

Mobile and fixed offshore units — Electrical installations —

Part 2: System design

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National foreword

This British Standard is the UK implementation of IEC 61892-2:2005.

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Electrical installations –**

**Part 2:
System design**



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INTRODUCTION

IEC 61892 forms a series of International Standards intended to enable safety in the design, selection, installation, maintenance and use of electrical equipment for the generation, storage, distribution and utilisation of electrical energy for all purposes in offshore units, which are being used for the purpose of exploration or exploitation of petroleum resources.

This part of IEC 61892 also incorporates and co-ordinates, as far as possible, existing rules and forms a code of interpretation, where applicable, of the requirements of the International Maritime Organisation, a guide for future regulations which may be prepared and a statement of practice for offshore unit owners, constructors and appropriate organisations.

This standard is based on equipment and practices, which are in current use, but it is not intended in any way to impede development of new or improved techniques.

The ultimate aim has been to produce a set of International standards exclusively for the offshore petroleum industry.

MOBILE AND FIXED OFFSHORE UNITS – ELECTRICAL INSTALLATIONS –

Part 2: System design

1 Scope

This part of IEC 61892 contains provisions for system design of electrical installations in mobile and fixed units used in the offshore petroleum industry for drilling, production, processing and for storage purposes, including pipeline, pumping or 'pigging' stations, compressor stations and exposed location single buoy moorings.

It applies to all installations, whether permanent, temporary, transportable or hand-held, to a.c. installations up to and including 35 000 V and d.c. installations up to and including 750 V.(a.c. and d.c. voltages are nominal values)

This standard does not apply either to fixed equipment used for medical purposes or to the electrical installations of tankers.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60038:2002, *IEC standard voltages*

IEC 60092-101:2002, *Electrical installations in ships – Part 101: Definitions and general requirements*

IEC 60092-504:2001, *Electrical installations in ships – Part 504: Special features – Control and instrumentation*

IEC 60447, *Basic and safety principles for man-machine interface, marking and identification – Actuating principles*

IEC 60533, *Electrical and electronic installations in ships – Electromagnetic compatibility*

IEC 60617-DB:2001²⁾ *Graphical symbols for diagrams – Architectural and topographical installation plans and diagrams*

IEC 60947-2:2003, *Low voltage switchgear and controlgear – Part 2: Circuit-breakers*

IEC 61000-2-4, *Electromagnetic compatibility (EMC) – Part 2-4: Environment – Compatibility levels in industrial plants for low-frequency conducted disturbances*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

²⁾ "DB" refers to the on-line IEC database.

IEC 61511, (all parts), *Functional safety – Safety instrumented systems for the process industry sector*

IEC 61892-1:2001, *Mobile and fixed offshore units – Electrical installations – Part 1: General requirements and conditions*

IEC 61892-3, *Mobile and fixed offshore units – Electrical installations – Part 3: Equipment*

IEC 61892-5:2000, *Mobile and fixed offshore units – Electrical installations – Part 5: Mobile units*

IEC 61892-7:1997, *Mobile and fixed offshore units – Electrical installations – Part 7: Hazardous areas*

IEC 62271-100, *High-voltage switchgear and controlgear – Part 100: High-voltage alternating-current circuit-breakers*

SOLAS, *International Convention for the Safety of Life at Sea*

IMO MODU Code:1990, *Code for the Construction and Equipment of Mobile Offshore Drilling Units,*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE The definitions included in this part are those having general application in the IEC 61892 series. Definitions applying to particular apparatus or equipment are included in the other parts of IEC 61892.

