



Exploration & Production

GENERAL SPECIFICATION

ELECTRICAL

GS ELE 013

Electrical requirements for generating units

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1. Scope

This specification defines the minimum requirements for the design, manufacture, inspection and testing of electrical equipment provided for generating units above 250 kVA.

This specification shall be read in conjunction with the General Specification **GS ELE 011** and the corresponding generating unit Project specification, drawings and data sheets, if any.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Design and engineering shall conform as a minimum requirement to the current edition of the following in order of precedence:

- Applicable laws and regulations of the country in which the system will be operated. In cases where no "local" regulations exist, the French laws and regulations shall be used.
- COMPANY Particular Specifications and data sheet (if any)
- COMPANY General Specifications
- Applicable International Electro technical Commission (IEC) Publications
- Applicable CENELEC Standards
- Applicable recognized standards and codes (UTE, BS, VDE, etc.) where IEC Publications have not yet been issued.

Standards

Reference	Title
Not applicable	

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

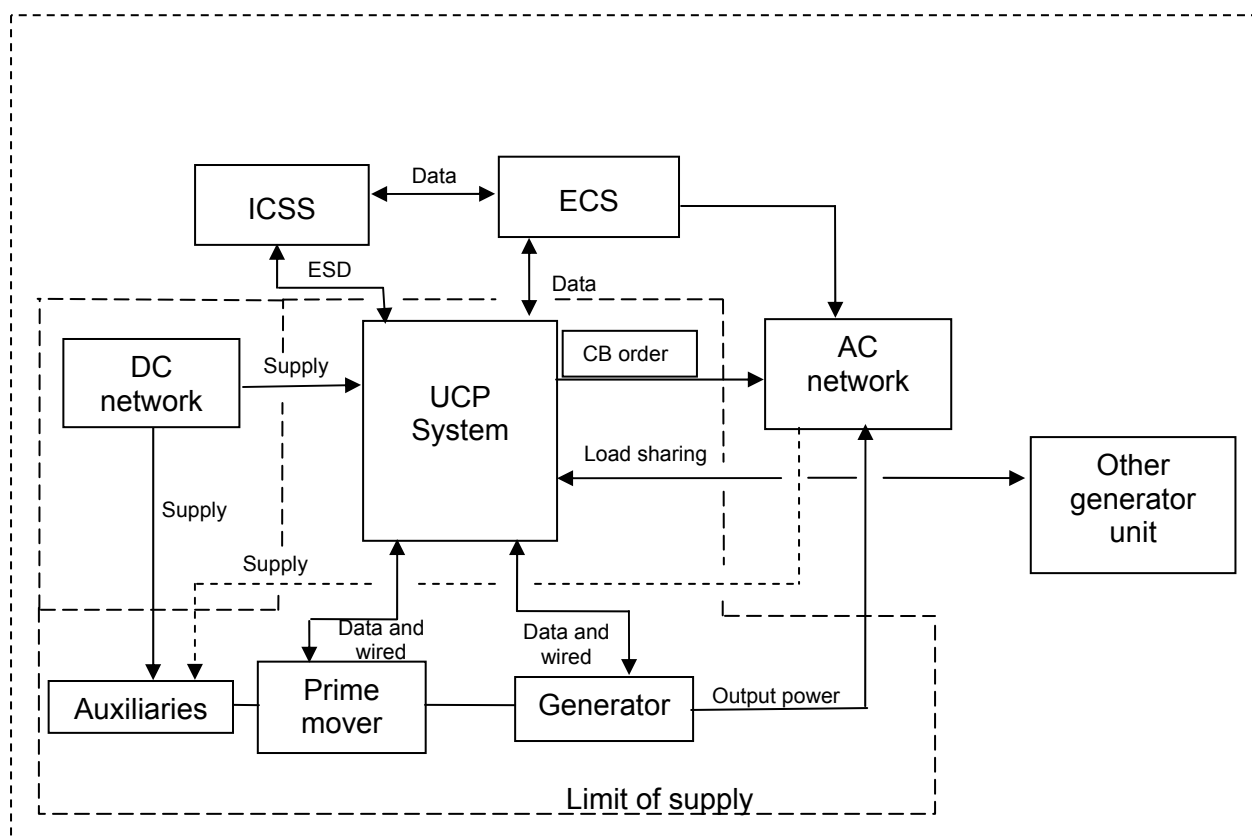
Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS ELE 011	Electrical requirements for packaged units
GS ELE 113	AC generators driven by turbines
GS ELE 115	AC generators driven by diesel engines

3. Design Basis

3.1 Standard general diagram



3.2 Generator

The generator shall be in accordance with the general specification **GS ELE 113** or **GS ELE 115**.

