



Exploration & Production

GENERAL SPECIFICATION

ELECTRICAL

GS ELE 152

AC Uninterruptible Power Systems (UPS)

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1. Scope

This specification covers the basic requirements for the design, manufacture, testing and operation of AC uninterruptible power systems (UPS).

The UPS shall provide power to critical loads including instrumentation and telecommunication systems.

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.

The following order of precedence applies specifically to electrical equipment:

- COMPANY specifications
- IEC Publications
- European Standards by CENELEC.

Standards

Reference	Title
IEC 60079	Electrical apparatus for explosive gas atmospheres
IEC 60146	Semi-conductor converters
IEC 60158	Low voltage control gear - Static switch
IEC 60269-1	Low voltage fuses
IEC 60622	Sealed nickel-cadmium rechargeable cells
IEC 60623	Vented nickel-cadmium prismatic rechargeable single cells
IEC 60726	Power transformers dry-type
IEC 60896-2	Lead acid batteries - Sealed and fitted with valve
IEC 60993	Electrolyte for open nickel cadmium element
IEC 61434	Alkaline batteries. Guide for the definition of current
IEC 62040	Uninterruptible power systems (UPS)
IEC 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
EN 50014	Electrical apparatus for explosive gas atmospheres

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
73/23/EEC	European Directive for Low Voltage Equipment
89/336/EEC	EMC European Directive and its subsequent amendments

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
Not applicable	

3. General

3.1 Environmental data

The equipment shall be installed inside an air-conditioned technical room, with an average ambient air temperature of 25°C but shall be able to operate on unusual condition such as specified in the project data sheet.

In case H₂S might be present in the technical room, as specified in the project data sheet, special provision shall be taken by the SUPPLIER to avoid equipment/material corrosion. The SUPPLIER shall indicate the proposed protection measures in his bid.

3.2 Reliability

Reliability of equipment to perform continuously is essential. Prototype or unproven equipment not having a well-established operating record will not be considered.

SUPPLIER shall state in his bid the availability, reliability and Mean Time Between Failure (MTBF) data for similar units in service.

If redundancy is required, the UPS shall be a redundant system with the following:

- Two units in parallel, each unit being equipped with a battery sized for the rated battery back-up at half-rated power and one static switch
- A by-pass transformer.



3.3 Specification deviations

The SUPPLIER shall advise the COMPANY of any deviations made in respect of this Specification at the time of tendering. Should this Specification conflict with requirements of the listed standards the SUPPLIER shall request clarification from the COMPANY.

4. Construction requirements

4.1 General

Battery chargers, inverters, transformer and static switches shall be completely assembled and wired in free standing sheet steel cabinets suitable for indoor operation.

For redundant UPS, each battery charger-inverter branch shall be installed in separate cabinets.

In the case of a UPS comprising a small number/volume of sealed batteries, these may also be contained inside the same cabinet. Larger batteries shall be installed on impregnated hardwood racks or insulated electrolyte resistant metal racks.

The equipment shall be arranged such that internal access can be made without shutting down. Removable side panels may be provided, but rear access shall not be required. Warning labels shall be fitted in prominent positions advising care to be taken when gaining access to live equipment.

The cubicles shall be designed to be lifted by use of detachable eyebolts.

Adequate ventilation shall be provided in order to guarantee the proper operation of the UPS at rated condition, whatever the mode of operation and the battery back-up duration.

Access doors shall be lockable with a common key provided. They shall be fitted with an internal pocket suitable for a complete drawing set.

Enclosures shall have at least IP 21 protection degree and IP 20 when the door is open. Unless otherwise specified, the enclosures shall be cleaned, primed and painted according to MANUFACTURER standard.

4.2 Internal wiring

Internal wiring shall be PVC insulated 1000 V grade, flame retardant and stranded copper conductors, except for connection on printed circuits.

Cabling between components shall be continuous, joining of cables is not permitted.

