

GENERAL SPECIFICATION

ELECTRICAL

GS EP ELE 021

Electrical design criteria for floating units
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1. Scope

This specification defines the design criteria used for the engineering, supply, manufacture, and installation of the electrical systems to be installed within the hull and accommodation of floating units such as FPSO (Floating Production, Storage and Offloading System), FSO (Floating Storage and Offloading System), FPS (Floating Production system), FSU (Floating Storage Unit).

The design criteria for Topsides process and utilities systems to be installed on steel decks/structures above the hull tank deck are covered by Company General Specification **GS EP ELE 001**.

For the purpose of the present specification, the abbreviation **"F.U" (Floating Unit)** shall be used.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

Design and engineering shall conform to the appropriate sections of the latest editions (with amendments) of the relevant IEC, CENELEC, Classification Society standards, codes and rules.

The following order of precedence applies specifically to electrical equipment:

- Applicable laws, rules and regulations of the country in which the system will be operated. In cases where no "local" regulations exist, then French laws and regulations shall be used
- Rules edited by the Classification Society¹
- Company Particular Specifications and data sheet (if any)
- Company General Specifications
- Applicable International Electrotechnical Commission (IEC) standards
- Applicable European Standards by CENELEC
- Applicable recognized standards and codes (UTE-NFC, BS, VDE, etc.) when IEC publications have not yet been issued.

In case of conflict between Classification Society rules and Company General Specifications the most stringent requirements shall apply.

Where no recognised standard exists the Contractor is to define and agree with the Company the requirements to be followed:

¹ Rules applying to Electrical systems subject to classification by one of the classification societies listed in Company General Specification **GS EP STR 651**.

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External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
CAP 437	Offshore helicopter landing areas - Guidance of standards
EN 50272-2	Safety requirements for secondary batteries and battery installations - Part 2: Stationary batteries
IALA	Recommendations for the marking of offshore structures
ICAO	International Convention On Civil Aviation
IEC 60038	IEC Standard Voltages
IEC 60050 (All parts)	International Electrotechnical Vocabulary - All parts
IEC 60083	Plugs and socket-outlets for domestic and similar general use standardized in member countries of IEC
IEC 60092 (All parts)	Electrical installations in ships - All parts
IEC 60228	Conductors of insulated cables
IEC 60309 (All parts)	Plugs, socket-outlets and couplers for industrial purposes - All parts
IEC 60331-21	Tests for electric cables under fire conditions - Circuit integrity - Part 21: Procedures and requirements-Cables of rated voltage up to and including 0.6/1.0 kV
IEC 60502 (Parts 1; 2)	Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV - Parts 1; 2
IEC 60529	Classification of degrees of protection provided by enclosures
IEC 60533	Electromagnetic Compatibility of Electrical and Electronic Installations in Ships and of Mobile and Fixed Offshore Units
IEC 60617 (All parts)	Graphical symbols for diagrams - All parts
IEC 60622	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Sealed nickel-cadmium prismatic rechargeable single cells
IEC 60623	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Vented nickel-cadmium prismatic rechargeable single cells
IEC 60909 (All parts)	Short-Circuit Current Calculation in 3 phase AC Systems - All parts
IEC 61000 (All parts)	Electromagnetic compatibility (EMC) - All parts

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Reference	Title
IEC 61558-2-6	Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100 V - Part 2-6: Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers
IEC 61892 (Parts 2; 4; 6; 7)	Mobile and fixed offshore units - Electrical installations - Parts 2; 4; 6; 7
IEC 62259	Secondary cells and batteries containing alkaline or other non-acid electrolytes-Nickel cadmium prismatic secondary single cells with partial gas recombination
IEC 62402	Obsolescence management - Application guide
IEEE 519	Recommended practices and requirements for harmonic control in electrical power systems
NR445	Bureau Veritas: Rules for the classification of offshore units
SOLAS	International Convention for the Safety of Life at Sea

