- Internal safety communication equipment.

b.Prevent services required for safety being immediately available when the power supply is restored to normal operating conditions, e.g.:

- Bilge pumps,
- Ventilating fans for engine and boiler rooms.

Examples of equipment in the item E5.300, for which the automatic load shedding or other equivalent arrangement is normally allowed, includes:

- Fuel oil transfer pumps and fuel oil treatment equipment
- Lubrication oil transfer pumps and lubrication oil treatment equipment
- Pre-heaters for heavy fuel oil
- Starting air and control air compressors (except for control air compressors for propulsion control and its safety systems)

3. Services for habitability in the item E5.400 may be included in the automatic load shedding or other equivalent arrangement.

600. Electrical Services Required to be Operable Under Fire Conditions and Fire Resistant Cables [IACS UR E15]

601. Electrical services required to be operable under fire conditions are as follows:

- Control and power systems to power-operated fire doors and status indication for all fire doors
- Control and power systems to power-operated watertight doors and their status indication
- Emergency fire pump
- Emergency lighting
- Fire and general alarms
- Fire detection systems
- Fire-extinguishing systems and fire-extinguishing media release alarms
- Low location lighting
- Public address systems
- Remote emergency stop/shutdown arrangements for systems which may support the propagation of fire and/or explosion

602. Where cables for services specified in item E5.601 above including their power supplies pass through high fire risk areas, they are to be so arranged that a fire in any of these areas or zones does not affect the operation of the service in any other area or zone.

603. This may be achieved by either of the following measures:

a. Cables being of a fire resistant type complying with IEC 60331-31 for cables of greater than 20 mm overall diameter, otherwise 60331-21, are installed and run continuous to keep the fire integrity within the high fire risk area.

b. At least two-loops/radial distributions run as widely apart as is practicable and so arranged that in the event of damage by fire at least one of the loops/radial distributions remains operational.

604. Systems that are self monitoring, fail safe or duplicated with cable runs as widely separated as is practicable may be exempted.

605. Notes**:**

a. For the purpose of this Subchapter E5 – Item 600 application, the definition for “high fire risk areas” is the following:

(i) Machinery spaces as defined by Chap. II-2 / Reg. 3.30 of SOLAS.

(ii) Spaces containing fuel treatment equipment and other highly flammable substances

(iii) Galley and Pantries containing cooking appliances

(iv) Laundry containing drying equipment

b. Fire resistant type cables shall be easily distinguishable.

c. For special cables, requirements in the following standards may be used:

IEC60331-23: Procedures and requirements – Electric data cables
IEC60331-25: Procedures and requirements – Optical fibre cables

CHAPTER F
DESIGN AND CONSTRUCTION OF ELECTRIC POWER GENERATION SYSTEM

CHAPTER CONTENTS

F1. ELECTRICALLOAD ANALYSIS

100. Criteria

101. An electric load analysis is to be submitted to the RBNA. The load analysis for the electric plant, including transformers or converters for high voltage drilling unit main service shall cover all operating conditions of the drilling unit, including normal seagoing (if applicable) and emergency operations.

102. In the preparation of the electricalconsumption analysis that serves as input to the dimensioning of the generators, transformers, converters, batteries and associated chargers, the following criteria are to be adopted:

a. each consumer equipment is to be listed individually with an indication of the rated load and demand factor;

b. concurrency factors to be considered for temporary loads groups are to be clearly indicated;

c. equipment in stand which only operate when their respective main equipment are shutdown are to be listed even though they are not computed in the calculation of demand;

d. to the maximum estimated demand obtained from the above criteria, is to be applied, where appropriate, a safety factor to cover peak loads of short duration and thus obtain the minimum capability of the generating system or batteries.

103. In the dimensioning of the ability of generating sets, shall be taken into account the starting up of high-rated

engines or of two or more motors simultaneously, so that as a result of a voltage drop higher than permissible limits for operation in steady state may cause operational disturbances in control and protection equipment, or even cause the shutdown of other engine in operation, in addition to affecting the performance of the lighting system.

F2. DIRECT CURRENT GENERATORS

100. Unbalance load on three wired a.c. generators

101. Unless otherwise specified, all three wire d.c.generators shall be designed for a current unbalance of 25%.

200. Voltage regulation

201. The inherent voltage regulation of a general service generator shall be designed in relation to the speed regulation and governing of the prime movers as outlined below.

Note – General Service means that supplying motors and other consumers are a part of the normal distribution system of the unit. Consumers such as propulsion motors and other special consumers, for which other governing characteristics can be accepted or are required, are not considered part of the general service.

300. Shunt or stabilized shunt-wound generators

301. Shunt or stabilized shunt-wound generators rated at 50 kW and above shall comply with the following requirements:

a. when the voltage has been set at full load to its rated value, the removal of the load shall not cause a permanent increase of the voltage greater than 15% of the rated voltage.

b. when the voltage has been set either at full load or at no load, the voltage obtained at any value of the load shall not exceed the no-load voltage.

400. Compound-wound generators

401. Compound-wound generators rated at 50 kW and above shall be so designed in relation to the governing characteristics of the prime-mover that, with the generator at full-load operating temperature and starting at a 20% load with voltage within 1% of the rated voltage, it gives at full load a voltage within 1,5% of the rated voltage.

402. The average of ascending and descending voltage regulation curves between 20% load and full load shall not vary by more than 3% from the rated voltage.

500. Other types of generators

501. Generators required to have characteristics not covered by F2.300 and F2.400 are subject to special consideration.

600. Automatic voltage regulation for d.c. service generators

601. General Service generators which are of the shunt type shall be provided with automatic voltage regulators.

[IEC 61892-3]

F3. ALTERNATE CURRENT GENERATORS

100. Specific conditions

101. The alternators are to be appropriately designed so that the apparent power delivered to the systemshallbe sufficient to avoid undesired voltage falls due to the startingup of motors. In no event the starting of motors of highstarting current may cause voltage drop in the system that result in shutdown or flickering of consumers in operation.

102. The shape of the curve of voltage in empty load is to be as sinusoidal as possible, being so that the deviations shall not be larger than 5% of the peak value of the fundamental sine curve. The effective values of the phase-neutral voltage of three-phase generators shall not differ more than 0.5 % between each other under conditions of balanced load- between phases.

103. The alternators and excitation systems must be dimensioned in such a way as to be able to operate without damage for two minutes, with 150 % of their rated currents with delayed power factor (inductive) equal to 0.5 and with rated voltage maintained.

104. The excitation system of a.c. generators rated 50 kW and above, and complying with F2.904, shall also comply with the requirements given below.

200. Voltage regulation

201. The inherent voltage regulation of a general service generator shall be designed in relation to the speed regulation and governing of the prime movers as outlined below.

Note – General Service means that supplying motors and other consumers are a part of the normal distribution system of the unit. Consumers such as propulsion motors and other special consumers, for which other governing characteristics can be accepted or are required, are not considered part of the general service.

300. Steady conditions: tolerance of voltage and wave form

301. Each a.c. generator for general service driven by its prime-mover, whose governor characteristics comply with IEC Publication 61892-3, shall be provided with an excitation system capable of maintaining the voltage under steady conditions within +/-2.5% of the rated voltage for all loads between zero and rated load at the rated power factor. These limits may increase to +/-3.5% for emergency sets (see F2.600).

302. When the generator is driven at rated speed, giving the rated voltage and rated symmetrical load, the tolerance of waveform shall not exceed the values listed below:

- total harmonic distortion: 5%;
- single harmonic: 3%.

Note – attention is drawn to the possibility that under certain operating conditions the power factor may be less than the rated value, and that this can affect the voltage regulation.

400. Transient conditions

401. When the generator is driven at rated speed, giving its rated voltage, and is subject to a sudden change of symmetrical load within the limits of a specific current and power factor, the voltage shall not fall below 85% nor exceed 120% of the rated voltage.

402. The voltage of the generator shall then be restored to within +/-3% of the rated voltage., for the main generator is set in no more than 1,5 s. For emergency sets these values may be increased to +/-4% in no mre than 5 s respectively.

403. In the absence of precise information concerning the maximum values of the sudden loads, the following conditions shall be assumed: 60% of the rated current with a power factor of between 0,4 lagging and 0 to be thrown on with the generator running at no load, and then withdrawn after steady-state conditions have been reached.

Note 1 – for the purpose of verifying the above conditions, the generator under test may be driven by a suitable electric motor at practically constant speed.

Note 2 – to achieve satisfactory performance on board a unit, the governor of the prime-mover must restore the speed to a steady state within the limits specified in IEC Publication 61892-3in no more than 3 s.

Note 3 – For gas-driven machines and turbines, other values may be applicable. See ISO Publication 8528-5

500. Steady short-circuit conditions

501. Under steady short-circuit conditions, the generator with its excitation system shall be capable of maintaining a current of at least three times its rated value for a duration of up to 2 s, unless protection selectivity conditions exist which allow a shorter duration and provided that, in any case, the safety of the installation is assured.

600. Emergency generators

601. Emergency generator sets which are required to meet the same general requirements as in F2.400 need only maintain the steady-state voltage within 3,5%, and during transient conditions to recover their voltage within 4% in not more than 5 s.

700. Parallel operation of general service generators – DC generators

701. Stability – DCgenerators which are required to run in parallel shall be stable in operation at all loads from no load to full load.

702. Load sharing – thedesign of d.c. generators and their connections shall be such that, when they operate in parallel, the individual load on each machine does not normally differ from the theoretical load (proportional to rating) by more than 12% of the rated full load of the largest machine, or more than 25% of the rating of the individual machine concerned. This requirement applies when the combined load on the sets is varied between 20% and 100% of the combined rating. Such a load sharing shall not result in overloading the smaller set.

703. Voltage drop – foreach generator of a group required to run in parallel, the voltage drop across the series fields and its connection to the switchboard (which may incorporate a resistor) shall be approximately equal.

800. Parallel operation of general service generators – AC generators

801. Reactive load sharing – whena.c. generators are operated in parallel, the reactive load on the individual generating sets shall not differ from their proportionate share of the total reactive load by more than 10% of the rated output of the largest machine, or more than 25% of the smallest machine where this value is lower than the former.

Note – the alternator design should incorporate sufficient damping in the rotor circuits to avoid power oscillations and instability when running in parallel.

802. Load sharing: for a.c. generating sets operating in parallel, the governing characteristics of the prime-movers shall be such that, within the limits of 20% and 100% total load, the load of any generating set does not normally differ from its proportionate share of the total load by more than

15% of the rated output of the largest machine, or more than 25% of the rating of the individual machine concerned.

803. The facilities for adjusting the governor at normal frequency shall be sufficiently accurate to permit a minimum adjustment of the load on the engine not exceeding 5% of the rated load (see also Note 2 at F2.403).

Note – It is assumed that the speed of the prime-mover decreases with the application of the load and increases with its removal, permanent variation being such that the speed does not at any load vary from the straight line joining rated load and no load by more than one-fifth of the maximum permanent speed variation involved.

(IEC 61892-3)

900. Control and excitation of generators

901. Field regulation of d.c. generators – meansshall be provided to enable the voltage of each generator to be adjusted separately. The equipment provided shall be capable of adjusting the voltage of the d.c. generator to within 0,5% of the rated voltage for machines above 100 kW and 1% of the rated voltage for smaller machines, at all loads between no load and full load, with the d.c. generator coupled to its prime mover at any permissible temperature within the working range. The regulator shall be capable of reducing the no-load voltage to 10% below the voltange when the generator is cold.

902. Polarity of series windings – theseries windings of each two-wire generator shall be connected to the negative terminal of each machine.

903. Equalizer connections – eachequalizer connection shall have a cross-sectional area not less than half that of the negative connection from the generator to the switchboard.

904. Excitation of a.c. generators – thecomponents of the excitation system, including the automatic voltage regulator if used, shall be of a type suitable for offshore conditions and shall be capable of operating under all specified conditions of steady and transient load, including short circuit, as stated in F2.300, F2.400 and F2.500.