Internal wiring within the board shall be securely held in position (either loomed or run in conduit/trunking).

Wiring identification shall be by numbered and/or lettered ferrules, of insulating material and located adjacent to the terminals.

Wiring connections for external connections shall be brought out to individual terminals on a readily accessible terminal block. Wires shall be terminated using compression type lugs or crimp sleeves.

4.3 Cable termination

External cable terminating facilities and terminals shall be suitable for the specified cable type, conductor size. The SUPPLIER shall provide cable supports to avoid undue strain on the cable

termination. The number of conductors connected to each terminal shall not exceed two for internal cabling and one for external cabling.

Power and control external cabling shall be separated: power and control terminals shall be fully segregated. Protection covers shall be split in order to provide independent access to power and control terminals.

4.4 Earthing

An earthing busbar shall be provided along the full length of the equipment structure with provision for earth cable connections at each end.

All metallic non-current carrying parts of the equipment shall be bonded together and connected to the earth busbar. All doors shall be bonded to the main structure by means of a flexible copper connection arranged so that it cannot be trapped as the door is opened or closed.

5. Batteries

5.1 Battery type

The batteries shall be one of the following types in accordance with IEC standards:

5.1.1 Vented type nickel-cadmium cells

This type of cell shall have a minimum of 60% gas recombination rate in floating mode.

End of discharge voltage shall not be lower than 1.0 V per cell at 20°C.

5.1.2 Sealed gas recombination type nickel-cadmium cells

This type of cell shall have a gas recombination rate equal to or greater than 95% in floating mode.

End of discharge voltage shall not be lower than 1.0 V per cell at 20°C.

5.1.3 Vented type lead-acid cells

No gas recombination in floating mode is required for this type of cell.

End of discharge voltage shall not be lower than 1.80 V per cell at 20°C.

5.1.4 Sealed gas recombination type lead-acid cells

This type of cell shall have a gas recombination rate equal to or greater than 95% in any floating mode. They shall be of the long life type.

End of discharge voltage shall not be lower than 1.80 V per cell at 20°C.

When used in cycling mode, the end of discharge voltage shall be higher than in floating mode in order to provide the long life mentioned above.

UPS using lead acid batteries shall be equipped with a deep discharge protection device.

Cell type selection shall be indicated in the data sheet.

SUPPLIER shall provide cell type certification by authoritative third party in his bid.



5.2 Battery construction

The battery cells shall be assembled in flame retardant, heat resistant, shock -absorbing plastic containers with covers attached to form a permanent leak-proof seal. Covers shall be also sealed against leakage of electrolyte and shall be fitted with spray-proof vent plugs.

Containers shall provide visual indication of electrolyte level.

Electrolyte level lines shall be marked on front side of each jar or container.

5.3 Battery installation

The battery installation shall be as indicated in the data sheet.

When battery is installed on stands they shall be supplied by the battery MANUFACTURER and made of electrolyte resistant steel or suitably treated wood.

When battery is installed in cabinet, electrolyte resistant sliding frames shall be provided with stoppers.

5.4 Operating duty

During normal operation, the battery will be floating on line with the battery charger maintaining the battery in the fully charged condition, at the same time supplying the normal steady state loads, consisting of instrumentation supplies, PC Consoles, gas metering package, analysers, etc.

The two batteries shall have the capacity to supply via the inverters, the loads for the duration stated in the data sheet, the charger being off.

During this time, the cells voltage shall remain above the value stated in item 5.1, and the inverter output voltage shall remain within the tolerance specified in the data sheet.

5.5 Battery terminals

All cell terminals shall have adequate current carrying capacity. Cell terminal posts shall be equipped with connector bolts. Cell terminal posts, bolts and associated hardware shall be of electrolyte resisting material and protected by insulating screens to prevent risk of contact with live parts.

5.6 Battery capacity

A load curve versus time shall be provided by ENGINEER/CONTRACTOR to allow definition of battery rating.

