

GENERAL SPECIFICATION

ELECTRICAL

GS EP ELE 001

Electrical design criteria

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1. Scope

This specification defines the design criteria used for the engineering, supply, manufacture, and installation of the electrical power/distribution systems to be installed within Company installations located either onshore or offshore.

This specification also covers design and engineering studies for Topsides 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) etc.

For Hull and accommodation systems of Floating Units, refer to general specification **GS EP ELE 021**.

Where particular or differing requirements exist for a particular location, these are stipulated separately.

The basic technical features are outlined and general guidelines are given for the design and engineering aspects.

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 standards and codes.

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
- Company Particular Specifications and data sheet (if any)
- Company General Specifications
- Applicable International Electrotechnical Commission (IEC) standards
- Applicable European Standards by CENELEC
- Applicable recognised standards and codes (UTE-NFC, BS, VDE, etc.) when IEC publications have not yet been issued.

Any conflict or inconsistency between the above set of documents (standards, specification, codes and local regulation or laws) shall be raised to Company attention for resolution.

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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
ATEX directive 94/9/EC	European Directive 94/9/EC (23/03/94) on the approximation of the laws of the Member State concerning equipment and protective systems intended for use in potentially explosive atmosphere
EN 50272-2	Safety requirements for secondary batteries and battery installations - Part 2: Stationary batteries
IEC 60038	IEC Standard Voltages
IEC 60050	International Electrotechnical Vocabulary
IEC 60059	IEC Standards current ratings
IEC 60071-1	Insulation co-ordination - Part 1: Definitions, principles and rules
IEC 60079 (Parts 10-1; 14)	Explosive atmospheres - Parts 10-1; 14
IEC 60196	IEC Standard Frequencies
IEC 60228	Conductors of Insulated Cables
IEC 60331-21	Tests for electric cables under fire conditions. Circuit integrity - Part 21: Procedures and requirements-Cables of rated voltage up to 0.6/1.0 kV
IEC 60332-3-22	Tests on electric and optical fibre cables under fire conditions - Part 3-22: Tests for vertical flame spread of vertically-mounted bunched wires or cables-Category A
IEC 60364 (All parts)	Low voltage electrical installations - All parts
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60533	Electromagnetic Compatibility of Electrical and Electronic Installations in Ships and of Mobile and Fixed Offshore Units
IEC 60617	Graphical symbols for diagrams
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 61000 (All parts)	Electromagnetic compatibility (EMC) - All parts
IEC 61111	Live working - Electrical insulating matting

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Reference	Title
IEC 61892 (Parts 1; 2; 3; 4; 5; 6; 7)	Mobile and fixed offshore units - Electrical installation - Parts: 1; 2; 3; 4; 5; 6; 7
IEC 61936-1	Power installations exceeding 1kV a.c. - Part 1: Common rules
IEC 62259	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Nickel-Cadmium prismatic secondary single cells with partial gas recombination
IEC 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impact (IK code)
IEC 62271-1	High voltage switchgear & controlgear - Part 1: Common specification
IEC 62402	Obsolescence management - Application guide
IEEE 519	Recommended practices and requirements for harmonic control in electrical power systems
NF C13-200	High voltage electrical installations - Requirements
NF C15-100	Low voltage electrical installations

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 CIV 401	Minimum requirements for building design and construction
GS EP CIV 403	Temporary construction camps and associated facilities (onshore)
GS EP ELE 011	Electrical requirements for package units
GS EP ELE 013	Electrical requirements for generating units
GS EP ELE 021	Electrical design criteria for floating units
GS EP ELE 031	Design of earthing and bonding systems
GS EP ELE 051	Design and installation of lightning protection
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

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Reference	Title
GS EP ELE 114	HV Synchronous Motors
GS EP ELE 121	HV Variable Speed Drive Systems
GS EP ELE 122	LV Variable Speed Drive Systems for ESP
GS EP ELE 131	High voltage switchgear and controlgear
GS EP ELE 133	G.I.S. 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
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 211	Electrical cabin. Construction and equipment
GS EP ELE 221	Electrical Control System (ECS)
GS EP ELE 251	Closed Cycle Vapour Turbogenerator (CCTV)
GS EP ELE 261	Solar Power System
GS EP ELE 311	Cables trays/ladders
GS EP ELE 321	Navigational Aids System
GS EP ELE 331	Tape trace heating
GS EP ELE 364	Electrical installations
GS EP ELE 374	Construction site electrical installations
GS EP ELE 451	Third party inspection. Independent verification of electrical facilities
GS EP ELE 460	Engineering Studies
GS EP ELE 765	Submarine cables
GS EP INS 107	Design and installation of instrumentation links
GS EP MEC 101	Driver Power Sizing
GS EP SAF 216	Area classification
GS EP TEC 007	Obsolescence and Lifetime Cycle Management

3. Environmental conditions

Electrical equipment design and installation shall be performed in accordance with the data given in the "Environmental conditions particular specification".