905. When it is intended to operate two or more generators in parallel, means shall be provided to divide the reactive power properly between the generators (see F3.801).

Note – It is desirable to ensure that failure of the excitation system (including the automatic voltage regulator if used) does not cause damage to the installation.

F4. MAIN SOURCE OF ELECTRICAL POWER AND LIGHTING SYSTEMS

100. Main source of electrical power

101. Every unit shall be provided with a main source of electrical power with sufficient capability to supply all the services mentioned in E5.101 and E5.102 above except for power servicing drilling operations, in the event of any one of these generating sets being stopped. This source consists of at least two generator sets.

102. Additionally, the generator sets are to be so arranged that, with any one of the generators or their primary sources of energy out of operation, the remaining generator set is capable of supplying the electric utilities needed to start up the main propulsion plant from the “dead ship condition”.

103. Where transformers or converters constitute an essential part of the supply system, the system shall be so arranged as to ensure the same continuity of the supply as stated in F4.101.

104. In the duplication of services, being one driven electrically and another non-electrically (for example, the main lubricating oil pump driven by the main motor and the stand by lube oil pump powered by electric motor), its electric capacity will not be included in the calculations for dimensioning.

105. The main electric lighting system which is to provide illumination of those parts of the unit normally accessible to and of use of the passengers or crew is to be supplied from the main source of electrical energy.

107. The main source of electrical power shall comply with the following:

a. Where the electrical power can normally be supplied by one generator, suitable load-shedding arrangements shall be provided to ensure the integrity of supplies to services required for propulsion and steering as well as the safety of the unit.

b. In the case of loss of the generator in operation, adequate provision shall be made for automatic starting and connecting to the main switchboard of a stand-by generator of sufficient capacity to ensure safe navigation when underway and to ensure the safety of the unit with automatic restarting of the essential auxiliaries including, where necessary, sequential operations.

c. RBNA may dispense with these provisions where the power necessary to ensure the functioning of the service referred to in A1.201.a, except for power servicing drilling operations, is 250 kW or less.

d. If the electrical power is normally supplied by more than one generator simultaneously in parallel operation, provision shall be made, for instance, by load shedding to ensure that, in case of loss of one of these generating sets, the remaining ones are kept in operation without overload to ensure safe navigation when underway and to ensure the safety of the unit.

e. Where the main source of electrical power is necessary for propulsion of the unit, the main busbarshall be subdivided into at least two parts which shall normally be connected by circuit breakers or other approved means; so far as is practicable, the connection of generating sets and other duplicated equipment shall be equally divided between the parts.

108. Where the total installed electrical power of the generator sets is greater than 3 MW, the main bus shall be subdivided into at least two parts, which shall normally be connected by removable links or other approved means; as far as practicable, the connection of the generator set and of any other duplicate equipment shall be equally divided between the parts. Equivalent arrangements are permitted, to the satisfaction of the RBNA.

F5. EMERGENCY SOURCE OF ELECTRICALPOWER
[MODU Code]

100. Emergency source of electrical power

101. Every unit shall be provided with a self-contained emergency source of electrical power.

102. The emergency source of power, the transitional source of emergency power and the emergency switchboard shall be located above the worst damage waterline and in a space not within the assumed extent of damage referred to in Part II, Title MODU, Section 1, Chapter H, and be readily accessible. They shall not be forward of the collision bulkhead, if any.

103. The location of the emergency source of power, the transitional source of emergency power and emergency switchboard in relation to the main source of electrical power shall be such as to ensure to the satisfaction of the RBNA that a fire or other casualty in the space containing the main source of electrical power or in any machinery space of category A will not interfere with the supply or distribution of emergency power. As far as practical, the space containing the emergency source of power, the transitional source of emergency power and the emergency switchboard shall not be contiguous to boundaries of machinery spaces of category A or of those spaces containing the main source of electrical power. Where the emergency source of power, the transitional source of emergency power, and the emergency switchboard are contiguous to the boundaries of machinery spaces of category A or to those spaces containing the main source of electrical power, or to spaces of zone 1 or zone 2, the contiguous boundaries shall be in compliance with Part II, Title MODU, Section 3, Subchapter E2.

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

105. For units where the main source of electrical power is located in two or more spaces which have their own systems, including power distribution and control systems, completely independent of the systems in the other spaces 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 under paragraph F5.106, the provisions of paragraph F5.101 may be considered satisfied without an additional emergency source of electrical power, provided that the RBNA is satisfied that:

a. there are at least two generating sets, meeting the provisions of paragraph F5.115 and each of sufficient capacity to meet the provisions of paragraph F5.106, in each of at least two spaces;

b. the arrangements under paragraph F5.105.a. in each such space are equivalent to those under paragraphs F5.108, F5.111, F5.114 and F5.200 so that a source of electrical power is available at all times to the services under paragraph F5.106;

c. the location of each of the spaces referred to in paragraph F5.105.a. is in compliance with paragraph F5.102 and the boundaries meet the provisions of paragraph F5.103 except that contiguous boundaries shall consist of an “A-60” bulkhead and a cofferdam, or a steel bulkhead insulated to class “A-60” on both sides.

106. The 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 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:

a. For a period of 18 h, emergency lighting:

   i. at every embarkation station on deck and over sides;

ii. in all service and accommodation alleyways, stairways and exits, personnel lift cars, and personnel lift trunks;

iii. in the machinery spaces and main generating stations including their control positions;

iv. in all control stations and in all machinery control rooms;

v. in all spaces from which control of the drilling process is performed and where controls of machinery essential for the performance of this process, or devices for emergency switching-off of the power plant are located;

vi. at the stowage position or positions for fire-fighters' outfits;

vii. at the sprinkler pump, if any, at the fire pump referred to in paragraph F5.106.e., at the emergency bilge pump, if any, and at their starting positions;

viii. on helidecks, to include perimeter and helideck status lights, wind direction indicator illumination, and related obstruction lights, if any;

b. For a period of 18 h, the navigation lights, other lights and sound signals, required by the International Regulations for the Prevention of Collisions at Sea, in force;

c. For a period of four days signalling lights and sound signals required for marking of offshore structures;

d. For a period of 18 h:

i. all internal communication equipment that is required in an emergency;

ii. fire and gas detection and their alarm systems;

iii. intermittent operation of the manual fire alarms and all internal signals that are required in an emergency; and

iv. the capability of closing the blow-out preventer and of disconnecting the unit from the well-head arrangement, if electrically controlled;

v. unless they have an independent supply from an accumulator battery suitably located for use in an emergency and sufficient for the period of 18 h;

e. For a period of 18 h, one of the fire pumps, if dependent upon the emergency generator for its source of power;

f. For a period of at least 18 h, permanently installed diving equipment, if dependent upon the unit's electrical power;

g. On column-stabilized units, for a period of 18 h:

i. ballast control and indicating systems under Part II Title MODU, Section 6, Subchapter F3; and

ii. any of the ballast pumps under paragraph Part II Title MODU, Section 6, F3.103; only one of the connected pumps need be considered to be in operation at any time;

h. For a period of half an hour:

i. power to operate the watertight doors as provided under Part II, Title MODU, Section 1, paragraph H2.201.a., but not necessarily all of them simultaneously, unless an independent temporary source of stored energy is provided; and

ii. power to operate the controls and indicators provided under Part II, Title MODU, Section 1, paragraph H2.201.a..

107. The emergency source of power may be either a generator or an accumulator battery.

108. Where the emergency source of power is a generator it shall be:

a. driven by a suitable prime mover with an independent supply of fuel, having a flashpoint of not less than 43°C;

b. started automatically upon failure of the normal electrical supply unless a transitional source of emergency power in accordance with paragraph F5.108.c. is provided; where the emergency generator is automatically started, it shall be automatically connected to the emergency switchboard; those services referred to in paragraph F5.110 shall then be connected automatically to the emergency generator; and unless a second independent means of starting the emergency generator is provided, the single source of stored energy shall be protected to preclude its complete depletion by the automatic starting system; and

c. provided with a transitional source of emergency power, as specified in paragraph F5.110, unless the emergency generator is capable of supplying the services mentioned in paragraph F5.110 and of being automatically started and supplying the required load as quickly as is safe and practicable but in not more than 45 s.

109. Where the emergency source of power is an accumulator battery it shall be capable of:

a. carrying the emergency load without recharging while maintaining the voltage of the battery throughout the discharge period within plus or minus 12% of its nominal voltage;

b. automatically connecting to the emergency switchboard in the event of failure of the main power supply; and

c. immediately supplying at least those services specified in paragraph F5.110.

110. The transitional source or sources of emergency power, under paragraph F5.108.c., shall consist of an accumulator battery suitably located for use in an emergency, which shall operate without recharging whilst maintaining the voltage of the battery throughout the discharge period within plus or minus 12% of 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 the emergency source of power, the following services for half an hour at least if they depend upon an electrical source for their operation:

a. the lighting under paragraphs F5.106.a. and F5.106.b. For this transitional phase, the required emergency lighting, in respect of the machinery space and accommodation and service areas, may be provided by permanently fixed, individual accumulator lamps which are automatically charged and operated;

b. all essential internal communication equipment under paragraphs F5.106.d.i. and F5.106.d.ii.; and

c. intermittent operation of the services referred to in paragraphs F5.106.d.iii. and F5.106.d.iv.,

d. unless, in the case of paragraphs F5.110.b. and F5.110.c., they have an independent supply from an accumulator battery suitably located for use in an emergency and sufficient for the period specified.

111. The emergency switchboard shall be installed as near as is practicable to the emergency source of power and, where the emergency source of power is a generator, the emergency switchboard shall preferably be located in the same space.

112. No accumulator battery fitted to meet the provisions for emergency or transitional power supply shall be installed in the same space as the emergency switchboard, unless appropriate measures to the satisfaction of the RBNA are taken to extract the gases discharged from the said batteries. An indicator shall be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries constituting either the emergency source of power or the transitional source of power, referred to in paragraphs F5.109 or F5.110, are being discharged.

113. The emergency switchboard shall be supplied in normal operation from the main switchboard by an interconnector feeder which shall be adequately protected at the main switchboard against overload and short circuit. The arrangement at the emergency switchboard shall be such that the interconnector feeder is disconnected automatically at the emergency switchboard upon failure of the main power supply. Where the system is arranged for feedback operation, the interconnector feeder shall also be protected at the emergency switchboard at least against short circuit.

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

115. The emergency generator and its prime mover and any emergency accumulator battery shall be designed to function at full rated power when upright and when inclined up to the maximum angle of heel in the intact and damaged condition, as determined in accordance with Part II, Title MODU, Section 1, ChapterH. In no case need the equipment be designed to operate when inclined more than:

a. 25° in any direction on a column-stabilized unit;

b. 15° in any direction on a self-elevating unit; and

c. 22.5° about the longitudinal axis and/or when inclined 10° about the transverse axis on a surface unit.

116. Provision shall be made for the periodic testing of the complete emergency system. This shall include the testing of transitional sources and automatic starting arrangements.

200. Starting arrangements for emergency generators

201. Emergency generators shall be capable of being readily started in their cold condition down to a temperature of 0°C. If this is impracticable, or if lower temperatures are likely to be encountered, consideration shall be given to the provision and maintenance of heating arrangements, acceptable to the RBNA, so that ready starting will be assured.

202. Each emergency generator which is arranged to be automatically started shall be equipped with starting arrangements acceptable to the RBNA with a storage energy capability of at least three consecutive starts. A second source of energy shall be provided for an additional three starts within 30 min unless hand (manual) starting can be demonstrated to be effective.

203. Provision shall be made to maintain the stored energy at all times.

204. Electrical and hydraulic starting systems shall be maintained from the emergency switchboard.

205. 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 energized by the emergency switchboard.