An appropriate de-rating factor for ageing shall be considered for battery sizing.

The SUPPLIER shall provide with his bid a calculation note justifying the type and reference of the battery selected and the number of elements.

5.7 Battery feeder cable sizing

The maximum voltage drop in main power cables between remotely located batteries and main equipment cubicles shall be limited to 1%, unless otherwise specified.

5.8 Maintenance requirement

A connection system shall be designed in order to perform the test of battery stored energy.

6. Battery chargers - Rectifiers

6.1 Electrical service conditions

All equipment shall be rated for continuous operation unless otherwise specified. The equipment rating (voltage, current, frequency, fault current, etc.) shall be as stated in the data sheet.

All equipment shall be suitable for operation with variations of voltage and frequency as stated hereafter:

- AC supply voltage: + 10% - 10%
- Hz frequency: $\pm$ 5%

The performance of the equipment shall not be affected by:

- Transient voltage depressions down to 80% of rated voltage
- Harmonic voltage up to 20%.

6.2 Battery charger characteristics

The charger rating shall be adequate for the normal operation duty, and for charging the battery from "discharged state" to a state of charge which will provide for repetition of the duty cycles described in 5.4 after eight hours of charging.

Unless otherwise specified, voltage of battery and charger and its tolerances are left to the discretion of the SUPPLIER but shall satisfy the inverter input characteristics. When a sealed lead acid battery is used the rms ripple voltage shall be limited to 0.1% of the rated value.

The same maximum allowable voltage fluctuation shall apply during charging of the battery. The rectifiers shall be protected from an over temperature by thermal switches that will de-energise the charger and initiate an alarm. A loss of control caused by a failure shall block the rectifier bridge.

Each charger shall be fed through an isolating three-phase transformer and designed in order to minimise the harmonic current rejected to the network. The charger shall be capable of limiting the battery charging current in accordance with battery MANUFACTURER's requirements.

The ratio of peak magnetising current/primary winding rated current for the transformer shall be less than 15. If this is not practical a two step soft energisation of the transformer shall be provided to limit the inrush current to an acceptable value

6.3 Battery charger operations

Chargers shall have two modes of operation: "charge" and "float".

When required in project data sheet, an automatic battery test function shall be provided.

Facilities shall be provided to manually initiate both modes of operation but the return to safe operation for the battery shall always be automatic.

The chargers shall be designed not to disturb the AC supply differential protection.

Facilities shall be provided to inhibit the charge in case of failure of the battery room ventilation system. If the ventilation failure occurs during charge, the charger shall revert to float mode.

Charge mode shall be automatically initiated upon restoration of AC power after an outage. An adjustable timer started when the battery reaches the second stage of charge shall automatically reset the charger to the float mode to prevent the battery from being overcharged.

A volt free contact for remote indication of charge mode status shall be provided.

Float voltage shall be adjusted automatically depending on the battery temperature monitored by a probe.

Battery test shall be automatically initiated every week or as per specified in the data sheet to check battery condition and stored energy. During this test, the charger voltage reference will be reduced and the voltage of both batteries will be monitored. If the battery voltage falls too low an alarm is generated. In all cases at the end of the test, the chargers return to float mode.

Another switch shall be provided to permit an off-line full discharge battery test of each battery at a time on an external load bank connected to extra terminals located in the charger cabinet close to the battery connection terminals.

During this annual test the two chargers and the remaining battery shall continue to supply the load. An auxiliary contact shall be provided for local and remote indication of battery isolated condition.

When required a circuit breaker with overcurrent protection only and an undervoltage trip coil for ESD, located in an EEx"d" IIC T3 enclosure, shall also be provided and installed close to each battery. "Reset" of this breaker shall be possible by an "externally accessible" operating handle.

7. Inverter

The inverter shall be a solid state type, rated to continuously supply load requirements and run in synchronism with the bypass supply.