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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.

Unless otherwise specified, Indoor electrical equipment shall be installed within air conditioned rooms with an ambient air temperature of 25°C but they shall be able to operate as long as room temperature does not exceed 40°C.

Unless otherwise specified in the project specification, in air conditioned rooms, electrical equipment shall be designed for continuous operation under relative humidity of 60% and below.

In case of corrosive atmosphere (Salt laden air, 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.

The minimum degree of protection of enclosures (IP and IK codes respectively as per [IEC 60529](#) and [IEC 62262](#)) shall comply with the relevant equipment general specification and/or data sheet.

4. Vocabulary, units and symbols

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

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).

5. Frequencies and voltages

5.1 General

Association of frequencies and voltages used for Company electrical installations shall be selected among the values recommended by the IEC.

Use of voltage levels and/or frequencies not herein recommended is subject to written Company approval.

5.2 Standard frequencies

50 Hz is the recommended frequency.

However at all times the frequency of the local National Electrical Board shall be adopted for the Company installation, either onshore or offshore.

AC equipment shall operate satisfactorily at frequencies within $\pm 5\%$ of the stated frequency unless otherwise specified.

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5.3 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-circuit levels
- Existing systems and supplies
- Distributor's supply voltage
- Distances between consumers and supplies.

5.3.1 AC systems

- **High voltage**

The general electrical characteristics shall be in compliance with the values indicated in [IEC 62271-1](#) - paragraph 4.2 rated insulation level, Table 1a - Rated insulation levels for rated voltages of range I, series I. and as follows:

System	3 phases / 3 wires				
Rated frequency	50 Hz				
Nominal system voltage	66 kV	33 kV	22 kV	11 kV	6.6 kV
Highest voltage for equipment kV (r.m.s)	72.5 kV	36 kV	24 kV	12 kV	7.2 kV
Rated one minute power-frequency withstand voltage kV (r.m.s)	140 kV	70 kV	50 kV	28 kV	20 kV
Rated lightning impulse withstand voltage kV (peak)	325 kV	170 kV	125 kV	75 kV	60 kV
Neutral system	Earthed through an impedance				
	See data sheet	200 A	150 A	20 to 50 A	20 to 50 A

- **Low voltage**

- 690 V or 400 V for motive power, main distribution, etc.
- 230 V for lighting, heat tracing and small power
- 230 V (UPS).for control and instrumentation supplies, public address (PA/GA).

5.3.2 DC systems

- 110 V for electrical control, essential lube oil pumps (e.g. turbogenerators, turbocompressors, etc.)

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- 48 V e.g. for electrical control, telephone system (PABX)
- 24 V e.g. for instrumentation (F&G, ESD, PCS) and telecommunications (SOLAS).

5.4 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:

5.4.1 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

5.4.2 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: $\pm 25\%$

5.5 System voltage drops

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

5.5.1 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 full current): 5%

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- During motor starting
 - The voltage at motor terminals shall ensure a sufficient accelerating torque and
 - The voltage drop at bus bar shall not cause shutdown of other consumers.

Note: For cable sizing, the usual practice in the industry is to limit the voltage drop for Direct On Line starter to 15% in such conditions.

- Lighting sub-circuits and sockets: 2% average with a maximum of 4% at to the farthest fitting
- Other (heaters, packages, etc.): 5% unless particular requirement.

5.5.2 DC systems

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

5.6 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. The following limits shall apply for the voltage distortions:

- 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 installation.

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

5.7 Electromagnetic Compatibility (EMC)

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

6. Earthing systems

6.1 High voltage systems

6.1.1 General

If the installation is derived from a Local Electricity Grid, the neutral system and the relevant fault current value are imposed by the local Electricity Board.

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For installation with their own power generation and electrically isolated from a Local Electricity Board, high voltage neutral shall be earthed by a low impedance, to limit the fault current to at least twice the capacitive current of the network.

6.1.2 Networks fed from an isolated generator

Neutral shall be earthed via a resistance.

6.1.3 Networks fed from generators operating in parallel

In the case of only two generators in parallel, the neutrals may be earthed either via an earthing transformer or directly via resistance.

These two solutions should be studied and a technical/commercial conclusion proposed.

In the case of three or more generators in parallel, an earthing transformer shall be installed on each bus bar section likely to be used separately with a minimum of two.

In the case where more than one section is used in parallel, only one earthing transformer shall be left in operation.