206. All of these starting, charging and energy storing devices shall be located in the emergency generator room; these devices shall not be used for any purpose other than the operation of the emergency generator set. This does not preclude the supply to the air receiver of the emergency generator set from the main or auxiliary compressed air system through a non-return valve fitted in the emergency generator room.

207. When automatic starting is not required by these provisions and where it can be demonstrated as being effective, hand (manual) starting is permissible, such as manual cranking, inertia starters, manual hydraulic accumulators, or powder cartridges.

208. When hand (manual) starting is not practicable, the provisions in paragraphs F5.202 and F5.203 to F5.206 shall be complied with, except that starting may be manually initiated.

F6. TRANSFORMERS
[API RECOMMENDED PRACTICE 14F]
[IEEE Std 45]

100. Transformers

101. Power transformers typically are used on offshore units to provide various transmission andutilization voltage levels.

102. Power transformers shall be designed and constructed in accordance ANSI C57 or IEC 60726 standards as a minimum.

103. In addition to power transformers, small control transformers are frequently utilized in control circuits.

104. Instrument transformers and both potential transformers (PTs) and current transformers (CTs) are frequently utilized for instrumentation circuits.

105. The following features shall be considered for offshore facilities:

106. For dry transformers:

a. nonventilated enclosures (TENV) are recommended for outdoor locations, but ventilated enclosures (TEV) aresuitable for most indoor locations;

b. flexible, multistrand copper primary and secondary lead wires with high-temperature insulation that is resistive tothe corrosive effects of salt water and alkaline mud;

c. Class H insulating material;

d. full load temperature rise not exceeding 115°C;

e. vacuum pressure impregnated (VPI) core and coil.

107. Copper coil material. (If aluminum coils are utilized, special precautions shall be taken at terminations.)

108. Permanently attached nameplates of corrosion resistant material - it is recommended that the nameplatesprovide the connection diagram, the name of the manufacturer, rated kilovolt-amperes, frequency, primary andsecondary voltages, percent impedance, class of insulation, and the temperature rise for the insulation system.

109. High-quality exterior coating for the entire enclosure, including mounting brackets and other peripheralcomponents, to resist corrosion, unless the components are of corrosion-resistant materials.

110. For liquid-filled transformers, the following:

a. It is recommended that permanently attached nameplates provide the connection diagram, the name of themanufacturer, rated kilovolt-amperes, frequency, primary and secondary voltages, percent impedance, and thetemperature rise for the insulation system.

b. High-quality exterior coating for the entire enclosure, including mounting brackets and other peripheralcomponents, to resist corrosion, unless the components are of corrosion-resistant materials.

c. Full load temperature rise not to exceed 55°C OA

d. Low oil-level indication/alarm.

e. High oil-temperature indication/alarm.

f. Gas-actuated protection device.

g. High gas pressure

h. Field replaceable cooling fin assemblies, if provided with cooling fins. Replaceable cooling fin assemblies made ofpainted 304 stainless steelshall be considered.

i. Where aluminum windings are utilized, the winding to terminal pad connection shall be oil-immersed.

200. Transformer types

201. For most typical offshore installations, dry-type, self-cooled transformers usually are more practical for sizes through 112.5 kVA at 600 Volts. Voltage ratings may be increased to 5,000 Volts with sound engineering.

202. When installed indoors, transformers are preferably of the dry type, self-cooled type.

203. Dry type transformers shall have copper windings, be air cooled by natural circulation, and have a dripproof enclosure as a minimum. Where used for essential services and located in areas where sprinkler heads or spraying devices for fire prevention are fitted, they shall be enclosed so that water cannot cause malfunction.

204. In cases in which capacity, space, or other restrictions warrant, transformers may be of the immersed (nonflammable liquid), self-cooled, or other suitable type. Immersed type transformers shall be suitable for operation at 40° inclination without leakage and provided with a liquid level gauge to give indication of the level of liquid. Drip tray(s) or other suitable arrangements shall be provided for collecting liquid leakage.

205. Liquid-filled, self-cooled transformers usually are more practical for higher voltages and larger kVA capacities.

206. For some applications, high fire point liquid-insulated transformers shall be considered.

207. All transformers shall be capable of withstanding the thermal and mechanical effects of a shortcircuit at the terminals of any winding for 2 s without damage. Foil-wound transformers constructed of conductors that are uncoated shall be vacuum impregnated. Transformers shall comply with ANSI C57 or IEC 60726, as applicable to the type, size, application, and voltage rating of the units installed.

300. Installation and location

301. Transformers shall be located in dry, well-ventilated places, avoiding exposure to the possibility of leaking pipes or condensation.

302. Transformers shall be placed so that, insofar as practicable, they are not exposed to mechanical damage. Transformers shall be located and mounted to preclude excessive noise in accommodation areas.

303. Suitable lifting lugs or eye bolts shall be provided for transformers weighing more than 50 kg.

400. Type, number, and rating

401. The number and rating of transformers supplying services and systems essential to the safety or propulsion of the unitshall have sufficient capacity to ensure the operation of those services and systems even when one transformer is out of service.

402. Transformers shall be either the three-phase type or the single-phase type, suitable for connection in a three-phase bank, with a Class B temperature rise.

403. All distribution and control transformers shall have isolated primary and secondary windings.

404. Transformers with electrostatic shielding between windings shall be used in distribution systems containing nonlinear load devices.

405. Autotransformers shall be used only for reduced voltage motor starting or other suitable special applications.

500. Voltageregulation

501. The inherent voltage regulation of transformers, at rated output, shall be such that the maximum voltagedrop to any point in the system in which the transformers are applied does not exceed the system voltage drop values.

600. Parallel operation

601. Transformers for parallel operation shall have coupling groups and voltage regulation characteristics thatare compatible. The actual current of each transformer operating in parallel shall not differ from its proportional share of the load by more than 10% of full load current. A means of isolating the secondary connections shall be provided.

700. Temperature rise

701. The limits of temperature rise in a 40 °C ambient shall be in accordance with Table T.F6.701.1.

TABLE T.F6.701.1 – LIMITS OF TEMPERATURE RISE IN A 40°C AMBIENT

Copper temperature rise by resistance (°C)					Hottest spot temperature rise (°C)			
Class of insulation								
Part	A	B	F	H	A	B	F	H
Insulated windings	55	80	115	150	65	110	145	180
Note: metallic parts in contact with or adjacent to simulation shall not attain a temperature in excess of the allowed for the hottest spot copper temperature adjacent to that insulation.								

702. Transformers shall also be designed to operate in an ambient temperature of 50 °C without exceeding the recommended total hot spot temperature, provided the output kilovoltampere at rated voltage does not exceed 90% of the rated capacity of the transformer with Class A

insulation and 94% of the rated capacity of a transformer with Class B insulation.

800. Terminals and connections

801. Provision shall be made to permit the ready connection of external cables to the primary and secondaryleads in an enclosed space of adequate size to prevent overheating. Terminals shall be readily accessiblefor inspection and maintenance.

F7. SEMICONDUCTOR CONVERTERS [IEC 61892-3]

100. General

101. The provisions of this clause are applicable to static converters using semiconductor rectifying elements such as diodes, reverse blocking triode thyristors, transistors, etc. for use in offshore units. The conversion may be from a.c. to d.c., from d.c. to a.c., from d.c. to d.c. and from a.c. to a.c.

102. Semiconductor converters shall comply with the relevant requirements of IEC 60146 Series, as well as with the additional requirements given in these Rules.

200. Cooling arrangements

201. Semiconductor converters shall preferably be of dry, air-cooled type.

202. Semiconductor converters of the liquid-immersed type shall preferably be hermetically sealed. If provision is made for breathing, a suitable dehydrator shall be provided.

203. Liquid immersed semiconductor devices shall use a non-toxic coolant, which does not combust easily. Consideration shall be given to the provision of a liquid over-temperature alarm and gas actuated protection devices.

Note – where a cooling medium for electrical equipment is used, consideration should be given to the detection of leakage in an equipment enclosure and provision of an alarm indication. In addition, the flow of coolant should be monitored to operate an alarm in the event of loss of flow.

300. Installation

301. Where semiconductor converter stacks or equipment are air-cooled, they shall be installed in such a manner that the circulation of air to and from the stacks, associated equipment or enclosures (if any) is not impeded, and that the temperature of the cooling inlet air to converter stacks does not exceed the ambient temperature for which the stacks arespecified.

302. Converter stacks and associated equipment shall not be mounted near sources of radiant heat energy, such as resistors, steam pipes and engine exhaust pipes.

303. For liquid cooled type converters, the same installation precautions as specified in Subchapter F6 for liquid-cooled transformers apply.

304. A nameplate large enough to at least hold the manufacturer's name and the identification number of the equipment shall be provided.

400. Accessibility

401. Semiconductor converter stacks or semiconductor components shall be mounted in such a manner that may be removed from the equipment without dismantling the complete unit.

500. Service conditions

501. The service conditions, for example ambient temperature, stated in E1.200, are applicable.

502. If the convertor equipment requires drying for maintenance and inspection purposes, special care shall be taken that the maximum permissible temperature limits are not exceeded when applying heat to the equipment.

600. Application

601. When forced cooling is utilized, the circuit shall be designed that the power cannot be applied to, or retained, on converter stacks or semiconductor components, unless cooling is maintained.

Note – Reduced power output in natural air cooling mode may be considered.

700. Effects from and on the supply or load system

701. Precautions shall be taken to guard the converter equipment against the harmful effects of overcurrent or overvoltage due to disturbance and supply or load system, including the effects of regenerated power if the load can operate in such a way.

702. Precautions shall also be taken to guard the supply and the load system against the harmful effects of any disturbance in the converter itself.

703. Semiconductor converters shall not cause distortion in the voltage waveform of the power supply to levels exceeding the voltage waveform tolerances at the other user input terminals. This is, in particular, applicable to converters that employ electronic switches operating once or more than once per cycle of the power supply voltage.

704. If fitted, filters shall not decrease the insulation resistance between the supply phases and earth to unacceptable levels. In cases where the earth current exceeds 30 mA, isolating transformers shall be fitted.

Note – Current harmonics, interacting with the impedance of the supply will generate voltage harmonics. Both the current and voltage harmonics can cause malfunction or overheating in other items of equipment in the unit, if their possible presence has not been taken into account in the equipment design. For systems where a converter rating is large and a significant proportion of the system rating, it may not be feasible to suppress such harmonics at the source. Consequently, appropriate measures may have to be taken to attenuate these effects on critical equipment. Such measures may include electrical isolation, e.g. Main Generator sets, filters in the supply to critical equipment, correct screening of cables and construction of enclosures, etc. General guidance is given in IEC 60533.

800. Diagrams

801. All applications shall contain schematic and wiring diagrams, or else instruction books shall be provided.

900. Converter transformers

901. If transformers are used in combination with semiconductor converters on the supply side or the load side of the converter, these transformers shall comply with the requirements of Subchapter F6.

CHAPTER G
DESIGN AND CONSTRUCTION OF ELECTRIC POWER DISTRIBUTION SYSTEM

CHAPTER CONTENTS

G1. EQUIPMENT AND CIRCUITS - PROTECTIONSYSTEM

100. Application

101. Generators, motors and circuits are to be protected against damages caused by overload or short-circuit. The protective devices are to be selected in order to provide a coordinated and selective system.

200. Protective equipment for generators of direct andalternatingcurrent

201. Circuit-breakers are to be equipped with elements of instantaneous trip adjusted to value lower than the short-circuit current and trigger element of inverse-time characteristic set to value not exceeding 115% of the maximum continuous current at full load of the generator. The settings of trips shall be such that coordinate with the circuit breakers of protection of feeders provided from the generator.

300. Protective equipment fortransformers

301. Circuit breakers are to be provided on the primary of the transformers, with:

a. instantaneous trip element properly set to value lower than the capacity of the transformer to withstand short-circuit current;

b. element of trip of characteristic of inverse time, properly set to value lower than capacity of the transformer to withstand continuous overload.

302. The settings of trips are to be such as to permit the circulation of magnetizing current during the energizing of the transformer.