3.1

a.c. systems of distribution

3.1.1

single-phase two-wire a.c. system

system comprising two conductors only, between which the load is connected

NOTE In some countries this is designated as a two-phase system

3.1.2

three-phase three-wire a.c. system

system comprising three conductors connected to a three-phase supply

3.1.3

three-phase four-wire a.c. system

system comprising four conductors of which three are connected to a three-phase supply and the fourth to a neutral point in the source of supply

3.2

appropriate authority

governmental body with whose rules a unit is required to comply

3.3

availability

the state of an item of being able to perform its required function
[IEV 603-05-04]

3.4**back-up protection³⁾**

equipment or system which is intended to operate when a system fault is not cleared in due time because of:

- failure or inability of a protective device closest to the fault to operate, or
- failure of a protective device, other than the protective device closest to the fault, to operate

3.5**centralized control**

control of all operations of a controlled system from one central control position

3.6**computer-based system**

system that consists of one or more programmable electronic devices with their connections, peripherals and software necessary to carry out automatically specified functions

3.7**continuity of service³⁾**

condition. that after a fault in a circuit has been cleared, the supply to the healthy circuits is re-established

NOTE See circuit 3 in Figure 1.

3.8**continuity of supply**

condition that during and after a fault in a circuit, the supply to the healthy circuits is permanently ensured

NOTE See circuit 3 in Figure 1.

3.9**control functions**

functions intended to regulate the behaviour of equipment or systems

3.10**control position (control station)**

group of control devices by which an operator can control the performance of a machine, apparatus, process or assembly of machines and apparatus

3.11**d.c. systems of distribution****3.11.1****two-wire d.c. system**

system comprising two conductors only, between which the load is connected

3.11.2**three-wire d.c. system**

system comprising two conductors and a middle wire, the supply being taken from the two outer conductors or from the middle wire and either outer conductor, the middle wire carrying only the difference-current

3.12**diversity factor (demand factor)**

ratio of the estimated total load of a group of consumers under their normal working conditions to the sum of their nominal ratings

³⁾ The International Electrotechnical Vocabulary (IEV) definition for this term is not applicable for this standard.

3.13

fail-to-safe

principle by which a failure or malfunction of a component of the system causes its output to automatically adjust to a predetermined safe state

[IEV 191-15-04 modified]

3.14

function

elementary operation performed by the system which, in conjunction with other elementary operations (system functions), enables the system to perform a task

3.15

high voltage

the set of voltage levels in excess of low voltage

[IEV 601-01-27 modified]

3.16

hull-return system

system in which insulated conductors are provided for connection to one pole or phase of the supply, the structure of the unit or other permanently earthed structure being used for effecting connections to the other pole or phase

3.17

integrity

capability of a system to satisfactorily perform the required functions under all the stated conditions within a stated period of time

[IEV 191-19-07 modified]

3.18

low voltage

a set of voltage levels used for the distribution of electricity and whose upper limit is generally accepted to be 1 000 V a.c.

[IEV 601-01-26]

3.19

machinery control room

room or spaces where centralized controls and measuring and monitoring equipment for main equipment and essential auxiliary machinery are located together with the appropriate means of communication

3.20

maintainability

ability of an item under given condition of use, to be retained in, or restored to, a state in which it can perform a required function, when maintenance is performed under given conditions and using stated procedures and resources

[IEV 191-02-07]

3.21

monitoring functions

functions intended to collect data from equipment and systems for the purpose of display and recording

3.22**over-current**

a current exceeding the rated current

[IEV 441-11-06]

3.23**over-current discrimination**

co-ordination of the operating characteristics of two or more over current protective devices such that, on the incidence of over-currents within stated limits, the device intended to operate within these limits does so, while the other(s) does (do) not

[IEV 441-17-15]

3.24**overload**

operating conditions in an electrically undamaged circuit, which cause an over-current

[IEV 441-11-08]

3.25**partial discrimination (partial selectivity)⁴⁾**

over-current discrimination where, in the presence of two or more over-current protective devices in series, the protective device closest to the fault effects the protection up to a given level of short-circuit current without causing the other protective devices to operate

3.26**primary distribution system**

system having electrical connection with the main source of electrical power

3.27**rated load**

highest value of load specified for rated conditions

3.28**reliability**

the probability that an item can perform a required function under given conditions for a given time interval

[IEV 191-12-01]

3.29**safety functions**

functions intended to prevent harm or danger to personnel

3.30**secondary distribution system**

system having no electrical connection with the main source of electrical power, e.g. isolated therefrom by a double-wound transformer or motor-generator

3.31**short-circuit**

accidental or intentional conductive path between two or more conductive parts forcing the electric potential difference between these conductive parts to be equal to or close to zero

[IEV 195-04-11]

⁴⁾ The International Electrotechnical Vocabulary (IEV) definition for this term is not applicable for this standard.