3.3 Unit Control Panel

The Unit Control Panel shall be in accordance with the general specifications **GS ELE 137** and **GS INS 110**.

The generating unit shall be considered as a P3 type package as per **GS INS 110**.

3.3.1 Electrical protection

Unless otherwise specified, the generating unit protections and all hardware components shall be provided by the PACKAGE SUPPLIER and installed into the Unit Control Panel.

The protections shall be of digital type with full testing facilities to allow secondary injection of the relays.

The protection system shall be supported by a software library of complete protection functions as defined in this specification.

An Engineering Workstation shall allow users to activate all protections and logic. For all functions user's guide with aid of screen menus and windows, shall be available.

The Man-machine interface shall allow easy communication with an Electrical Control System via a serial link.

The entire protective system shall consist of a relatively small number of hardware components. This applies also to the number of signals and tripping relays.

3.3.1.1 Turbine driven generator

Protection ANSI	Code	Action
Earth overcurrent	51N	Open breaker and stop generator
Bearing overtemperature	26	Alarm (1st) and stop generator (2nd)
Bearing vibration	39	Alarm (1st) and stop generator(2nd)
Winding overtemperature	26	Alarm (1st) and trip CB (2nd)
Coolant overtemperature or failure	26	Alarm
Stator differential overcurrent	87 G	Stop machine
Instantaneous phase overcurrent	50	Trip circuit breaker
3 phases stator overcurrent	51 V	Trip circuit breaker
Stator reverse power	32	Trip circuit breaker
Stator under/over frequency	81	Load shedding or Trip circuit breaker
Stator under/over voltage	27-59	Trip circuit breaker
Overload	49	Trip circuit breaker
Neutral voltage displacement (1)	51N/64S	Stop machine
Rotor earth fault (1)	64R	Stop machine
Rotating rectifier diode failure	94 d	Stop machine
Field failure or loss of synchronism	40	Trip circuit breaker

Protection ANSI	Code	Action
Phase unbalance	46	Trip circuit breaker
Directional overcurrent protection	67 67N	Trip circuit breaker

(1) For generator above 5000 kVA

3.3.1.2 Diesel or gas engine driven generator

Protection ANSI	Code	Action
Earth overcurrent	51N	Open breaker and stop engine
Stator differential overcurrent	87 G	Stop engine (2)
Instantaneous phase overcurrent 3 phases stator overcurrent	50 51 V	stop engine
Stator reverse power	32	Trip circuit breaker
Stator under/over frequency	81	Load shedding or Trip circuit breaker
Stator under/over voltage	27-59	Trip circuit breaker
Overload	49	Trip circuit breaker
Winding overtemperature	26	Alarm (1st) and trip CB (2nd)
Bearing overtemperature	26	Alarm (1st) and stop generator (2nd)

(2) For generator above 1250 kVA

3.3.2 Control functions

The following table gives the minimum required control functions and their initiation mode(s).

Those functions are noted as:

- “M”, requiring manual initiation
- “A” initiated by automatic signal
- “C” operating on a continuous signal.

Unit Control Panel	
Generating unit status	A
Start-up sequence	A, M
Synchronizing generator	A, M
Voltage regulation	C
Speed regulation	C
Active and reactive load sharing	C

Unit Control Panel	
Frequency control system	C
Alarms	A
Shutdown sequence	A, M
Emergency shutdown	M
ICSS	
Emergency shutdown	A, M
ECS	
Load shedding	A

3.3.1 Voltage regulation

The voltage regulation shall be automatic and it shall be equipped with manual adjustment.

Unless otherwise specified, the Automatic Voltage Regulation (AVR) shall be of digital design type and shall perform a three phase regulation.