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP ELE 001	Electrical design criteria
GS EP ELE 011	Electrical requirements for packaged units
GS EP ELE 013	Electrical requirements for generating units
GS EP ELE 061	Minimum requirements for HV & LV cable sizing
GS EP ELE 079	Electrical apparatus for potentially explosive gas atmospheres
GS EP ELE 081	Lighting
GS EP ELE 091	Minimum Contractor document requirements
GS EP ELE 111	Induction motors
GS EP ELE 113	AC generators
GS EP ELE 114	HV Synchronous Motors
GS EP ELE 121	HV Variable Speed Drive Systems
GS EP ELE 131	High voltage switchgear and controlgear
GS EP ELE 135	Low voltage switchgear assembly
GS EP ELE 137	Distribution boards
GS EP ELE 141	Power transformers

Reference	Title
GS EP ELE 151	DC Uninterruptible Power Systems (UPS)
GS EP ELE 152	AC Uninterruptible Power Systems (UPS)
GS EP ELE 161	Electrical cables
GS EP ELE 221	Electrical Control System (ECS)
GS EP ELE 311	Cables trays/ladders
GS EP ELE 321	Navigational Aids System
GS EP ELE 364	Electrical installations
GS EP ELE 451	Third party inspection. Independent verification of electrical facilities
GS EP ELE 460	Engineering Studies
GS EP EXP 105	Precommissioning execution
GS EP EXP 107	Commissioning execution
GS EP INS 107	Design and installation of instrumentation links
GS EP SAF 216	Area classification
GS EP STR 651	General principles for a F(P)SO design
GS EP TEC 007	Obsolescence and Lifetime Cycle Management

3. Vocabulary, units and symbols

The Electrotechnical vocabulary and graphical symbols used shall be as defined in the [IEC 60050](#) and [IEC 60617](#) standards.

Units used shall be as defined in the International System of units (SI).

In the case of utilisation of any vocabulary, units or symbols that are not in the above IEC publications, the Engineer/Contractor is required to produce a glossary (for vocabulary), correspondence table to IEC units (for units) and/or clear legend (for symbols).

4. Design parameters

4.1 Design lifetime and environmental conditions

Electrical equipment design lifetime shall be minimum 20 years.

Environmental conditions shall be specified, according to the actual site environmental conditions, subject to Society approval.

Outdoor electrical equipment shall be designed to operate continuously in an ambient temperature corresponding to the extreme outside temperatures as defined in the project specific environmental data.

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4.2 Ambient air temperatures and Humidity

Unless otherwise specified in project particular specification, electrical equipment design temperature for continuous operation shall be:

- 45°C in enclosed spaces
- 40°C in environmentally controlled spaces, provided requirements of BV rule [NR445](#) part C + CH2 Sect. 12 - § 1.4 are fulfilled, except equipment used for Emergency services which shall be designed for 45°C.

Unless otherwise specified in project particular specification following values of relative humidity in non air conditioned areas shall be considered:

- 95% up to 45°C
- 70% above 45°C.

In air conditioned rooms, electrical equipment shall be designed for continuous operation under relative humidity of 60%.

4.3 Sea water temperature

Sea water temperature range shall be specified, according to the actual site environmental conditions, subject to Classification Society approval.

4.4 Corrosive atmosphere

In case of corrosive atmosphere (e.g.: H₂S...) special provisions shall be taken by the equipment Supplier to avoid equipment corrosion. The Supplier shall indicate in his bid which protection / measures have been taken for all equipment.

4.5 Degrees of protection provided by enclosures

Degree of protection of enclosures as defined in [IEC 60529](#) shall comply with the requirements of the Classification Society rules.

Yet, the minimum degree of protection of enclosures shall comply with the relevant equipment specification and/or data sheet and shall be at least:

- | | |
|---|--|
| • Internal equipment: | IP 21 |
| • External equipment (general): | IP 55 |
| • External equipment (on exposed deck): | IP 56 (IP 66 for lighting apparatus, junction boxes) |

4.6 Operating design conditions

Electrical equipment design shall take into account the maximum operating conditions defined for transit to the Operating Site, as well as for conditions after Installation at the Operating Site.

Maximum operating conditions data are those required on table 1 and table 2 of [GS EP STR 651](#) - Appendix 2.

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5. Hazardous area

ATEX European directive 94/9/EC shall apply to equipment installed in hazardous areas.

For category 3 equipment, certification by Manufacturer only is not accepted. A "type examination certificate" shall be delivered by a Notified Body.