400. Protective equipment for batteries

401. Except in the case of batteries for the starting of Diesel engines, the protection against short-circuit is to be provided in cubicle next to each set of batteries. Such protection may be by means of circuit breaker or fuses.

402. Protection of circuits from secondary batteries: appropriate circuit breakers or switches shall be provided to disconnect the battery installation from all lines of incoming and outgoing circuits and from earth potential.

403. For special applications, e.g. starting batteries for emergency generators or fire pump engines, protective devices may be omitted. The conductors from the batteries shall then be installed so as to be adequately protected against short-circuits and earth faults and as short as possible. This requirement can be met by using for example single-core double-insulated cables. (See IEC 60092-350).

500. Protective equipment forcircuits

501. All the distribution circuits and feeders are to be individually protected by circuit breakers or fuses properly selected and fitted to protect the conductors against overload and short-circuit.

G2. EARTHING SYSTEMS

100. System earthing

101. System earthing shall be effected by means independent of any earthing arrangements of the non-current-carrying parts.

102. Any earthing impedances shall be connected to the hull. The connection to the hull shall be so arranged that any circulating current in the earth connections do not interfere with radio, radar, communication and control equipment circuits.
[IACS UR E11 2.1.4]

103. If the system neutral is connected to earth, suitable disconnecting links or terminals shall be fitted so that the system earthing may be disconnected for maintenance or insulation resistance measurement. Such means shall be for manual operation only.

104. If the system neutral is connected to earth at several points, equalising currents in the neutral earthing exceeding 20% of the rated current of connected generators or transformers is not acceptable.

105. Transformer neutrals and generator neutrals shall not be simultaneously earthed in the same distribution system at same voltage level. On distribution transformers with star connected primary side, the neutral point shall not be earthed.

106. Secondary windings of instrument transformers shall be earthed.

107. The earthing shall be such as to give a substantially equal potential and a sufficiently low earth-fault loop impedance to ensure correct operation of protective devices.

108. In any four wire distribution system the system neutral shall be connected to earth at all times.
[IEC61892-2, sec. 5.4.2]

109. Combined PE (protective earth) and N (system earth) is allowed between transformer /generator and N-busbar in first switchboard where the transformer secondary side/generator is terminated i.e. TN-C-S-system. There shall be no connection between the N- and PE-conductor after the PENconductor is separated.

110. In case of earth fault in high voltage systems with earthed neutral, the current shall not be greater than full load current of the largest generator on the switchboard or relevant switchboard section and not less than three times the minimum current required to operate any device against earth fault. Electrical equipment in directly earthed neutral or other neutral earthed systems shall withstand the current due to single phase fault against earth for the time necessary to trip the protection device. It shall be assured that at least one source neutral to ground connection is available whenever the system is in the energised mode. For divided systems, connection of the neutral to the earth shall be provided for each section.
[IACS UR E11 2.1.2 and 2.1.5 and IEC61892-2 and sec 5.7,Table 1]

200. Protective earthing and bonding of equipment

201. Earth conductors shall normally be of copper. However, other suitable materials may be accepted if, for example the atmosphere is corrosive to copper.

202. The earth conductor's cross section shall be equivalent to that of copper with regard to conductivity.

203. The connection to the hull of earth conductors or equipment enclosure parts, which shall be earthed, shall be made by corrosion resistant screws or clamps, with cross section corresponding to the required cross section of earth given in G3.401.

204. Earthing screws and clamps shall not be used for other purposes. Suitable star washers and conductor terminals shall be used, so that a reliable contact is ensured.

205. Metal enclosures or other exposed conductive parts being a part of electrical equipment shall be earthed by fixing the metal enclosure or exposed parts in firm

(conductive) contact to the hull (main earth potential) or by a separate earth conductor.

206. Portable equipment shall always be earthed by an earth conductor contained in the flexible supply cable.

207. All extraneous conductive parts supporting electrical equipment and cable support systems, that is ladders, pipes and ducts for electrical cables, are considered to be in firm electrical contact with the hull as long as elements are welded or mechanically attached (metal to metal without paint or coating) with a star washer, thereby ensuring a firm conductive contact. If firm electrical contact is not achieved, the parts shall be bonded by a separate copper conductor between extraneous parts and the hull.

208. Additional precautions shall be applied regarding earthing of portable electrical equipment for use in confined or exceptionally damp spaces where particular risks due to exposure and conductivity may exist.

209. High voltage metal enclosures and the steel hull shall be connected by a separate earth conductor. The enclosures fixing device shall not be the sole earthing connection of the enclosure.

210. If a separate earthing conductor is chosen for equipment, then the connection of the separate earth conductor to the hull (safe earth potential) shall be made in an accessible position. The conductor shall be terminated by a pressure type cable lug onto a corrosion protected bolt, which shall be secured against loosening. Other suitable terminating systems for direct receipt of the conductor may be considered.

Note - *Additional precautions in G2.209 might be: the equipment having extra safe low voltage, or for ordinary 230 V equipment, by using a safety transformer system or by having an earth fault switch of maximum 30 mA in front of the circuit.*

300. Protection against galvanic corrosion

301. Methods of securing dissimilar materials, for example aluminium to the structure or steel hull of a unit, often include insulation to prevent galvanic corrosion between the materials. In such cases, a separate bonding connection shall be provided between, for example, an aluminium superstructure and structure or hull, which shall be made in such a manner that galvanic corrosion is avoided and the points of connection may be readily inspected.

400. Metal covering of cables

401. All metal coverings of cables shall be earthed at both ends, except in so far as the provisions given for single-core cables for AC wiring apply (see D2.200). Single-point earthing is admitted for final sub-circuits (at the supply end) and in those installations (control and instrumentation cables, intrinsically safe circuits, control circuits, etc.) where it is required for technical or security reasons, if any.

402. To avoid sparking, any power and lighting circuit or final sub-circuit shall have the metal covering of cable earthed at equipment side when installed in hazardous area.

403. Earthing connections shall be carried out with conductors that have cross-sectional areas related to the current rating of the cables, or by equivalent means, such as metal clamps gripping the metal covering of the cable and connected to earth.

404. The metal covering of cables may be earthed by means of glands intended for that purpose and so designed as to ensure an effective earth connection.

405. The glands shall be firmly attached to, and in effective contact with, a metal structure earthed in accordance with these Rules.

406. The electrical continuity of all-metal coverings throughout the length of the cables, particularly at joints and tappings, shall be ensured.

407. Metal casings, pipes and conduits or trunking shall be effectively earthed.

408. Conduits may be earthed by being screwed into a metal enclosure, or by nuts on both sides of the wall of a metal enclosure, provided the surfaces in contact are clean and free from rust, scale or paint and that the enclosure is in accordance with these provisions on earthing.

409. The connections shall be painted immediately after assembly in order to prevent corrosion.

411. Metallic covering of cable and conduits, may be earthed by means of clamps or clips of corrosion-resistant and galvanically compatible metal, making effective contact with the metallic covering and earthed metal.

412. All joints in metal conduits and ducts and in metallic covering of cables used for earth continuity shall be soundly made and protected, where necessary, against corrosion.

413. Instrument cables without armour shall normally have the screen earthed at both ends. If the screen is earthed in one end only, this should be at the supply end.

414. An evaluation shall be made regarding the need for earthing in one or both ends of the armour/screen in relation to the required suppression of the frequency band.

415. Instrument cables with armour shall have screen and armour insulated from each other with the screen earthed at the supply end only and the armour earthed at both ends, unless it is required for functional reasons to be earthed at one end only, in which case it shall normally be earthed at

the field instrument side or, in the case of intrinsically safe circuits.

416. An evaluation shall be made regarding the need for earthing in one or both ends of the armour/screen in relation to the required suppression of the frequency band.

417. Intrinsically safe (IS) cables shall normally have a screen connected to the IS earth bar.

G3. DETERMINATION OF THE CROSS SECTIONAL AREA OF THE CONDUCTORS

100. Current capacity

101. Current values shown in Table T.G3.101.1. shall be considered as the maximum allowable in steady state regime, for direct current systems and ambient temperature of 45° C, applicable to cables in groups of 3 or 4 cables with ambient air circulating freely around the cables. For ambient temperature other than 45° C the cable conductive capacity is to be corrected using the correction factors from the Table T.G3.101.2.

102. The correction factors for current capacity of the conductors for ambient temperature different from 45° C mentioned in Table T.G3.101.2 do not consider the temperature increase, if happens, due to solar radiation or other infrared radiation. When the insulated cables or conductors are submitted to this kind of radiation, the current conduction capacity shall be calculated in accordance with the methods in the standard IEC 60287. [IEC 60092-352, item 3.3.4]

200. Correction factors for cable grouping

201. Cables grouped or installed side by side, around which the air cannot circulate freely, shall be considered with their current conducting capacity reduced to 85 % of the values given in Table T.G3.101.1.or in such a way that the conductor maximum allowable temperatureshall not be exceeded.

300. Voltage drop

301. The following maximum voltage drop limits shall be considered:

a. cables conducting the maximum circuit current, under normal service conditions:

– 5 % rated voltage to lighting circuitand

– 7 % to power circuits

b. for special conditions of short duration voltage limits turn to be 8 % and 11 % respectively.

400. Rating of earth conductors

401.Earthing connections and conductors - all earthing connections of copper shall have sufficient cross-section to prevent the current density exceeding 150 A/mm2 at the maximum earth fault currents that can pass through them.Minimum cross-section of earthing conductors shall be as listed in Table T.G3.401.1.

TABLE T.G3.101.1 – MAXIMUM PERMISSIBLE CURRENT FOR CONTINUOUS SERVICE AT AMBIENT TEMPERATURE OF 45º C AND MAXIMUM RATED TEMPERATURE IN THE CONDUCTORS OF 90º C

Quantity of conductors / Nominal cross sectional area in mm^2	1 (A)		2 (A)		3 or 4 (A)	
1	17		14		12	
1,5	23		20		16	
2,5	30		26		21	
4	40		34		28	
6	52		44		36	
10	72		61		50	
16	96		82		67	
25	127		108		89	
35	157		133		110	
50	196		167		137	
70	242		206		169	
95	293		249		205	
120	339		288		237	
150	389		331		272	
185	444		377		311	
240	522		444		365	
300	601		511		421	
	d.c.	a.c.	d.c.	a.c.	d.c.	a.c.
400	690	670	587	570	483	469
500	780	720	663	612	546	504
630	890	780	757	663	623	546

TABLE T.G3.101.2. - MAXIMUM CURRENT CORRECTION IN ETHYLENE PROPILENNIC RUBBER-INSULATED CABLES (90° C)

Ambient temperature in °C / Maximum temperature in the conductor in °C	35	40	45	50	55
75	1,15	1,08	1,00	0,91	0,82
90	1,10	1,05	1,00	0,94	0,88

TABLE T.G3.401.1 – EARTHING CONNECTIONS AND CONDUCTORS

Arrangementofearthconductor		Cross-section Q of associated current carrying conductor (one phase or pole) (mm2)	Minimum cross-section of earth conductor
1	i) Insulated earth conductor in cable for fixed installation. ii) Copper braid of cable for fixed installation. iii) Separate, insulated earth conductor for fixed installation in pipes in dry accommodation spaces, when carried in the same pipe as the supply cable. iv) Separate, insulated earth conductor when installed inside enclosures or behind covers or panels, including earth conductor for hinged doors.	$Q \leq 16$	Q
		$16 < Q$	1/2 of the current-carrying conductor, but not less than 16 mm2
2	Uninsulated earth conductor in cable for fixed installation, being laid under the cable's lead sheath, armour or copper braid and in metal-to-metal contact with this.	$Q \leq 2.5$	1 mm^2
		$2.5 < Q \leq 6$	1.5 mm^2
		$6 < Q$	Notpermitted
3	Separately installed earth conductor for fixed installation other than specified in 1 iii) and 1 iv).	$Q < 2.5$	Same as current-carrying conductor subject to minimum 1.5 mm^2 for stranded earthing connection or 2.5 mm^2 for unstrandedearthing connection
		$2.5 < Q \leq 120$	1/2 of current-carrying conductor, but not less than 4 mm^2
		$120 < Q$	70 mm^2
4	Insulated earth conductor in flexible cable.	$Q \leq 16$	Same as current-carrying conductor
		$16 < Q$	1/2 butminimum 16 mm^2

[IEC 61892-4, Table 2]

G4. PRECAUTIONS AGAINST SHOCK, FIRE AND OTHER HAZARDS OF ELECTRICAL ORIGIN

100. Precautions against shock, fire and other hazards of electrical origin

101. 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 (grounded) unless the machines or equipment are:

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

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

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

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

103. All electrical apparatus shall be so constructed and so installed that it does not cause injury when handled or touched in the normal manner.