The parameters shall be readily adjustable. The voltage setting shall be manually adjustable.

Manual voltage control shall be achieved by the use of a separate, independent module controlling the field current with control switches or pushbuttons for increasing or decreasing the excitation.

All faults shall be indicated in the digital display to allow rapid finding.

The voltage regulation shall be powered from Permanent Magnet Generator or equivalent. Self excited is not authorized

When located on the package, the voltage regulator shall be encapsulated for humidity and abrasion protection.

Unless otherwise specified the voltage regulator shall be able either to operate in power factor, voltage or reactive power regulation mode.

After AVR fault the shut down is authorized, generator shall be able to restart in manual voltage control.

The ceiling voltage and response to system faults shall be such that a rapid field forcing is obtained. Sufficient current shall be available to energise backup protective systems in the event of short circuits.

The AVR shall have the following integrated functions:

- Rotor current limitation
- Stator current limitation
- Polar angle limitation

Regulator drift shall be less than 1% for a 40°C ambient temperature.

3.3.1 Speed regulation

For turbine, the speed regulator system shall be a digital design.

For engine the speed regulator shall be electronic type and installed in the UCP.

When located on the package the regulation unit shall be encapsulated for humidity and abrasion protection.

Speed regulation shall be able to operate in isochronous, droop and base load mode

- The isochronous mode shall be used for one generating unit on an isolated network.
- The droop mode shall be used for parallel operation of two or more generating units on an isolated network.
- The base load mode shall be used for test. The load setting shall be set by a fixed reference or an external contact, analog or digital input.

Speed regulation shall be provided with closed loops dedicated to output power and speed. A closed loop dedicated to actuator position is not authorised.

Manual control shall be achieved by the use of a separate, independent module controlling the frequency, with local control switches or pushbuttons for increasing or decreasing the speed.

The setup of droop shall be adjustable by digital control and not by a load bank system.

3.3.2 Failed Speed Signal

Generating unit shall be able to operate in the event of loss of speed signal.

A contact to override the failed speed signal circuit shall be installed in order to test this function.

Prior to start-up of the prime mover, the speed signal override contact shall be of the time delay type to ensure that the failed speed sensor alarm circuit is enabled after start-up.

3.3.3 Governor

The governor shall be of electronic type. The hydro-mechanical governor is not authorised.

3.3.4 Parallel operation

The generating units shall be able to operate in parallel up to their maximum output power.

The active and reactive loads shall be shared by means of an automatic load sharing device without hunting, in accordance with their rating under all conditions.

Even though droop mode is required, the steady state frequency and voltage shall be maintained by a centralised automatic frequency control system.

Manual control speed and voltage shall be effective during parallel operation.

3.3.5 Synchronizer

When specified the synchronizer shall be provided by the package SUPPLIER.

The synchronizer shall be able to operate automatically or manually.

The synchronizer shall utilise three phases for frequency, voltage and phase angle comparison.

The synchronizer shall provide a direct contact to close the generator circuit breaker.

Either automatic or manual signal command shall be monitored by independent synchronism check relay (ANSI 25) before breaker closure is permitted.

The synchronism check relay shall be installed into the unit control panel.

The synchronizer output shall remain disabled when the frequency and voltage difference are outside the permissive synchronizing window.

The synchronizer shall be part of a closed-loop feedback control system for the frequencies and voltages

The synchronizer shall be able to alter generating unit frequency and voltage.

When the frequency, phase angle and voltage conditions are fulfilled, the duration of the synchronizing conditions is checked so as to ensure that they will still be met when the contacts of the circuit breaker close.

The synchronizer shall be provided with at least four operating modes. These modes intend to facilitate system testing and installation checkout without electrically disconnecting the synchronizer from the control system.

These four modes shall be able to be selected by an external switch and shall allow:

- Synchronization and automatic breaker closure,
- Testing correct synchronizing operation, but without circuit breaker closure,
- Checking for acceptable synchronization, but does not trim speed or adjust voltage. When synchronization is correct, the breaker is allowed to close,
- Disabling of the synchronizer.