6.1.4 Networks or power supply 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 might be provided.

6.2 Low voltage systems

6.2.1 Motive and main power distribution

The main low voltage system (3-phase, 3 wires) shall be earthed by a high impedance (diagram IT) with neutral not distributed. This impedance shall be sized to limit the first earth fault to 150 mA maximum.

In case of supply by HV/LV transformer, a surge arrester shall be installed between the neutral and the earth

Permanent earth fault monitoring device shall be installed on each L.V. switchboard busbar. Only one device shall be in operation when busbar is closed.

Onshore plant:

An earth fault leakage relay (with time delay if required) will be provided for each consumer, it shall be set at 2 A in order to trip when a second fault occurs

Offshore installations:

Similarly to onshore, an earth fault leakage relay (with time delay if required) will be provided for each consumer, it shall be set at 2 A in order to trip when a second fault occurs unless following conditions are fulfilled:

- Local equipotential bonding is provided on each equipment
- Short-circuit calculation is performed at each feeder termination to allow selection of the appropriate protective device

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- Impedance measurements shall be done on Site at commissioning stage to confirm the assumptions taken on the grounding network impedance for the cable calculation.

Welding Socket outlets shall be fitted with an earth fault leakage relay set at 30 mA.

6.2.2 Lighting and small power distribution system

The lighting and small power distribution system 400 V/230 V, 3-phase, 4-Wires shall have neutral earthed and distributed (TT system).

Multipoles (phases and neutral) switching is required for all incoming/outgoing circuits.

Each individual outgoing feeder shall have differential device with 300 mA sensitivity, which will trip on first earth fault.

Socket outlets shall be fitted with an earth fault leakage relay set at 30 mA.

TNS system 400 V/230 V, 3 phase + Neutral + Earth (Protection conductor), 5-Wires for 3 phase distribution (or 1 phase + Neutral + earth, 3 wires for single phase distribution) may be considered for FPSO Topside (harmonisation between Hull & Topside based on Classification Societies rules applicable to the Hull lighting and small power distribution system).

6.2.3 Heat Tracing distribution system

Where required by process or other reasons, a heat tracing system shall be provided. If the trace heating system requires more than 50 kVA, this system shall be independent and comprise a transformer (400/230 V) and dedicated distribution panel.

The 400/230 V, 3-phase + neutral, tracing system shall have a neutral earthed and distributed (TT system).

Each individual outgoing feeder shall be fitted with earth leakage circuit breaker (ELCB) with 30 mA sensitivity, which will trip on first earth fault.

6.2.4 400/230V UPS distribution system

Unless otherwise specified by the ICSS Supplier or by particular project specification, isolated IT system shall be used.

Permanent earth fault monitoring device shall be installed.

Socket outlet circuits shall be fitted with an earth fault leakage relay set at 300 mA. A maximum number of three socket outlets per circuit are allowed.

6.3 Construction site electrical installation

Refer to Company Specification [GS EP ELE 374](#) - [GS EP CIV 403](#).

6.4 Buildings and permanent base camps

For Low-voltage, if the neutral system is not imposed by the local Electricity Board it shall be preferably TNC-S. For small installations, the neutral system might be TT.

Refer to Company Specification [GS EP CIV 401](#).

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6.5 Direct current systems

DC systems shall be insulated from earth and equipped with permanent earth fault detection except for DC supplies for PABX equipment, which shall have, positive or negative earthed according to equipment Manufacturer requirements.

6.6 System Voltages - Neutral Earthing system

Nominal voltages	Neutral system	Service	Maximum voltage drops at equipment terminals
Internal power generation 11 kV/6.6 kV AC	Earthed by low impedance One or two generators: Earthing resistance Two or more generators: Earthing transformer	Generators output voltage	
		Motors	5% at full load current
		Interconnection with other platform, sub station	
Power distribution 66-33-22-11-6.6 kV	Earthed by low impedance at transformer or earthing transformer.	Main HV switchboard	
690 VAC or 400 VAC	IT (Neutral not distributed) Earthed via high impedance	MCC	
		Motors	5% at full load current
		Diesel generators	
230 VAC	TT system (Neutral earthed and distributed)	Lighting distribution board	
		Lighting fittings	8% max to the farthest fitting
		Small power board	
	TT System Neutral earthed and distributed	Heat tracing	
230 V UPS	Isolated IT system (Neutral not distributed) TN acceptable	Control and instrumentation	
DC system 110/48/24 VDC	Unearthed	Control, instrumentation, telecommunications, essential services	2% of nominal voltage

7. Electrical distribution systems

The following principles shall be applied regarding the basic requirements and configuration of the generation and distribution systems.