3.32

software

program, procedures and associated documentation pertaining to the operation of a computer system and including application (user) program, middleware and operating system (firmware) program

3.33

sources of electrical power

3.32.1

emergency source of electrical power

source of electrical power intended to supply the emergency system in the event of failure of the supply from the main source of electrical power

3.32.2

main source of electrical power

source of electrical power intended to supply all services necessary for maintaining the unit in normal operational and habitable condition

3.34

system

collection of components organised to accomplish a specific function or set of functions

3.35

total discrimination (total selectivity)⁵⁾

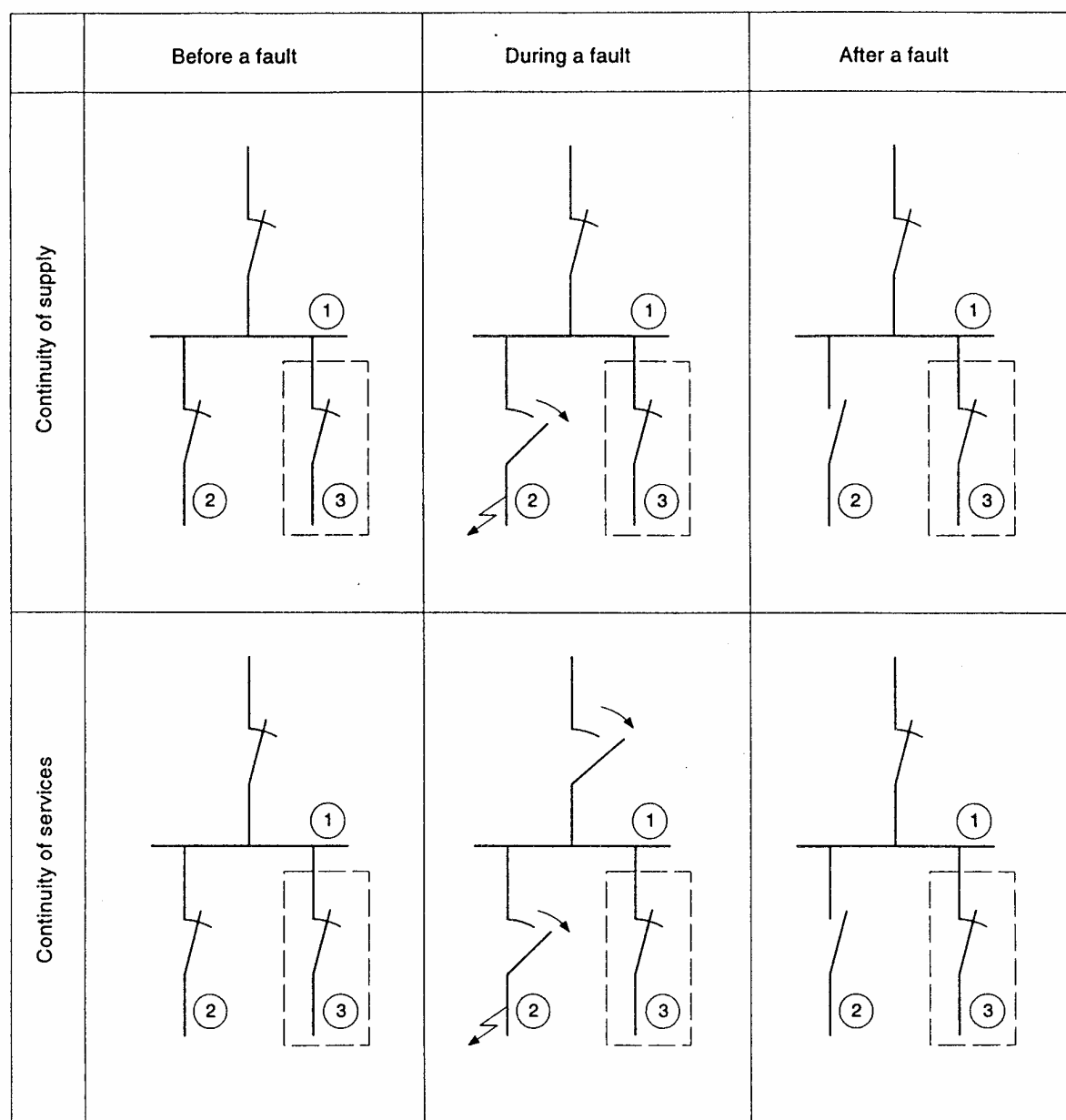
over-current discrimination where, in the presence of two or more over-current protective devices in series, the protective device on the load side effects the protection without causing the other protective devices to operate