3.3.6 Load shedding

To perform the load shedding, the generating units shall transmit by direct link to ECS the following information:

- The instantaneous active and reactive power,
- All shutdown and breaker trip signals,
- The exhaust temperature (for turbine only).

3.3.7 Communication interfaces

The Communication interfaces shall be in accordance with the general specification **GS INS 110**.

All parameters, signals, measured values shall be exchanged via appropriate interfaces and serial communication channels to ECS (Electrical Control System) or ICSS (Integrated Control and Safety System).

All other input and output signals shall be wired to terminal blocks within the UCP for connection by others.

3.4 Starting system for essential and emergency generating unit

Generating unit shall be suitable for rapid starting and loading to full capacity within 30 seconds. In case of start failure an alarm shall be provided on remote control panel.

Power for successive cranking cycles shall have two separate systems, fully independent of the plant support facilities.

Each system shall provide energy for six (6) consecutive starting attempts.

Each attempt shall consist of five (5) second cranking followed by ten (10) second rest.

The starting system may be a combination of electric, pneumatic or hydraulic starters.

When the generating unit is in hazardous area, starting system shall not be of electrical type.

One of the starting systems shall be of hydraulic type with manual pump to pressurize the storage bottle. Both starting systems may be of independent hydraulic type.

The pneumatic and hydraulic starting systems shall be defined in the mechanical particular specification.

When required electric starting system shall consist of:

- Nickel Cadmium batteries,
- Battery box designed for Nickel Cadmium batteries
- Independent battery charger (even when the diesel engine is supplied with a driven generator as a manufacturer standard),
- Ammeter and floating/boost charging facility,
- Manual start-up facility by-passing the driver controller (optional).

The battery charger shall be capable of full recharge in eight hours.

When the Battery Charger is used to supply control and command system, it shall be in accordance with **GS ELE 151**.

When battery charger and batteries are located in the electrical room and/or battery room the battery charger supplier shall size the cables between the batteries and the battery charger.

3.4.1 Automatic starting

Unless otherwise specified, a remote command shall be foreseen for automatic starting initiated from ECS (Electrical Control System) or ICSS (Information Control and Safety System).

3.4.2 Manual start mode

Manual starting shall be possible locally on the package and on a remote control panel.

Provisions shall also be made to periodically test the essential/emergency generator starting and loading.

The generating unit shall be able to be synchronised and coupled with the normal generation.

4. Rating and performance

4.1 General

The generating units shall be designed for continuous service, at rated output under specified ambient conditions without harmful effects.

All electrical auxiliary consumers shall be deducted from the generator unit output rating.

Unless otherwise specified, the expected lifetime of the generating unit shall be at least 20 years.

Electrical equipment shall be suitable for at least three years uninterrupted operation under conditions specified.

4.2 Unit Control Panel

4.2.1 Voltage regulation

The excitation system shall be able to generate at the generator output:

- 150% of rated current for a period of at least 30 seconds
- 110% of rated current for a period of at least one hour, without dangerous overheating.

The excitation system shall withstand the following duty cycle, repeated every five minutes:

- Continuous rated excitation current
- Excitation current at ceiling voltage for 20 seconds
- Continuous rated excitation current.

The excitation system shall be rated for 110% of the excitation current required during full load operation at rated voltage and rated power factor.

The excitation system shall allow 100% voltage to be maintained at 90% speed.

The output voltage of the generator shall be adjustable between 90% and 110% of the rated value during normal operation.

Steady state voltage variations at any load when operating isolated from electrical network shall be limited to $\pm 2.5\%$ of the rated voltage.

Voltage variation after instantaneous application of 100% load shall not exceed -15% and recovery to 97% of rated voltage shall occur within 1.5 seconds.

4.2.2 Speed regulation

Speed shall be adjustable over the range 95% to 105% of the rated speed during normal operation.

Steady state speed variations, at any load when operating isolated from the electrical network shall be limited to $\pm 0.5\%$ of the rated speed.

For diesel engine, frequency variation after instantaneous application of 100% load shall not exceed -10% (excepted subtransient) and recovery to 97% of rated frequency shall occur within 3 seconds.

For gas engine, frequency variation after instantaneous application of 50% load shall not exceed -10% (excepted subtransient) and recovery to 97% of rated frequency shall occur within 3 seconds.