104. Where not obtained through normal construction, arrangements shall be provided to effectively earth (ground) all permanently installed machinery, metal structures of derricks, masts and helicopter decks.

105. Switchboards shall be so arranged as to give easy access, where needed, to apparatus and equipment, in order to minimize danger to personnel. The sides and backs and, where necessary, the fronts of switchboards shall be suitably guarded. Exposed live parts having voltages to earth (ground) exceeding a voltage to be specified by the RBNA shall not be installed on the front of such switchboards. There shall be non-conducting mats or gratings at the front and rear, where necessary.

106. Distribution systems with hull return shall not be installed, but this does not preclude, under conditions approved by the RBNA, the installation of:

a. impressed current cathodic protective systems;

b. limited and locally earthed systems (e.g., engine starting systems);

c. limited and locally earthed welding systems; where the RBNA is satisfied that the equipotential of the structure is assured in a satisfactory manner, welding systems with hull return may be installed without this restriction; and

d. insulation level monitoring devices provided the circulation current does not exceed 30 mA under the most unfavourable conditions.

107. 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.

108. Except as permitted by the RBNA in exceptional circumstances, all metal sheaths and armour of cables shall be electrically continuous and shall be earthed (grounded).

109. 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, the RBNA may permit the use of special types of cables such as radio frequency cables, which do not comply with the foregoing.

* Refer to the recommendations published by the International Electrotechnical Commission concerning flame-retarding properties of bunched cables and characteristics of cables of a fire-resistant type.

110. Cables and wiring serving essential or emergency power, lighting, internal communications or signals shall, so far as practicable, be routed clear of galleys, machinery spaces of category A and their casings and other high fire risk areas. Cables connecting fire pumps to the emergency switchboard shall be of a fire-resistant type where they pass through high fire risk areas. 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. *

* Refer to the recommendations published by the International Electrotechnical Commission concerning flame-retarding properties of bunched cables and characteristics of cables of a fire-resistant type.

111. Cables and wiring shall be installed and supported in such a manner as to avoid chafing or other damage.

112. Terminations and joints in all conductors shall be so made that they retain the original electrical, mechanical, flame-retarding and, where necessary, fire-resisting properties of the cable.

113. Each separate circuit shall be protected against short circuit and against overload, except as permitted in the MODU Code, section 7.6, or where the RBNA may exceptionally otherwise permit.

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

115. 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.

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

117. Electrical or other equipment which may constitute a source of ignition of flammable vapours shall not be permitted in these compartments except as permitted in G4.119.

118. Accumulator batteries, except for batteries of self-contained battery-operated lights, shall not be located in sleeping quarters. RBNA may grant exemptions from or equivalencies to this provision where hermetically sealed batteries are installed.

119. In paint lockers, acetylene stores, and similar spaces where flammable mixtures are liable to collect as well as any compartment assigned principally to accumulator batteries, no electrical equipment shall be installed unless the RBNA is satisfied that such equipment is:

a. essential for operational purposes;

b. of a type which will not ignite the mixture concerned;

c. appropriate to the space concerned; and

d. .appropriately certified for safe usage in the vapours or gases likely to be encountered.

120. Electrical apparatus and cables shall, where practicable, be excluded from any compartment in which explosives are stored. Where lighting is required, the light shall come from outside, through the boundaries of the compartment. If electrical equipment cannot be excluded from such a compartment it shall be so designed and used as to minimize the risk of fire or explosion.

121. Where spilling or impingement of liquids could occur upon any electrical control or alarm console, or similar electrical enclosure essential to the safety of the unit, such equipment shall have suitable protection against the ingress of liquids. *

* Refer to IEC 60529 - Degrees of protection provided by enclosures (IP Code). Other arrangements for the enclosures of electrical components may be fitted provided the RBNA is satisfied that an equivalent protection is achieved.

CHAPTER I
REQUIREMENTS FOR SYSTEMS WITH VOLTAGES ABOVE 1 KV UP TO 15 KV [IACS UR E11]

CHAPTER CONTENTS

I1. APPLICATION

100. Field of application

101. The following requirements apply to A.C..three-phase systems with nominal voltage exceeding 1kV, the nominal voltage is the voltage between phases. If not otherwise stated herein, construction and installation applicable to low voltage equipment generally apply to high voltage equipment.

200. Nominal system voltage

201. The nominal system voltage is not to exceed 15 kV.

Note: Where necessary for special application, higher voltages may be accepted by the RBNA.

300. High-voltage, low-voltage segregation

301. Equipment with voltage above about 1 kV is not to be installed in the same enclosure as low voltage equipment, unless segregation or other suitable measures are taken to ensure that access to low voltage equipment is obtained without danger.

I2 SYSTEM DESIGN

100. Distribution

101. Network configuration for continuity of unit services: It is to be possible to split the main switchboard into at least

two independent sections, by means of at least one circuit breaker or other suitable disconnecting devices, each supplied by at least one generator. If two separate switchboards are provided and interconnected with cables, a circuit breaker is to be provided at each end of the cable.

102. Services which are duplicated are to be divided between the sections.

200. Earthed neutral systems

201. In case of earth fault, the current is not to be greater than full load current of the largest generator on the switchboard or relevant switchboard section and not less than three times the minimum current required to operate any device against earth fault.

202. It is to be assured that at least one source neutral to ground connection is available whenever the system is in the energised mode. Electrical equipment in directly earthed neutral or other neutral earthed systems is to withstand the current due to a single phase fault against earth for the time necessary to trip the protection device.

203. Neutral disconnection: Means of disconnection are to be fitted in the neutral earthing connection of each generator so that the generator may be disconnected for maintenance and for insulation resistance measurement.

204. Hull connection of earthing impedance: All earthing impedances are to be connected to the hull. The connection to the hull is to be so arranged that any circulating currents in the earth connections do not interfere with radio, radar, communication and control equipment circuits.

205. Divided systems: In the systems with neutral earthed, connection of the neutral to the hull is to be provided for each section.

300. Degrees of protection

301. Each part of the electrical installation is to be provided with a degree of protection appropriate to the location, as a minimum the requirements of IEC Publication 60092-201.

302. Rotating machines:

a. The degree of protection of enclosures of rotating electrical machines is to be at least IP23.

b. The degree of protection of terminals is to be at least IP44.

303. For motors installed in spaces accessible to unqualified personnel, a degree of protection against approaching or contact with live or moving parts of at least IP4X is required.

304. Transformers:

a. The degree of protection of enclosures of transformers is to be at least IP23.

b. For transformers installed in spaces accessible to unqualified personnel a degree of protection of at least IP4X is required.

c. For transformers not contained in enclosures, see I7.101 below.

305. Switchgear, control gear assemblies and static converters:

a. The degree of protection of metal enclosed switchgear, controlgear assemblies and static **converters** is to be at least IP32.

b. For switchgear, control gear assemblies and static convertersinstalled in spaces accessible to unqualified personnel, a degree of protection of at least IP4Xis required.

400. Insulation

401. **Air clearance**: in general, for Non Type Tested equipment phase-to-phase air clearances and phase to earth air clearances between non-insulated parts are to be not less than those specified in Table T.I2.401.1

TABLE T.I2.401.1

Nominal Voltage (kV)	Minimum air clearance (mm)
3 (3.3)	55
6 (6.6)	90
10 (11)	120
15	160

402. Intermediate values may be accepted for nominal voltages provided that the nexthigher air clearance is observed.

403. In the case of smaller distances, appropriate voltage impulse test must be applied.

404. **Creepage distances**: Creepage distances between live parts and between live parts and earthed metal partsfor standard components are to be in accordance with relevant IEC Publications for thenominal voltage of the system, the nature of the insulation material and the transientovervoltage developed by switch and fault conditions.

405. For non-standardised parts within the busbar section of a switchgear assembly, the minimum creepage distance is to be at least 25 mm/kV and behind current limitingdevices, 16mm/kV.

500. Protection

501. **Faults on the generator side of circuit breaker**: Protective devices are to be provided against phase-to-phase faults in the cables connecting the generators to the main switchboard and against interwinding faults within the generators. The protective devices are to trip the generator circuit breaker and to automatically de-excite the generator.

502. In distribution systems with a neutral earthed, phase to earth faults are also to be treated as above.

503. **Faults to earth:** any earth fault in the system is to be indicated by means of a visual and audible alarm.

504. In low impedance or direct earthed systems provision is to be made to automatic disconnect the faulty circuits. In high impedance earthed systems, where outgoing feeders will not be isolated in case of an earth fault, the insulation of the equipment is to be designed for the phase to phase voltage.

505. **Note**: earthing factor is defined as the ratio between the phase to earth voltage of the health phase and the phase to phase voltage. This factor may vary between (1/sqrt 3) and 1.

506. A system is defined **effectively earthed** (low impedance) when this factor is lower than 0.8. A system is defined non-effectively earthed (high impedance) when this factor is higher than 0.8.

507. **Power transformers:power** transformers are to be provided with overload and short circuit protection.

508. When transformers are connected in parallel, tripping of the protective devices at the primary side has to automatically trip the switch connected at the secondary side.

509. **Voltage transformers for control and instrumentation**: voltage transformers are to be provided with overload and short circuit protection on the secondary side.

510. **Fuses**
Fuses are not to be used for overload protection.

511. **Low voltage systems**: lower voltage systems supplied through transformers from high voltage systems are to be protected against overvoltages. This may be achieved by:

a. direct earthing of the lower voltage system

b. appropriate neutral voltage limiters

c. earthed screen between the primary and secondary windings of transformers.

I3. ROTATING MACHINES

100. Stator winding of generators

101. Generator stator windings are to have all phase ends brought out for the installation ofthe differential protection.

200. Temperature detectors

201. Rotating machinery is to be provided with temperature detectors in their statorwindings to actuate a visual and audible alarm in a normally attended positionwhenever the temperature exceeds the permissible limit.

302. If embedded temperature detectors are used, means are to be provided to protect thecircuit against overvoltage.

300. Tests

301. In addition to the tests normally required for rotating machinery, a high frequency highvoltage test in accordance with IEC Publication 60034-15 is to be carried out on theindividual coils in order todemonstrate a satisfactory withstand level of the inter-turninsulation to steep fronted switching surges.

I4. POWER TRANSFORMERS

100. General

101. Dry type transformers have to comply with IEC Publication 60726.

102. Liquid cooled transformers have to comply with IEC Publication 60076.

103. Oil immersed transformers are to be provided with the following alarms and protections:

- liquid level (Low) alarm
- liquid temperature (High) alarm
- liquid level (Low) - trip - or load reduction

I5. CABLES

100. General

101. Cables are to be constructed in accordance with the IEC Publication 60092-353 and 60092-354 or other equivalent Standard.

I6. SWITCHGEAR AND CONTROL GEAR ASSEMBLIES

100. General

101. Switchgear and control gear assemblies are to be constructed according to the IEC Publication 60298, IEC 60092-302 or equivalent (IEEE St45 Chapter 8) and the following additional requirements.

200. Construction

201. Mechanical construction: switchgear is to be of metal – enclosed type in accordance with IEC Publication 60298 or of the insulation – enclosed type in accordance with the IEC Publication 60466.