3.36

usability

extent to which a system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use

⁵⁾ The International Electrotechnical Vocabulary (IEV) definition for this term is not applicable for this standard.



IEC 525/05

Figure 1 – Continuity of supply/continuity of service

4 Sources of electrical power

4.1 General

Electrical installations shall be such that:

4.1.1 All electrical services necessary for maintaining the unit in normal operational and habitable condition shall be assured without recourse to the emergency source of electrical power.

4.1.2 Electrical services essential for safety shall be assured also under various emergency conditions.

4.1.3 When a.c. generators are involved, the design basis of the system shall include the effect of inrush current of e.g. large motors, transformers, capacitors and chokes, connected to the system. The voltage drop due to such current shall not cause any motor already operating to stall or to have any adverse effect on other equipment in use.

NOTE Consideration regarding harmonic distortions should be given to installations with a high load from power semiconductor systems.

4.1.4 The voltage profile of the system shall be confirmed by studies as defined in Clause 9. Voltage tolerances are given in IEC 61892-1. The total voltage drop between generators or transformers and load shall not exceed the following values:

AC systems:	– normal continuous load	6 %
	– motor starting	20 %
DC systems:		10 %

NOTE 1 The voltage drop should be calculated from the distribution board where regulating facilities are included, that is, supplied by a transformer with tapings or a generator.

NOTE 2 Voltage drop calculations should take account of the power factor of the load. Where this is not known, a value of 0,85 for normal a.c. loads and 0,3 for motor starting conditions is recommended.

NOTE 3 Where specific loads require closer tolerances for voltages in order to maintain functionality or performance, then specific calculations should be made to confirm values of voltage drop, particularly in cables.

NOTE 4 Operating limit values for generators are given in IEC 60034-22.

4.2 Main source of electrical power

4.2.1 The main source of electrical power shall consist of at least two generator sets. For fixed units other sources of electrical power supply arrangements may be acceptable subject to approval by the appropriate authority.

For small installations where renewable sources of energy are used, for example photovoltaic cells or wind generators, stationary batteries shall be provided to guarantee the distribution of the electrical power during the time without sun or wind. The batteries' autonomy shall be in accordance with the appropriate authority.

4.2.2 The capacity of the generators shall be such that in the event of any one generator being stopped, it shall still be possible to supply those services necessary to provide:

a) normal operational conditions and safety;

NOTE It is not required that full operation with maximum load shall be maintained with one generator being stopped.

b) minimum comfortable conditions of habitability;

NOTE Minimum comfortable conditions of habitability include at least adequate services for lighting, cooking, heating, domestic refrigeration, mechanical ventilation, sanitary and fresh water.

4.2.3 Where transformers, converters or similar appliances constitute an essential part of the electrical supply system required by 4.2.1, the system shall be so arranged as to ensure the same continuity of supply as stated in 4.2.2.

4.3 Emergency source of electrical power

4.3.1 A self-contained emergency source of electrical power shall be provided as required by the appropriate authority. Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances, the emergency source of electrical power may, in exceptional cases and for periods of short duration, be used to supply non-emergency circuits subject to agreement by the appropriate authority.