It shall be operating on-line, i. e. voltage and frequency independent (VFI).

7.1 Inverter characteristics

The inverter shall be capable of operating within the specified output limits either continuously fed from the rectifier output with the battery connected (floating and charge) or directly from the battery over the required period after failure of the electricity supply.

The inverter output shall be 230 V. The output voltage shall be adjustable by $\pm 5\%$ to allow for voltage drop across the 230 V distribution system. The total harmonic content shall not exceed 5% in all operating duties.

Under steady state load conditions the inverter output voltage measured at the UPS distribution bus shall be maintained at $\pm 1\%$ of nominal voltage with a maximum frequency tolerance of $\pm 0.5\%$. The maximum allowable transient voltage variation except where otherwise specified, shall not exceed $\pm 10\%$ under the following conditions:

- Removal of AC supply to charger/rectifier
- Transfer of full load to bypass transformer
- Return of full load to inverter
- Load change.

Voltage recovery to 95% nominal following any of the above disturbances shall be within 50 ms.

The inverter shall be capable of starting up and supplying the load without reference to an external alternate supply. A test facility shall be provided to operate the inverter when the static switch is bypassed.

The current rating of the inverter semi-conductor components shall not be less than 120% of the maximum current flowing through the elements at full load. The maximum allowable operating temperature of the inverter semi-conductors shall be limited to 80% of their maximum permissible value.

The inverter rated output shall, where necessary, take into account the non-sinusoidal nature of the connected load.

7.2 Inverter operations

The inverter shall be automatically disconnected from the load if the inverter output is outside the stated voltage and frequency tolerances and if voltage is available on the by-pass transformer.

For redundant UPS, the inverters shall run in parallel, sharing the load at 50% in normal operation.

8. Static transfer switch

The static switch shall, on inverter failure, transfer the power supply of the loads to the bypass transformer output.

The static transfer switch shall feature continual synchronism between the inverter and bypass transformer outputs. Transfer of load from the inverter to the bypass transformer shall be uninterruptible provided the two supplies are synchronised within the inverter output tolerance. In the event of an inverter failure, the maximum supply interruption to the load shall be 0.5 ms.

Operation of the static switch to the bypass supply shall only take place when voltage is available.

Return to normal operation upon restoration of inverter output shall be a manually initiated sequence when synchronised with the bypass transformer supply.

Facilities for manual operation of the static switch shall be incorporated enabling complete isolation of the inverter for maintenance purposes.

In addition, for maintenance purposes, a manual make-before-break switch shall allow the complete isolation of the static switch and the inverter.

The static switch operation shall be adjustable within the following tolerances:

- Frequency: $\pm 5\%$
- Voltage: $\pm 10\%$.

9. Bypass transformer

The transformer shall be double wound type with an earth shield between windings and operated in conjunction with the static transfer switch and manual bypass switch

When required in the project specification, the bypass transformer, manual bypass switch and distribution shall be installed in separate cabinet in order to allow rectifier/inverter replacement without shutdown.

10. Features to be provided

10.1 Battery chargers

Each charger shall be equipped with the following as a minimum:

- AC supply three pole ON/OFF switch
- Blocking of the bridge in case of abnormal input voltage
- High speed fuses for power semi-conductors
- Miniature circuit breakers for auxiliary circuits
- Imminent battery shutdown remote alarm
- End of discharge remote alarm for ESD trip. Contact shall be open to alarm.

10.2 Inverter

The following shall be provided for the inverter as a minimum:

- Incoming ON/OFF switch
- Outgoing ON/OFF switch
- Ammeter to indicate inverter output current.

Local and remote alarms as follows as a minimum:

- Inverter failure
- Load on bypass
- Out of synchronisation.

10.3 Bypass transformer

The transformer shall be equipped with the following as a minimum:

- Incoming ON/OFF isolator
- A local alarm shall be provided for transformer undervoltage condition.