For facilities located outside the European Union (EU countries), alternative IECEx scheme may be applied (IEC Scheme for Certification relating to Equipment for use in Explosive Atmospheres).

Selection of electrical apparatus for hazardous areas shall be done according to the recommendations of the Classification Society rules, [IEC 61892-7](#) and [GS EP ELE 079](#). In case of discrepancy, the most stringent shall apply.

6. System basis of design

6.1 General principles

All distribution systems shall be designed to fulfil the following requirements:

- To ensure maximum continuity of supply to users as far as possible
- To provide reliable power sources
- To allow operation and maintenance of the system in a safe manner without unduly affecting the production of the plant
- To allow remote operation from a centralised control room, or technical room
- To design a system for which the necessary elements e.g. switchgear, cables, etc. are currently manufactured, and tested. Industrial type equipment with a minimum of two years field proven experience is required
- Selection of equipment shall be based on OPEX and CAPEX considerations.

For the purpose of this specification, the loads are classified into normal, essential or emergency according to the following definitions:

- Normal loads:

Loads which in case of failure of the main power generation have no effect either on the safety or on the safeguard of installation or equipment. They are mainly equipment for process treatment and offloading.

- Essential loads are:
 - Essential Marine/LQ loads
 - Equipment for maintaining normal comfort and habitability conditions for people on board
 - Equipment for maintaining marine operations
 - Essential Flow assurance loads
 - Essential start-up loads (starting of main power generation).

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- Emergency loads:
 - Loads affecting personal safety whether directly or indirectly and inducing risk of major damages on installation or equipment.

For the purpose of this specification typical lists of essential and emergency services are given in § 10 below.

6.2 Frequencies and voltages

Association of voltages and frequencies used must keep to the values recommended by the IEC standards.

For new F.U the standard [IEC 60038](#) shall apply.

For existing F.U (refurbished units) the standard [IEC 60092](#) remains acceptable.

6.3 Standard frequency

50 Hz, unless otherwise specified in the Project Particular Specification.

6.4 Standard voltages

Selection of voltages shall be based on the following parameters:

- Power to be delivered (based on the power balance established for each consumer voltage level)
- Short-circuits levels.

Unless otherwise specified, the following voltage levels shall be used:

- **A.C High voltage** (50 Hz)

Power generation:	11 - 6.6 kV	Main & Essential generators output voltage
Power distribution:	22 - 11 - 6.6 kV	HV/HV - HV/LV transformers, HV motors, Interconnection with other fields and satellites

- **A.C Low voltage** (50 Hz)

Power generation:	400 - 690 V	Essential & Emergency generators output voltage
Power distribution:	400 - 690 V	Motor loads, and main power distribution
	230 V	Lighting, heat tracing, small power boards
	400 V - 230 V	UPS, Control and instrumentation - Telecommunications - Navigational aids

- **D.C Low voltage**

110 V - 120 V	DC lube oil pumps (e.g. turbine packages), Electrical control
48 V	Electrical control, etc.
24 V	Electrical control, Instrumentation, Telecom systems (SOLAS)

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6.5 Voltage and frequency variations

All A.C. electrical equipment supplied is to be so designed and manufactured that it is capable of operating satisfactorily at the variations of voltage and frequency hereunder specified:

6.5.1 A.C systems

Unless otherwise specified electrical equipment shall operate satisfactorily with the following simultaneous variations, from their nominal value, when measured at the consumer input terminals.

Voltage:

- Steady state variations: +10%, -10%
- Transient variations: +20%, -20% Recovery within 1.5 seconds

Frequency:

- Steady state variations: $\pm 5\%$
- Transient variations: $\pm 10\%$ Recovery time: within 5 seconds

6.5.2 D.C systems

Voltage variations

For D.C. equipment the following shall apply:

- Steady state voltage variations: +10%, -15%
- Voltage Cyclic variation: 5%
- Transient voltage variations: $\pm 25\%$
- Voltages variations for DC components supplied by battery shall be as per BV rule [NR445](#) part C - CH2 - Sect. 2.

6.6 Distribution System Voltage Drops

The maximum allowed voltage drops at equipment terminals are based on the system nominal voltage.