NOTE 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 required by 4.7.1, the requirements of 4.3.1 may be considered satisfied without an additional emergency source of electrical power, subject to approval of the appropriate authority.

The power available, duration of supply and services provided for safety in an emergency shall be as required by the appropriate authority.

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

- a) driven by a suitable prime-mover with an independent supply of fuel and cooling medium;
- b) started automatically upon failure of the supply from the main source of electrical power to the emergency system, and it shall be automatically connected to the emergency system;
- c) provided with a transitional source of emergency electrical power according to 4.3.4.

NOTE 1 Further consideration should be given to other conditions affecting the emergency generator prime-mover such as environmental conditions, etc.

NOTE 2 For starting arrangements of emergency generators, see 4.9.

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

- a) carrying the emergency electrical load without recharging whilst maintaining the voltage of the battery throughout the discharge period within $\pm 12\%$ of its nominal voltage;
- b) automatic connection to the emergency switchboard in the event of failure of the main source of electrical power supply; and
- c) immediately supplying at least those services required for the transitional source of electrical power in 4.3.4.

4.3.4 The transitional source of emergency electrical power required in Item c) of 4.3.2 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 $\pm 12\%$ of its nominal voltage and so arranged as to supply automatically in the event of failure of either the main or the emergency source of electrical power the services which are required by the appropriate authority. The capacity shall be sufficient for a period of at least 30 min or for the period defined by the appropriate authority.

For mobile units, reference shall be made to IMO 1989 MODU CODE 5.3.10.

NOTE A UPS system is acceptable as a transitional source of emergency power.

4.3.5 Provision shall be made for the testing at regular intervals of the complete emergency power system and shall include the testing of the automatic starting arrangements. Testing at regular intervals shall also cover load operation.

4.3.6 The emergency source of electrical power may be used for the purpose of starting a main generator set from a power blackout condition if its capability either alone or combined with that of any other source of electrical power is sufficient to provide at the same time the emergency services required by the appropriate authority.

Where the means for starting a main generator set from a power blackout condition is solely electrical and the emergency source of electrical power cannot be used for this purpose, the means for starting the generator set to be used for start-up from the power blackout condition shall be provided with starting arrangements at least equivalent to those required for starting the emergency generator set.

4.3.7 During changeover from the main source of electrical power to the emergency source of electrical power, an uninterruptible power supply (UPS) system shall ensure uninterrupted duty for consumers which require continuous power supply, and for consumers which may malfunction upon voltage transients.

4.4 Additional requirements for periodically unattended machinery spaces

4.4.1 Units intended for operation with periodically unattended machinery spaces shall comply with 4.4.2 to 4.4.8 inclusive.

4.4.2 Where electrical power is normally supplied by one of the unit's generating sets, arrangements such as load shedding, shall be provided to ensure that the safety of the unit with regard to station-keeping, propulsion and steering, is at least equivalent to that of a unit having the machinery space manned.

4.4.3 In the event of failure of the generating set(s) in service, provision shall be made for the automatic starting and connection to the main switchboard of a stand-by generating set of sufficient capacity to supply those services necessary to ensure that the safety of the unit with regard to station-keeping, propulsion and steering, is at least equivalent to that of a unit having the machinery space manned.

4.4.4 The arrangement shall permit automatic re-starting of all essential services, which may be sequentially started if necessary.

4.4.5 The automatic starting system and characteristics of the stand-by generating set shall be such as to permit the stand-by generator to carry its full load as quickly as is safe and practicable, subject to a maximum of 45 s.

4.4.6 Arrangements shall be provided to prevent more than one automatic closing of a given generator circuit breaker under short-circuit conditions.

4.4.7 If the electrical power is normally supplied by more than one generator operating in parallel, provisions shall be made by means such as load shedding or by appropriate separation of the switchboard busbar to ensure that, in the event of loss of one of these generating sets, the remaining set(s) are kept in operation without overload to permit station-keeping, propulsion and steering, and to ensure the safety of the unit.