For turbine, frequency variation after instantaneous application of 40% load when the turbine is 60% loaded shall not exceed -10% (excepted subtransient) and recovery to 97% of rated frequency shall occur within 3 seconds.

Frequency variation after instantaneous load rejection of 100% shall not exceed 10% (excepted subtransient) and recovery to rated frequency shall occur within 3 seconds.

Manufacturer shall confirm the speed variations and recovery time after sudden load impact and load rejection.

Speed regulation shall be equipped with $\pm 5\%$ adjustable droop.

4.2.3 Parallel operation

The generating units shall operate within 3 or 4 % of droop for speed and voltage.

Even though droop mode is required, the steady state speed variations shall be limited to $\pm 0.5\%$ of the rated speed.

Even though droop mode is required, the steady state voltage variations shall be limited to $\pm 2.5\%$ of the rated voltage.

4.2.4 Synchronizer

The phase match window shall be able to be chosen from 0.2 to 1 second and be adjustable to at least 10 degrees phase angle.

The voltage matching range shall be adjustable from 1% to 5%

The synchronizer shall only be active within $\pm 10\%$ of the rated frequency.

5. Inspection and tests

The package SUPPLIER shall submit an Inspection & Test Plan (ITP) including subcontract items.

The package SUPPLIER shall provide access in his factory and SUBSUPPLIER's ones as well to COMPANY representatives at any time during the manufacture of the equipment.

Inspections and tests shall be carried out in accordance with applicable specifications and standards mentioned in this document.

The witnessing of inspection of any item shall be the prerogative of the COMPANY but does not relieve the package SUPPLIER of his responsibility to comply with the specification.

The generator shall be tested at the SUB Supplier's works and witnessed by the COMPANY.

The package SUPPLIER shall provide all auxiliary supplies (electricity, air, water,...) necessary to make the complete run test of the generating unit.

The generating unit shall be factory tested and when stated in the purchase order commissioned by the SUPPLIER.

The Factory Acceptance Test (FAT) shall include, but not be limited to the following:

- Visual inspection and dimensional checks
- Compliance to standards and specifications
- Installation of equipment checking as well as cabling, wiring and accessibility
- Insulation resistance test for all electrical equipment (motors, lighting, Unit Control Panel, wiring,...)
- Earth continuity test
- Protection and relay setting checks

- Satisfactory functional operation of all control circuits and auxiliary systems.
- Partial load test
- Full load tests (optional)
- Load impact and load rejection (optional).

6. Documentation

The Package SUPPLIER shall provide all the drawings required for connection and co-ordination with other equipment in the plant as specified in the requisition, especially load requirements (400 VAC - 24 VDC - 230 VAC UPS, etc.) and remote control and feedback signals.

6.1 List of documents

The Package SUPPLIER shall provide at least the following documents:

6.1.1 With the bid

List of electrical consumers

Power balances (24 VDC, 230 V - AC UPS; 230 V, 400 V, 6600 V)

Completed data sheets

Apparatus list

Deviation list from COMPANY and Project specifications.

List of proposed MANUFACTURERS/SUPPLIERS from the "VENDOR List" for bulk items

List of subcontractors.

6.1.2 For approval

- Design drawings, calculation sheets.
- General arrangement and interface drawings
- Unit Control Panel outline drawing and arrangement
- Single-line and three line diagrams, schematics and logic diagrams
- Cable block diagrams (for turbine)
- Cable schedules, connection diagrams and wiring diagrams (for turbine)
- Cable sizing calculation note if any
- Interconnection diagrams
- Installation drawings including equipment location and cable routing
- Earthing lay out
- Power requirement for each consumer (rated, absorbed, duty factor, etc.), equipment list
- Specification/data sheets related to supplied equipment (motors, switchboards, cables, etc.).



6.1.3 Final documentation

A complete set of drawings shall be provided for each unit.

- As-built drawings
- FAT reports
- Operating and maintenance instruction manuals
- Electrical system operating and maintenance manuals
- Spare part list
- Sub-supplier documentation
- Transfer function block diagram for voltage and speed regulation (simplified models) for main generating units only.