6.6.1 AC systems

The distribution system cable sizing shall ensure that the following voltage drops, at the circuit full load current, are not exceeded:

- Feeders (from main to sub-main Switchboard & MCC's): 2%
- Transformer feeders (from Transformer to Switchboard): 1%
- Motor feeders (at motor terminals, running at FLC): 3%
- During motor starting
 - The voltage at the motor terminals shall ensure a sufficient accelerating torque
 - The voltage drop at bus bar shall not cause shutdown of other consumers.

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Note: For cable sizing, the usual practice in the industry is to limit the voltage drop for Direct on line (D.O.L) starter to 15% in such conditions.

- Lighting & small power (at distribution board): 2%
- Lighting sub-circuits:
 - Average 2%
 - Maximum at farthest lighting fixture 4%
- Other (heaters, packages...): 5% unless particular requirement.

6.6.2 DC systems

The voltage drops through DC distribution shall not exceed 2% of nominal voltage taking into account inrush currents and transient loads.

6.7 Harmonic distortions

For installations which contain a significant percentage of non-linear loads (e.g. variable speed drives, large thyristor-controlled heaters, etc.), harmonic studies shall be produced.

- Total Harmonic distortion: $\leq 5\%$
- Single harmonic: $\leq 3\%$

For shorter periods, e.g. during start-ups or unusual conditions, the limits may be exceeded by 50%.

Calculations to demonstrate that emission levels of harmonics remains within the requirements of [IEEE 519](#), including size and effect of harmonics and inter harmonics, shall be provided by Contractor, taking into account data of all drives and converters installed on the F.U.

When required, action shall be taken either by equipment over-sizing or by additional filtration to meet these limits.

6.8 Electromagnetic Compatibility (EMC)

In order to comply with the EMC requirements of [IEC 60533](#) and [IEC 61000](#) all electrical systems and equipment shall meet the current applicable levels of "emission" and "immunity" detailed therein.

7. Neutral Earthing Systems

Principles defined hereafter shall apply to both Topsides and Hull & Accommodation electrical networks.

7.1 High voltage systems

7.1.1 General

High voltage system shall be 3 phase - 3 wire, earthed by a low impedance, to limit the fault current to at least twice the capacitive current of the network. A basic value of 30A shall be usually considered, unless otherwise specified.

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When the F.U distribution network with HV generators on both topsides and Hull, one earthing transformer at least shall be provided on each side.

7.1.2 Generators operating in parallel

In the case of a network configuration with two or more generators running synchronized, provision shall be taken to keep only one earthing transformer in operation. Automatic transfer sequences shall be implemented into the Electrical Control System in case of failure of the earthing transformer.

7.1.3 Networks branch lines fed by transformers

A neutral point resistor shall be installed on the secondary side of each transformer. Depending on the operating philosophy, a switching device may be provided.

7.2 Low voltage systems

System earthing shall be as follows:

- The 400 V - 690 V, three phases - three wires, system shall be isolated, (IT system)
- In case of supply by HV/LV transformer, a surge arrester shall be installed between the neutral and the earth.
 - A permanent earth fault monitoring device shall be installed on each primary L.V. switchboard bus bar.
 - Only one device shall be in operation when the tie-breaker is closed.
 - The permanent insulation monitoring device characteristics shall be such that the maximum earth fault current remains below 30 mA.
 - The permanent insulation monitoring device shall have functionality allowing fault localization.
 - When required fixed fault localization device shall be provided on each outgoing feeder of the primary switchboards/MCCs.
- The lighting and small power distribution system 400 V/230 V, 3-phase, 5-Wires shall have neutral earthed and distributed (TNS system).
- The heat tracing system 400 V/230 V, 3-phase, 5-Wires shall have neutral earthed and distributed (TNS system).
- The AC UPS distribution system derived via inverters shall be insulated from earth (IT system).
- DC systems shall be isolated from earth (IT system).
- Each unearthed system (AC UPS distribution networks, DC distribution networks) shall be provided with an earth fault monitoring device. Each earth fault monitoring device shall provide a local alarm signal with a remote alarm to the **F.U** Electrical Control System (ECS).