4.4.8 Requirements relating to safety and alarm systems are specified in Clause 12.

4.5 General requirements for renewable sources of electrical power

4.5.1 Photovoltaic System

The system shall be sized in a way that guarantees the power for normal operating conditions and ensures the supply of the loads even in periods of "no sun".

When sizing the system, the following shall be taken into consideration:

- environmental conditions;
- geographic location;
- solar radiation;
- days foreseen with "no sun";
- required energy by the loads (Wh/day);
- energy for preferential load supply;
- rated voltage and current;

- photovoltaic module maintenance coefficient;
- safety factor;
- efficiency of storage battery.

NOTE For information on photovoltaic design and systems reference should be made to IEC 60904 series and IEC 61194.

4.5.2 Eolic System

The system shall be sized in a way that guarantees the power for normal operating conditions and ensures the supply of the loads even in periods of “wind lull”.

When sizing the system, the following shall be taken into consideration:

- environmental conditions;
- geographic location;
- ventilation;
- days foreseen with “wind lull”;
- required energy by the loads (Wh/day);
- energy for preferential load supply;
- rated voltage and current;
- wind generator maintenance coefficient;
- safety factor;
- efficiency of storage battery.

To allow for periods when there is no wind an alternative means of charging batteries shall be installed.

NOTE 1 To allow for safe maintenance of wind generator systems a suitable means of braking should be fitted to the turbines together with a safe means of access.

NOTE 2 For information on wind energy systems reference should be made to AWEA standards 3.1 and 6.1.

4.6 Arrangement and location

4.6.1 The generating plant, switchboards and batteries shall be separated from any hazardous areas according to IEC 61892-7. Batteries, e.g. for nav-aid systems, may be accepted in hazardous areas, provided the batteries with enclosure are certified for the area in question.

NOTE The hazardous area generated by the battery itself is not covered by this requirement.

4.6.2 The emergency source of electrical power, any associated transforming equipment, the emergency switchboard and related cables shall not be located in any space(s) containing the main source of electrical power or other equipment presenting a fire risk nor in any room or compartment having direct access to such space(s).

For mobile and floating production units the location shall be on or above the uppermost continuous deck or equivalent and shall be readily accessible from the open deck.

Rooms or compartments in which the emergency source of electrical power, any associated transforming equipment, or the emergency switchboard are located shall be separated from any machinery space containing the main source of electrical power, by classified partitions as defined in the International Convention for the Safety of Life at Sea.

For fixed units the requirement for separation of the main and emergency power plant shall be in accordance with the requirements of the appropriate authority.

The emergency power system shall be arranged so as to permit total electrical separation from the main power system. During normal service, interconnection from the main switchboard shall supply power to the emergency switchboard provided that automatic interruption of the interconnection at the emergency switchboard is ensured in the event of failure of the main source of electrical power.

The functioning of the emergency power systems shall be ensured in the event of fire in the space(s) containing the main source of electrical power.

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

4.7 Output

4.7.1 The emergency source of electrical power shall be sufficient to supply all those services that are essential for safety in a case of emergency for at least 18 hours or for the time defined by the appropriate authority. Due regard shall be paid to such services as may have to be operated simultaneously.

The most common services are the following:

- a) navigation and obstruction signals and lights;
- b) lighting of all zones essential for survival such as escapeways, personnel lift cars and trunks, landing pads, boat boarding stations;
- c) external communication systems;
- d) fire detection, fire alarms and emergency fire-fighting equipment operating on electric power;
- e) equipment, operating on electric power, at life-saving stations serving platform disembarkation;
- f) emergency shutdown systems
- g) safety telecommunication systems;
- h) general alarm;
- i) equipment to be used in connection with the drilling process in case of an emergency (for example Blow Out Preventer systems);
- j) equipment essential for the immediate safety of diving personnel;
- k) gas detection and gas alarm;
- l) internal communication systems required in an emergency;
- m) any other emergency or essential system;
- n) lighting of machinery spaces to allow essential operations and observations under emergency conditions and to allow restoration of service;
- o) all power-operated watertight door systems;
- p) all lighting relative to helicopter operations and landing;
- q) all permanently installed battery chargers servicing equipment required to be powered from an emergency source;
- r) sufficient number of bilge and ballast pumps to maintain safe operations during emergency conditions.