202. **Locking facilities:** Withdrawable circuit breakers and switches are to be provided with mechanical locking facilities in both service and disconnected positions. For maintenance purposes, key locking of withdrawable circuit breakers and switches and fixed disconnectors is to be possible.

203. **Withdrawable circuit breakers** are to be located in the service position so that there isno relative motion between fixed and moving portions.

204. **Shutters**: The fixed contacts of withdrawable circuit breakers and switches are to be so arranged that in the withdrawable position the live contacts are automatically covered.

205. **Earthing and short-circuiting**: For maintenance purposes an adequate number of earthing and short-circuiting devices is to be provided to enable circuits to be worked upon with safety.

300. Auxiliary systems

301. Source and capacity of supply: If electrical energy and/or physical energy is required for the operation of circuit breakers and switches, a stored supply of such energy is to be provided for at least two operations of all the components.

302. However, the tripping due to overload or short-circuit, and under-voltage is to be independent of any stored electrical energy sources. This does not preclude shunt tripping provided that alarms are activated upon lack of continuity in the release circuits and power supply failures.

303. Number of external supply sources: When external source of supply is necessary for auxiliary circuits, at least two external sources of supply are to be provided and so arranged that a failure or loss of one source will not cause the loss of more than one generator set and/or set of essential services.

304.0 Where necessary one source of supply is to be from the emergency source of electrical power for the start up from dead ship condition.

400. High voltage test

401. A power-frequency voltage test is to be carried out on any switchgear and control gear assemblies. The test procedure and voltages are to be according to the IEC Publication 60298.

I7. INSTALLATION

100. Electrical equipment

101. Where equipment is not contained in an enclosure but a room forms the enclosure of the equipment, the access doors are to be so interlocked that they cannot be opened until the supply is isolated and the equipment earthed down.

102. At the entrance of the spaces where high-voltage electrical equipment is installed, a suitable marking is to be placed which indicates danger of high-voltage. As regard the high-voltage electrical equipment installed out-side a.m. spaces, the similar marking is to be provided.

200. Cables

201. Runs of cables: In accommodation spaces, high voltage cables are to be run in enclosed cable transitsystems.

300. Segregation

301. High voltage cables are to be segregated from cables operating at different voltageratings each other; in particular, they are not to be run in the same cable bunch, nor inthe same ducts or pipes, or, in the same box.

302. Where high voltage cables of different voltage ratings are installed on the same cabletray, the air clearance between cables is not to be less than the minimum air clearancefor the higher voltage side in item I2.401. However, high voltage cables are not to beinstalled on the same cable tray for the cables operating at the nominal system voltageof 1 kV and less.

400. Terminations

401. Terminations in all conductors of high voltage cables are to be, as far as practicable, effectively covered with suitable insulating material. In terminal boxes, if conductors are not insulated, phases are to be separated from earth and from each other by substantial barriers of suitable insulating materials.

402. High voltage cables of the radial field type, i.e. having a conductive layer to control the electric field within

the insulation, are to have terminations which provide electric stress control.

403. Terminations are to be of a type compatible with the insulation and jacket material of the cable and are to be provided with means to ground all metallic shielding components (i.e. tapes, wires etc).

500. Marking

501 High voltage cables are to be readily identifiable by suitable marking.

CHAPTER J
HAZARDOUS AREAS

CHAPTER CONTENTS

J1. HAZARDOUS AREAS

100. General

101. The unit shall be classified into hazardous areas in accordance with J1.102 and J1.103 or alternatively with an acceptable code of practice.

102. Hazardous areas are all those areas where, due to the possible presence of a flammable atmosphere arising from the drilling operations, the use without proper consideration of machinery or electrical equipment may lead to fire hazard or explosion.

103. Hazardous areas are subdivided into Zones 0,1 or 2, the definitions of each category being as follows:

d. Zone 0 an area in which an explosive gas-air mixture is continuously present or present for long periods.

e. Zone 1 an area in which an explosive gas-air mixture is likely to occur in normal operating conditions.

f. Zone 2 an area in which an explosive gas-air mixture is not likely to occur, and if it occurs, it will only exist for a short time.

104. The hazardous areas defined in J1.201 toJ1.203 are those which normally apply to offshore drilling units for oil and gas exploration. Equipment for well testing is to be specially considered, if present. The hazardous areas as specified may be extended or reduced depending on the actual arrangements in each case, by use of windshields, special ventilation arrangements, structural arrangements (e.g., low deck head), etc.

105. For the purpose of J1:

a. An enclosed space is considered to be a space bounded by bulkheads and decks which may have doors, windows, or other similar openings.

b. A semi-enclosed location is considered to be a location where natural conditions of ventilation are notably different from those on open decks due to the presence of structure such as roofs, windbreaks and bulkheads and which are so arranged that the dispersion of gas may not occur.

200. Classification of areas

201. Hazardous areas Zone 0 include the internal spaces of closed tanks and piping for containing active non-degassed drilling mud, oil that has a closed-cup flashpoint below 60°C or flammable gas and vapour, as well as produced oil and gas in which an oil/gas/air mixture is continuously present or present for long periods.

202. Hazardous areas Zone 1 include:

a. Enclosed spaces containing any part of the mud-circulating system that has an opening into the spaces and is between the well and the final degassing discharge.

b. In outdoor or semi-enclosed locations except as provided for item e. below, the area within 1,5 m (5 ft) of the boundaries of any openings to equipment which is part of the mud system as specified in item a. above, any ventilation outlets of Zone 1 spaces, or any access to Zone 1 spaces.

c. Outdoor locations below the drill floor and within a radius of 1,5 m from a possible source of release such as the top of a drilling nipple.

d. Pits, ducts or similar structures in locations which otherwise would be Zone 2 but which are arranged so that the dispersion of gas may not occur.

e. Enclosed spaces or semi-enclosed locations that are below the drill floor and contain a possible source of release such as the top of a drilling nipple.

f. Enclosed spaces that are on the drill floor and which are not separated by a solid floor from the spaces in item e. above.

203. Hazardous areas Zone 2 include:

a. Enclosed spaces which contain open sections of the mud circulating system from the final degassing discharge to the mud pump suction connection at the mud pit.

b. Outdoor locations within the boundaries of the drilling derrick up to a height of 3m (10 ft) above the drill floor.

c. Semi-enclosed derricks to the extent of their enclosures above the drill floor or to a height of 3 m (10 ft) above the drill floor, whichever is greater.

d. Semi-enclosed locations below and contiguous with the drill floor and to the boundaries of the derrick or to the extent of any enclosure which is liable to trap gases.

e. In outdoor locations below the drill floor with a radius of 1,5 beyond the zone 1 area as specified in item F2.202.c.

f. The areas 1,5 m (5 ft) beyond the Zone 1 areas specified in J1.202.b. and beyond the semi-enclosed locations specified in J1.202.e.

g. Outdoor spaces within 1,5 m (5 ft) of the boundaries of any ventilation outlet from or access to a Zone 2 space unless J1.202.d. is applicable.

h. Air locks between a Zone 1 and a non-hazardous area.

TABLE T.J1.203.1 - CORRESPONDENCE BETWEEN ZONES AND DIVISIONS

Divisions and zones			
	Continuous Hazard	Intermitent Hazard	Hazard under abnormal conditions
NEC 500-503	Division 1	Division 1	Division 2
IEC	Zone 0	Zone 1	Zone 2
ATEX	Category 1	Category 2	Category 3

204. Well test facilities –areaclassification relevant to well test facilities shall be carried out in accordance with the requirements of J1.201, J1.202 and J1.203.

205. Thefollowing provisions regarding floating, mobile and fixed offshore units are to be taken into account:

a. Pipelines without flanges, connections, valves or other similar fittings shall not be regarded as a source of release.

b. Certain areas and rooms shall, if so indicated by the circumstances, be classified as a more hazardous zone than set out in these examples.

c. Certain areas and rooms may under certain circumstances and/or when special precautions are taken, be classified as a less hazardous zone than indicated by these examples. Such special circumstances may be, for example, redundant ventilation arrangements.

d. Enclosed rooms, without ventilation, with openings to an area with explosion risks, shall be designated as the same, or as a more hazardous zone than such an area.

300. Openings, access and ventilation conditions affecting the extent of hazardous zones

301. Except for operational reasons access doors or other openings shall not be provided between:

- a non-hazardous space and a hazardous zone;

- a Zone 2 space and a Zone 1 space.

302. Where such access doors or other openings are provided, any enclosed space not referred to under J1.202 or J2.203 and having a direct access to any Zone 1 location or Zone 2 location becomes the same zone as the location except that:

a. an enclosed space with direct access to any Zone 1 location can be considered as Zone 2 if:

i. the access is fitted with a gas-tight door opening into the Zone 2 space, and

ii. ventilation is such that the air flow with the door open is from the Zone 2 space into the Zone 1 location, and

iii. loss of ventilation is alarmed at a manned station;

b. and enclosed space with direct access to any Zone 2 location is not considered hazardous if:

i. the access is fitted with a self-closing gas-tight door that opens into the nonhazardous location, and

ii. ventilation is such that the air flow with the door open is from the non-hazardous space into the Zone 2 locations, and

iii. loss of ventilation is alarmed at a manned station;

c. an enclosed space with direct access to any Zone 1 location is not considered hazardous if:

i. the access is fitted with gas-tight self-closing doors forming an air lock, and

ii. the space has ventilation overpressure in relation to the hazardous space, and

iii. loss of ventilation overpressure is alarmed at a manned station.

303. Where ventilation arrangements of the intended safe space are considered sufficient by the RBNA to prevent any ingress of gas from the Zone 1 location, the two self-closing doors forming an air lock may be replaced by a single self-closing gas-tight door which opens into the non-hazardous location and has no hold-back device.

304. Notices warning that the doors are to be kept closed and the ventilation is to be kept running at all time shall be fitted whenever any of the above arrangements are adopted.

400. Ventilation

401. **General**: Attention is to be given to ventilation inlet and outlet location and airflow in order to minimize the possibility of cross contamination. Inlets are to be located in non-hazardous areas as high and as far away from any hazardous area as practicable. Each air outlet is to be located in an outdoor area which, in the absence of the considered outlet, is of the same or lesser hazard than the ventilated space. Ventilation for hazardous areas is to be completely separate from that used for non-hazardous areas. Where passing through hazardous areas, the inlet ducts are also to have overpressure in relation to this area.

402. **Ventilation of hazardous areas**: Enclosed hazardous spaces are to be provided with adequate ventilation with under pressure in relation to the less hazardous space or zone. The arrangement of ventilation inlet and outlet openings in the space is to be such that the entire space is efficiently ventilated, giving special consideration to location of equipment which may release gas, and to spaces where gas may accumulate.

403. The outlet air from Zone 1 and Zone 2 spaces is to be led in separate ducts to outdoor locations.

404. The internal spaces of such ducts belong to the same Zone as the inlet space. Air inlet ducts designed for constant relative underpressures are to be rigidly constructed to avoid air leaks. Fans are to be designed so as to reduce the risk that sparks may occur.

500. Ventilation requirements for battery compartments

501. General: the purpose of ventilating a battery location or enclosure is to maintain the hydrogen concentration below 20 % of the LEL threshold (the LEL for hydrogen is 4 % by volume) and limit the oxygen content to normal level. Battery locations and enclosures are to be considered as safe from explosions, when by natural or forced (artificial) ventilation the concentration of hydrogen is kept below this limit.

502. Particular attention shall be given to the fact that the gas emitted is lighter than air and will tend to accumulate in any pockets at the top of the space. When batteries are arranged in two or more tiers, all shelves shall have not less than 50 mm space, front and back, for circulation of air.