10.4 Control and monitoring

Control and monitoring shall be provided by a microprocessor based controller.

Local control and monitoring shall be given on the front of equipment and shall include as a minimum:

- One alpha-numeric display with pushbuttons for operator interface
- Two LED's normal and fault
- On/off switch
- A buzzer providing audible alarm.

The display shall provide for each branch, the following indications as a minimum:

- Measurements:
 - AC supply voltage
 - AC supply current
 - DC output voltage
 - DC output current
 - Battery current (+ or -)
 - Inverter output current
 - Inverter output voltage
 - Inverter output frequency
- Status of operating modes
- Alarms and faults.

Remote alarms and faults (the same as in local) shall be provided through a serial link with a protocol that shall be defined in the Project specification.

The SUPPLIER shall ensure the serial link compatibility with the ECS or ICSS of the plant and, if required, provide the necessary interfaces without any time and cost implication to the COMPANY.

A mimic (graphic display) showing the complete UPS or one mimic per branch, shall be provided on the front of the cubicle with appropriate LED's.

10.5 Marking

Rating plates shall be provided as per [IEC 62040](#) and riveted on the front panel.

Components nameplates shall be laminated engraved plastic with black letters on a white background.

11. AC distribution panel

In case of redundant UPS, the distribution panel shall include two incoming switches.

The distribution shall be split into 2 buses "A" and "B" by means of a bus-tie switch. This would allow replacement or installation of additional outgoing CB without complete UPS distribution shutdown.

Busses suitable for "clip-on" CB mounting shall be used.

The neutral connections to ground shall be made by means of removable jumpers.

If an earth fault detector relay is required, it shall be based on the detection of a low frequency AC current circulating between AC network and earth.

Each outgoing circuit shall be protected by a two poles circuit breaker with overcurrent protection plus a tripping fault contact and, if specified in the Project particular Specification, also a tripping coil to facilitate isolation.

The circuit breaker shall be sized for the specific circuit requirements and shall be fully selective with other devices in the circuit. The SUPPLIER shall state in his bid the maximum rated circuit breaker that can be fitted.

All circuit breaker tripping fault contacts shall be gathered on a signalling loop and brought to control terminals for remote indication.

A minimum of 10% equipped spare outgoing CBs shall be fitted, plus 20% additional space including the clip-on bus ready for use.

12. Accessories

A complete set of tools required for maintaining the equipment shall be provided.

A tin of paint shall be provided to permit final touch-up following installation.

13. Inspection and testing

The SUPPLIER shall carry out tests upon completion of construction to demonstrate to COMPANY, or his representative, that the requirements of this Specification and any subsequent amendments have been fulfilled in accordance with the applicable standards and regulations.

The minimum tests required are those specified in [IEC 62040-3](#), plus tests required in the Project data sheet.

13.1 Factory acceptance tests

Factory acceptance tests shall comprise:

- Visual inspection and operational tests
- Prove integrity of panel earth bonding
- Operation of battery circuit breakers from undervoltage tripping facility
- The completeness and quality of the contractual technical documents.

13.2 Routine tests

The SUPPLIER shall allow in his quotation for the provision of all necessary test equipment, load banks and technical personnel to carry out the following routine and optimal tests required in the Project data sheet.

13.3 Test report

A draft test report and test procedure shall be presented to the COMPANY for approval before order placement.

The completed test report shall contain as a minimum:

- The expected theoretical values
- The permissible tolerance values
- The results of the measurements including, if applicable, any intermediate value which has caused a temporary rejection.



The test report shall be incorporated into the contractual technical documents and shall be considered as an integral part of them.

14. Transport/Packing

In all cases, vented batteries shall be delivered electrically formed by the MANUFACTURER. They shall be shipped preferably filled and charged, but this choice is left to the MANUFACTURER.

Sealed batteries shall be delivered charged.