4.7.2 Navigation and obstruction signals and lights, which may be required for marking of offshore units, shall be provided with power for a period of 4 days without external power supply.

4.8 Additional requirements for electrical emergency power systems

4.8.1 Prime movers for emergency generators shall have as few automatic safety functions as possible in order to ensure continuous operation. Normal motor and generator protection shall be provided if running unattended for test of the emergency generator or if it is used as a harbour generator.

4.8.2 An indicator shall be mounted in a suitable place to indicate when an emergency battery is discharging.

NOTE Battery backed light fittings do not do this in general. Trip of supply to emergency lighting shall give alarm at a manned position.

4.8.3 For floating units 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 stated in IEC 61892-5.

4.9 Starting arrangements for emergency generators

4.9.1 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, applicable to the appropriate authority, so that ready starting will be assured.

4.9.2 Each emergency generator, which is arranged to be automatically started, shall be equipped with starting arrangements acceptable to the appropriate authority 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.

4.9.3 Where both the main and secondary start arrangements are electrical, the systems shall be independent and include two chargers, and two batteries.

NOTE Consideration should be given to the provision of two starter motors.

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

4.9.5 All 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.

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

4.9.7 For a unit which is normally manned the readiness of the emergency generator to start shall be indicated in a manned location, for example the control room.

5 System earthing

5.1 General

Clause 5 gives requirements and recommendations for system earthing, i.e. an intentional connection of the neutral point of the electrical power supply system to hull or structure.

NOTE 1 The intent of the requirements is to promote broad application of the fewest varieties of system earthing patterns that will satisfy operational and safety requirements. Even minor deviations in design are to be avoided.

NOTE 2 On occurrence of a fault from line to earth, the steady state and transient voltages to earth and fault currents vary with the impedance between the neutral point and earth. This impedance is dependent on the treatment of the neutral point.

5.2 General requirements

5.2.1 System earthing shall be considered for all electrical power supply systems in order to control and keep the system's voltage to earth within predictable limits. It shall also provide for a flow of current that will allow detection of an unwanted connection between the system conductors and earth, which should instigate automatic disconnection of the power system from conductors with such undesired connections to earth. For an IT system (see Clause 6) an alarm shall be given at a manned control centre.

NOTE Guidance to a system for the investigation of earth faults should be available.

5.2.2 The magnitude and duration of a potential earth fault current shall not exceed the design capacity of any part of the electrical power supply system.

5.2.3 Where an earthed system is divided into two or more sections, means for neutral earthing shall be provided for each section.

NOTE For installations in hazardous areas, see IEC 61892-7.

5.2.4 For emergency power systems consideration shall be given to the need for continuous operation of the consumers supplied from the emergency power system when deciding between earthed and isolated systems.

NOTE A system with isolated neutral should normally be used to supply to the emergency consumers.

5.2.5 AC uninterruptible power systems (UPS) shall have an isolated neutral.

5.3 Neutral earthing methods

The selection of one of the following methods of treating the neutral for a specific electrical power system shall be based on technical and operational factors:

- directly earthed (TN system);
- impedance earthed (IT system);
- isolated (IT system).

NOTE 1 The principal features of these methods are presented in Table 1.

NOTE 2 Although not intentionally connected to earth, the so called "unearthed" or "isolated" system is in fact capacitively earthed by the distributed capacitance to earth of the conductors throughout the system together with any interference suppression capacitors.

5.4 Neutral earthing for systems up to and including 1 000 V

5.4.1 The neutral point shall either be directly connected to earth or through an impedance.

NOTE 1 Earthed neutral systems should be achieved by connecting the neutral point directly to earth. The earth loop impedance shall be low enough to permit the passage of a current at least three times the fuse rating for fuse protected circuits or one and a half times the tripping current of any excess current circuit breaker used to protect the circuit.