503. Regarding location of batteries, see IEC 61892-6.

504. The ventilation requirements in the following are quoted from IEC 62485-2.

505. The minimum air flow rate for ventilation of a battery location or compartment shall be calculated by the following formula:

$Q = v \times q \times s \times n \times I_{gas} \times C_{rt} \times 10^{-3}$ (m^3/h)

Where

Q is the ventilation air flow in m^3/h;

v is the necessary dilution of hydrogen:

$$v = \frac{(100\% - 4\%}{4\%})$$

q = 0,42 x 10^{-3} m^3/Ah generated hydrogen at 0 °C

Remark: for calculations at 25 °C, the value of q at 0 °C shall be multiplied by factor 1,095.

s = 5, general safety factor;

$n$is the number of cells;

$/_{gas}$ is the current producing gas in mA/Ah rated capacity for the float charge current I_{float} or the boost charge current I_{boost}

C_{rt} is the C_{10} capacity for lead acid cells (Ah), U_f = 1,80 V/cell at 20 °C or C_5 capacity for NiCd cells (Ah), U_f = 1,00 V/cell at 20 °C.

With v x q x s = 0,05 m^3/Ah the ventilation air flow calculation formula is:

Q = 0,05 x n x I_{gas}x C_{rt}x 10^{-3} (m^3/h)

The current I_{gas} producing gas is determined by the following formula:

$I_{gas} = /_{float/boost}$ x f_gx f_s(mA/Ah)

Where

I_{float} is the float charge current under fully charged condition at a defined float charge voltage at 20 °C;

I_{boost} is the boost charge current under fully charged condition at a defined boost charge voltage at 20 °C

f_g is the gas emission factor, proportion of current at fully charged state producing hydrogen;

f_s is the safety factor, to accommodate faulty cells in a battery string and an aged battery.

Unless otherwise stated by the manufacturer, the preferred values for I_{float} and I_{boost} with supporting data are given in the following Table T.J1.505.1.

TABLE T.J1.505.1 – VALUES FOR CURRENT I WHEN CHARGING WITH IU- OR U-CHARGING PROFILES

Parameter	Lead-acid batteries vented cells Sb< 3 %, a)	Lead-acid batteries VRLA cells	NiCd batteries vented cells b)
Gasemission factor *f*g	**1**	**0,2**	**1**
Gas emission safety factor fs (incl. 10 % faulty cells and ageing)	**5**	**5**	**5**
Float charge voltage ***U***float C) V/cell	**2,23**	**2,27**	**1,40**
Typical float charge current ***I*float** mA/Ah	**1**	**1**	**1**
Current (float) ***Igas*** mA/ Ah (under float charge conditions relevant for air flow calculation)	**5**	**1**	**5**
Boost charge voltage ***Uboost*** C V/cell	**2,40**	**2,40**	**1,55**
Typical boost charge current ***I*boost**m A/Ah	**4**	**8**	**10**
Current (boost) ***Iboost*** mA/Ah (under boost charge conditions relevant for air flow calculation)	**20**	**8**	**50**

a) For an antimony (Sb) content higher than 3 %, the current used for cDigite a equação aqui.alculations shall be doubled.
b) For recombination type NiCd and NiMH cells consult the manufacturer.
c) Float and boost charge voltage can vary with the specific gravity of electrolyte in lead-acid cells.

506. In case of use of gas recombination vent plugs, the gas producing current I_{gas} can be reduced to 50% of the values for vented cells.

Note 1 - The values of float and boost charge current increase with temperature. The consequences of an increase in temperature, up to a maximum of 40 °C, have been accommodated in the values in Table T.J2.505.1.

Note 2 - The ventilation air volume requirements, for example, for two 48 V strings of VRLA cells in the same battery room or in the same battery cabinet and each with 120 Ah rated C_{10} capacity amount, under float and under boost charge service conditions, to

Service with float charge condition only:
$Q = 0,05 \times 24 \times 1 \times 120 \times 0,001 = 0,144$ m³/h per string or 288 I/h total

Service with boost charge condition:
$Q = 0,05 \times 24 \times 8 \times 120 \times 0,001 = 1,15$ m³/h per string or 2 300 l/h total

507. If batteries of types other than listed in Table T.J1.505.1 are used, advice regarding ventilation shall be sought from the battery manufacturer.

508. Natural ventilation may be employed if ducts can be run directly from the top of the room or locker to the open air above, with no part of the duct more than 45° from the vertical. These ducts shall not contain appliances (for example for barring flames) which may impede the free passage of air or gas mixtures.

509. Where lockers are provided for batteries, the duct shall terminate not less than 0,9 m above the top of the battery enclosure.

510. If natural ventilation is impracticable or insufficient, artificial extract-ventilation shall be provided with exhaust at the top of the room. Adequate openings, whether connected to ducts or not, for air inlets shall be provided near the floor of battery rooms or the bottom of lockers or boxes.

511. If natural ventilation is employed the battery rooms or enclosures require an air inlet and an air outlet with a

minimum free area of opening calculated by the following formula:

$A = 28 \times Q$, where

Q = ventilation flow rate of fresh air (m^3/h), according to J1.504.

A = free area of opening in air and outlet (cm^2).

Note - For the purpose of this calculation the air velocity is assumed to be 0,1 m/s.

The air inlet and outlet shall be located at the best possible location to create best conditions for exchange of air, i.e.

– openings on opposite walls,

– minimum separation distance of 2 m when openings on the same wall.

512. Forced ventilation: **w**here an adequate air flow Q cannot be obtained by natural ventilation and forced ventilation is implemented, the charger shall be interlocked with the ventilation system or an alarm shall be actuated when the required air flow, for the selected mode of charging, is not assured.

513. Fans and ducts: fans of accumulator compartments shall be so constructed and be of a material such as to render sparking impossible in the event of the impeller touching the fan casing. Steel or aluminum impellers shall not be used.

514. Ducts shall be made of a corrosion-resistant material or their interior surfaces shall be painted with corrosion-resistant paint.

515. Any fan motor associated with a duct used to exhaust the air from an accumulator space shall be placed external to the duct. Adequate means shall be provided to prevent entrance of gas into the motor. The duct shall be arranged to discharge into the open air.

516. The exhaust and ventilation fans, ducts and louvers dampers shall, as far as possible, be kept open to allow natural convection and ventilation in case of failure of any single component, fan or damper of ducting system.

517. Ventilation of battery rooms shall be monitored and an alarm shall be given at a manned station in case of failure of the ventilation.

518. For critical battery systems, installation of redundant ventilation systems should be considered. Consideration should also be given to installation of H_2 detectors.

CHAPTER K
INSTALLATION OF EQUIPMENT IN HAZARDOUS AREAS

CHAPTER CONTENTS

K1. INSTALLATION OF EQUIPMENT IN HAZARDOUS AREAS

100. Selection of electrical equipment in hazardous areas

101. Electrical equipment and wiring installed in hazardous areas should be limited to that necessary for operational purposes. Only the cables and types of equipment described in this chapter may be installed. Selection and installation of equipment and cables in hazardous areas should be in accordance with international standards (refer to IEC 61892 Series).

102. In selection of electrical apparatus for use in hazardous areas, consideration should be given to:

a. the zone in which the apparatus will be used;

b. the sensitivity to ignition of the gases or vapours likely to be present, expressed as a gas group; and

c. the sensitivity of the gases or vapours likely to be present to ignition by hot surfaces, expressed as a temperature classification.

103. Types of electrical equipment permitted should be determined according to the electrical hazardous area classification of the location in which the equipment is to be installed. Electrical apparatus used in hazardous areas should be manufactured, tested, marked and installed in accordance with international standards (refer to IEC 60079 Series) and certified by an independent testing laboratory recognized by the RBNA. Equipment classified in accordance with the following protection classes as per Table T.K1.103.1 may be used. Types of electrical equipment permitted shall be determined according to the electrical hazardous area classification of the location in which the equipment is to be installed.. The use of type “o” (oil immersion) should be limited. For transportable apparatus, protection type “o” should not be used.

TABLE T.K1.103.1 – TYPE AND LOCATION OF ELECTRICAL EQUIPMENT IN HAZARDOUS AREAS

Zone	Equipment protection level (*)	Degree of protection	Code	Reference standard
0	Ga	Intrinsically safe	Ex(ia)	IEC 60079-11
		Encapsulated	Ex(ma)	ABNT NBR 60079-18
1	-	Any type that may be considered for Zone 0		
		Through runs ofcable		
	Ga	Intrinsically safe	Ex(ia)	IEC 60079-11
		Encapsulated	Ex(ma)	ABNT NBR 60079-18
	Gb	Flame proofenclosure	Ex(d)	ABNT NBR 60079-1
		Increased safety	Ex(e)	ABNT NBR 60079-7
		Intrinsically safe	Ex(ib)	IEC 60079-11
		Encapsulated	Ex(m)Ex(mb)	ABNT NBR 60079-18
		Oil immersion	Ex(o)	ABNT NBR 60079-6
		Pressurized	Ex(p)	ABNT NBR 60079-2
		Sand filled	Ex(q)	ABNT NBR 60079-5
2	-	Any type that may be considered for Zone 1		
	Gc	Intrinsically safe	Ex(ic)	IEC 60079-11
		Encapsulated	Ex(mc)	ABNT NBR 60079-18
		Not ignited	Ex(n)Ex(nA)	ABNT NBR 60079-15
		Restricted “breathing”	Ex(nR)	ABNT NBR 60079-15
		Energy restriction	Ex(nL)	ABNT NBR 60079-15
		Sparking apparatus in which the contacts are protected in a suitable way	Ex(nC)	ABNT NBR 60079-15
		Pressurized	Ex(pZ)	ABNT NBR 60079-2
		FISCO – Fieldbus intrinsically safe concept		ABNT NBR 60079-27
		Special	Ex(s)	IEC 60079-33

(*) EPL – EquipmentProtectionLevel
EPL a – with very high level of protection and thus a very high degree of safety
EPL b – with high level of protection and therefore a high degree of safety
EPL c – with normal level of protection and therefore a conventional degree of safety

104. Selection with respect to the classification of gas or vapour: Flameproof enclosures and intrinsically-safe electrical apparatus, apparatus incorporating flameproof or intrinsically-safe components, or otherwise tested or certified for particular groups, shall be selected according to IEC 60079-12. Apparatus marked for particular gases shall be selected only where no other flammable gas can be present. Symbols for the groups which may be marked on the apparatus are listed against representative gases in Table T.K1.104.1.

Note – For certain categories of chemicals and liquefied gases, equipment of groups IIB and IIC may be required.

105. Group selection for electrical equipment shall be as follows:

- Group II shall be selected for types “e”, “m”, “n”, “o”, “p”, “q” and “s” apparatus.

- Group IIA, IIB or IIC shall be selected for types “i”, “d”, and certain types of “n” apparatus according to table T.K1.105.1.

TABLE T.K1.104.1 – RELATIONSHIPS BETWEEN APPARATUS GROUP AND REPRESENTATIVE GASES*

Apparatus group	Representative gas
IIA	Propane
IIB	Ethylene
IIC	Hydrogen
*Derived from IEC 60079-1	
Note - Gases generally are allocated to various groups upon determination of the maximum experimental safe gap or the minimum ignition current. These are related to the maximum gaps permissible in flameproof enclosures and the maximum	

currents permitted in intrinsically-safe circuits; both reduce progressively from group IIA to group IIC. See IEC 60079-12.

TABLE T.K1.105.1- RELATIONSHIP BETWEEN GAS/VAPOUR GROUP AND PERMITTED EQUIPMENT GROUP

Gas/vapour group	Electrical equipment group
IIC	IIC
IIB	IIB or IIC
IIA	IIA, IIB or IIC

106. Electrical apparatus shall be so selected that its maximum surface temperature will not reach ignition temperature of any gas/vapour possibly presenting in the hazardous areas in which the electrical apparatus is located. The relationship among equipment temperature class, equipment maximum surface temperature, gas/vapour ignition temperature is shown in Table T.K1.106.1.

TABLE T.K1.106.1 – RELATIONSHIP AMONG TEMPERATURE CLASS, MAXIMUM SURFACE TEMPERATURE AND IGNITION TEMPERATURE *

Temperature class of electrical apparatus	Maximum surface temperature of electrical apparatus (^{0}C)	Ignition temperature of gas or vapour (^{0}C)
T1	450	>450
T2	300	>300
T3	200	>200
T4	135	>135
T5	100	>100
T6	85	>85

*Derivedfrom IEC 60079-14

Note 1 - Generally, the ignition temperature of a mixture is taken to be equal to that of the component having the lowest ignition temperature, or is determined by test. However, it is recognized that the properties of certain categories of cargo are sufficiently well established to allow selection of equipment without individual analysis or test; for example equipment of temperature class T3 may be accepted for use in hazardous areas on crude oil or oil products tankers without analysis or test of particular cargoes.
Note 2 - For certain categories of chemicals, equipment of temperature class T4, T5 or T6 may be required.

200. Installation of electrical equipment in hazardous areas

201. Electrical apparatus located in hazardous drilling well and mud processing areas shall meet at least Group IIA and temperature class T3.

202. Electrical cables should meet the following:

a. Only cables associated with type “ia” equipment should be permitted in zone 0 areas.

b. Thermoplastic sheathed cables, thermosetting sheathed cables or elastomeric sheathed cables should be used for fixed wiring in zone 2 areas.

c. Flexible and portable cables, where necessary, used in zone 1 and zone 2 areas should be to the satisfaction of the RBNA.

d. Permanently installed, fixed cable passing through zone 1 hazardous areasshould be fitted with conductive covering, braiding or sheathed for earth detection.

300. Sources of electrical power

301. Sources of electrical power and their main/emergency switchboards and distribution boards, etc., shall, to the extent possible, not be located in hazardous areas

302. The generating plant, switchboards and batteries shall be separated from any zone 0 by cofferdams or equivalent spaces and from other hazardous areas by gas-tight steel divisions or in areas protected by overpressure. Access between such spaces shall comply with J1.300.

400. Distribution systems

401. **General:** distributionsystems for electrical installations in offshore units shall comply with provisions stated in IEC 61892-2. Additional provisions for distribution systems in hazardous areas are given below.

402. Earth fault detection – a device, or devices, shall be installed to monitor continuously the insulation resistance to earth of every insulated primary and secondary distribution systems with isolated neutral and to give audible and visual alarm at a manned position in the event of an abnormally low level of insulation resistance.

500. Protectionby over-pressure
[IEC 61892-7, IEC 60079-13]

501. Where a space has an opening into an adjacent, more hazardous space or area, it may be made into a less hazardous space or non-hazardous space in accordance with the following requirements as indicated in Tables T.K1.501.1 and T.K1.501.2.

502. Stagnant air spaces created within the room, that may allow a gas or vapour accumulation, for example by suspended ceilings, space between stiffeners, raised floors and similar shall be avoided unless otherwise monitored or protected to assure that an explosive atmosphere cannot persist during normal operation.

503. Doors shall be automatically self-closing, close fitting and designed to close and latch against the normal pressure differential. Doors shall be capable of being opened from within, even if locked (for example by the use of a panic bar). Doors shall not be fitted with any devices to hold the door in open position.

504. The location of inlets and outlets shall be arranged to ensure even distribution of the clean air flow so as to avoid pockets where gases or vapours could accumulate, taking into account the density of those gases and vapours. Design parameters and constraints shall be documented. Exterior air intakes and outlets shall be arranged to minimize the effect of outside conditions. The clean air supply used for pressurization shall be monitored with flammable gas detectors.

505. Clean air supply – the source of air shall be from a non-hazardous area. The continuous flow of clean air through the room shall be a minimum of 6 air changes per hour. This may need to be increased where dilution is necessary where there is an internal source of release.

506 A minimum over-pressure of 25 Pa (0,25 mbar) with respect to the adjacent, more hazardous, space or area shall be maintained at all points inside the space and its associated ducts at which leaks are liable to occur, all doors and windows being closed.

Note – This over-pressure will prevent the ingress of the external atmosphere for wind speed up to approximately3,5 m/s.

507 During initial start-up, or after shutdown, and whatever the classification of the hazardous area, it is necessary, before energizing any electrical apparatus within the space which is not suitably protected for the classification of the space in the absence of pressurization, to:

a. either ensure that the internal atmosphere is non-hazardous, or proceed with prior purging of sufficient duration that the internal atmosphere may be considered as non-hazardous, and

b. pressurize the space.

Note1 – The atmosphere is considered non-hazardous when, at all points in the space, the equipment enclosures and any associated ducts, the concentration of explosive gases or vapors is below 30 % of the lower explosive limit. The place of measurement shall be judiciously chosen to determine the highest concentration of gas.

Note 2 – For purging sequence see IEC 61892-7.

508. A differential pressure monitoring device or a flow monitoring device, or both, shall be provided for monitoring the satisfactory functioning of pressurization of spaces having an opening into a more hazardous zone.

Note – A fan motor running or a fan rotation monitoring device indication will not satisfy this requirement.

509. Where a flow monitoring device is used to indicate failure of pressurization, it is either to be verified that the pressurization level required by K1.502 is maintained with any door or other opening open, or an alarm is to be given if any door or opening is not closed.

510. In the event of the loss of overpressure, the protective measures indicated in Table T.K1.506.1 shall apply.

TABLE T.K1.501.1 – SPACES WITHOUT SOURCE OF RELEASE AND SEPARATED BY DOOR(S) FROM THE ZONES MENTIONED IN THE COLUMN

	Protected by overpressure	
	Separated by one door [1]	Separated by two doors [2]
Zone 1	Zone 2 (Table T.K1.501.2 – item 1)	Non-hazardous area (Table T. K1.501.2 – item 3)
Zone 2	Non-hazardous area (Table T. K1.501.2 – item 2)	Non-hazardous area (one door is sufficient)
[1] Door capable of maintaining the overpressure. [2] Two doors forming and air-lock capable of maintaining the overpressure.		

TABLE T.K1.501.2 – HAZARDOUS AREA CLASSIFICATION – SPACES WITHOUT SOURCE OF RELEASE, PROTECTED BY OVERPRESSURE RELATIVE TO SURROUNDING HAZARDOUS AREA AND SEPARATED BY DOOR(S)

p Pressure above atmospheric pressure

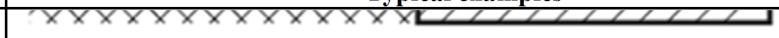
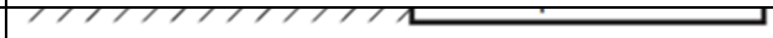
Item	Typical examples	Remarks
1		Pressurized space
2		Pressurized space
3		Pressurized spaces

TABLE T.K1.510.1 – PROTECTIVE MEASURES TO BE TAKEN IN THE EVENT OF FAILURE OF PRESSURIZATION

Classification of the space[1]	Electrical equipment installed		
	Equipment suitable for use in zone 1	Equipment suitable for use in zone 2	Equipment not protected forany hazardous area
Zone 1	No actionnecessary	– Suitable alarm(visible and audible) – Immediate action to restore pressurization – Programmed disconnection of power supplies if thepressurization cannot berestored for an extendedperiod or if the concentration of flammable gas risesto a dangerous level	– Suitable alarm(visible and audible) – Immediate action to restore pressurization – Automatic interruption of the power supplies as rapidly as practicable within aprescribed delay time with regard to the needs of a programmed shut-down
Zone 2	No action necessary	No action necessary	– Suitable alarm(visible and audible) – Immediate action to restore pressurization – Programmed disconnection of power supply if thepressurization cannot berestored for an extendedperiod or if the concentration of flammable gas risesto a dangerous level

[1] Classification of the space or area into which the opening leads

600. Movable equipment

601. Movable equipment, if accepted by the appropriate authority to be used in a hazardous area, is to be of a certified safe type, suitable for portable or transportable use and selected in accordance with this Subchapter.

NOTE – Hand-held (portable) equipment shall meet the drop test requirements of IEC 60079-0.

700. Electrical apparatus in hazardous drilling well and mud processingareas

701. Electrical apparatus located in hazardous drilling well and mud processing areas shall meet at least Group IIA and temperature class T3.

702. Electrical cables shall meet the following:

a. Only cables associated with type "ia" equipment shall be permitted in zone 0 areas.

b. Thermoplastic sheathed cables, thermosetting sheathed cables or elastomeric sheathed cables shall be used for fixed wiring in zone 2 areas.

c. Flexible and portable cables, where necessary, used in zone 1 and zone 2 areas shall be to the satisfaction of the RBNA.

d. Permanently installed, fixed cable passing through zone 1 hazardous areasshall be fitted with conductive covering, braiding or sheathed for earth detection.

800. Emergency shutdown facilities

801. Emergency conditions due to drilling operations – in view of exceptional conditions in which the explosion hazard may extend outside the areas defined in Chapter J below, special arrangements shall be provided to facilitate the selective disconnection of shutdown of:

a. Ventilation systems, except fans necessary for supplying combustion air to prime movers for the production of electrical power;

b. All electrical equipment outside Zone 1 areas, except where of a certified safe type for Zone 1 applications;

c. Main generator prime movers, including the ventilation systems for these;

d. Emergency equipment except those items listed in F5.203;

e. Emergency generator prime movers.

802. Initiation of the foregoing shutdown of facilities will be the operator's responsibility. The initiated action may vary according to the nature of the emergency. A recommended sequence of shutdowns shall be included in the Operating Manual (see Part I, Title 01, Section 2, B3.108).

803. In the case of units using dynamic positioning systems as a sole means of position keeping, special consideration may be given to the selective disconnection or shutdown of machinery and equipment associated with maintaining the operability of the dynamic positioning system in order to preserve the integrity of the well.

804. Disconnection or shutdown shall be possible from at least two strategic locations, one of which shall be outside hazardous areas.

805. Shutdown systems that are provided to comply with K1.601 shall be so designed that the risk of unintentional stoppages caused by malfunction in a shutdown system and the risk of inadvertent operation of a shutdown are minimized.

806. Equipment to remain operational after emergency shutdown – at least the following facilities are to be operable after an emergency shutdown. Equipment which is located in spaces other than enclosed spaces and arranged to be operated after complete shutdown as given K1.601 is to be suitable for installation in Zone 2 locations. Such equipment, when located in enclosed spaces, is to be suitable for its intended application to the satisfaction of the RBNA:

a. Emergency lighting required by F5.102 for half an hour;

b. Blow-out preventer control system;

c. General alarm system;

d. Public address system;

e. Battery-supplied radio communication installations; and

f. Fire and gas detection systems and their alarm systems.

900. Cables and types of electrical equipment permitted in hazardous areas

901. Electrical equipment in hazardous areas

a. Zone 0 Areas:

- Certified intrinsically safe circuits or equipment and associated wiring.

b. Zone 1 Areas:

- Certified intrinsically safe circuits or equipment and associated wiring.
- Certified flameproof (explosion proof) equipment.
- Certified increased safety equipment; for increased safety motors due consideration
- shall be given to the protection against overcurrent.
- Pressurized enclosure type equipment which is acceptable to the Society.
- Through runs of cables.

c. Zone 2 Areas:

- All equipment approved for Zone 1 Areas.
- Any equipment of a type which ensures absence of sparks or arcs and of “hot spots”during normal operation and which is acceptable to the Society.

902. Cables in hazardous areas

a. Zone 0 Areas:

- Cables associated with intrinsically safe circuits.

b. Zone 1 Areas – all cables shall be sheathed as follows:

- Nonmetallic impervious sheath plus metal screening or braiding for earth detection.
- Copper sheath plus nonmetallic outer sheath for earth detection (for mineral insulatedcable only).

c. Zone 2 Areas – all cables are to be sheathed as follows:

- As for Zone 1 areas.
- Nonmetallic sheath without metal screening or braiding, provided the cable is adequatelyprotected against mechanical damage.

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