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1. General

1.1 This specification covers the design, supply, delivery, installation, testing and commissioning of a continuous duty, redundant 50/60 Hz, ___ kVA, 400/230V, three phase, four-wire uninterruptible power supply system complete with maintenance-free sealed battery.

The uninterruptible power supply system, hereafter referred to as the UPS system, shall operate in conjunction with the existing power distribution system. In the event of an emergency it shall be able to supply independently at least ___ minutes of clean and regulated uninterruptible power for computer equipment and other critical loads.

Only "True-On-Line" technology also called Continuous Operation with Bypass (COB) or real VFI (Voltage and Frequency Independent) UPS following the EN-50091-2 / IEC 62040 standard, are accepted.

1.2 The UPS system, though initially furnished as a redundant-parallel system of ___ units, shall have provisions for all necessary interface connections and ancillary items such that it can be easily and economically expanded up to eight (8) units at a future time with minimum disruption for increased capacity or to provide a fully redundant system.

Only systems fully respecting the conditions of the technical term "redundant", meaning the system has no single point of failure, (including no master-slave relationships or common parallel electronic) with proven installations of more than ten (10) years will be accepted.

The tenderer has to provide sufficient technical details to explain the redundant-parallel configuration.

Only systems with decentralized bypass and redundant communication bus between units are accepted.

1.3 The UPS system and all associated equipment and components shall be manufactured in accordance with the EN-50091-2 / IEC 62040 standards.

1.4 The UPS manufacturer must be ISO 9001 certified and must have a minimum of 30 years experience in the design, manufacture, servicing and testing of UPS systems.

1.5 Recommended UPS manufacturer:

- **GE Digital Energy – Site Pro Series**

2. Tender submission requirement

2.1 The tender submission shall be in sufficient detail to show compliance to the specification and shall include a full set of descriptive and technical literature on the equipment and system proposed.

2.2 The following drawings and information are to be submitted with the proposal:

- a) System configuration with Single Line Diagrams.
- b) Functional relationship of various equipment and shall include weights, dimensions and heat dissipation of each unit.
- c) Layout plan of control panel, alarm panel, mimic diagram.
- d) A detailed description of acceptance test procedures and checklist.
- e) A reference list of similar systems installed.

3. Environmental conditions

- 3.1 The UPS system shall be capable of withstanding any combination of the following environment conditions in which it must operate, without mechanical or electrical damage or degradation of operating characteristics:
- a) Ambient temperature: 0 to 40 degrees C
 - b) Relative Humidity: Up to 95% (non-condensing)
 - c) Interference: The UPS equipment shall be provided with EMI/RFI suppression following EN-50091-2 / IEC 62040
- 3.2 Audible Noise: Noise generated by the UPS system under any condition of normal operation shall not exceed an allowable sound pressure level of ____ dBA measured at a height of 1 metre and at 1 metre from the nearest UPS cabinet surface.

4. System description

- 4.1 Each UPS system shall consist of the following major components:
- a) One rectifier/charger.
 - b) One static inverter.
 - c) One no-break static transfer switch.
 - d) One maintenance bypass switch.
 - e) One battery bank.
 - f) One main control and alarm panel complete with mimic diagram and LCD display.
- 4.2 The UPS system shall be able to operate in any of the following modes:
- 4.2.1 On-line Mode - During normal operation, the UPS system shall be used to provide precise regulated and transient-free power to the computer equipment loads.
The mains supply provides power to the rectifier/charger.
The rectifier/charger shall provide regulated DC power to support the inverter and simultaneously maintain the battery in a fully charged condition.
The inverter shall convert the DC power into regulated AC power for the load.
- 4.2.2 Battery Mode - Upon failure of the mains supply, input power for the inverter shall automatically be supplied from the directly connected battery.
When the mains is restored or the standby generator set supply is ready, input power for the inverter and for recharging the battery shall automatically be supplied from the rectifier/charger.
If the input does not return, the UPS shall automatically shut itself down in an orderly manner when the discharge limit of the battery is reached.
- 4.2.3 Bypass Mode - Upon the failure of static inverter, the no-break static transfer switch shall be activated automatically to isolate the faulty inverter and at the same time maintain a continuous supply to the system load.
The automatic transfer mode shall also operate in the event of system overloading or if irregular or undesirable output for the load is detected.

In this case, the system shall automatically return to the original mode of operation if the disturbance is cleared.

4.2.4 Manual Bypass Mode - If the UPS system needs to be isolated for testing or removed from service for maintenance, the maintenance bypass shall transfer the loads from inverter to the mains without interruption and vice versa.

4.2.5 Power Conditioner Mode - If the battery only must be taken out of service for maintenance, it will be disconnected from the rectifier/charger and inverter by means of a circuit breaker.

The UPS shall continue to function and meet all the performance criteria specified herein except for the protection time requirement of paragraph 1.1.

5. Electrical characteristics

5.1 General

- a. UPS Output Power Rating ___ x ___ kVA, 3 phase, 4 wire plus earth, power fact.0,9
- b. Overall Efficiency - _____ % minimum at full load

5.2 Rectifier

- c. Input Power
 - Voltage = 400/230V
 - Voltage tolerance = 320-460V
 - Frequency = 50 Hz \pm 10%
 - Power Factor \geq 0.8 lagging

Inverter

- d. Output Power
 - Voltage = 400/230V, 3 phase, 4 wire
 - Frequency = 50 Hz \pm 0,1%
 - Adjustment = \pm 4% w/mains synch.
- e. Total Harmonics
 - Linear Load = < 2%
 - Non-linear Load = < 3% (to EN-50091)
- f. Phase Displacement
 - 100% balanced load = 120° +/-1%
 - 100% unbalanced load = 120° +/-2%
- g. Unbalanced Voltage
 - for balanced load = +/- 1%
 - for unbalanced load = +/- 3%
- h. Voltage Transients
 - at 50% load step = +/- 2%
 - at 100% load step = +/- 3%
 - static 100% load = +/- 1%
 - by mains recovery = +/- 1%
- i. Recovery Time = 20 m sec. to \pm 1%
- l. Inverter Overload Capability
 - = 125% for 10 min.
 - = 150% for 1 min.
- k. Crest Factor >3:1 (according to EN-50091)

6. Rectifier/charger

6.1 General - The rectifier/charger must consist of a 6-pulse SCR bridge, which converts the 3-phase utility voltage into a controlled and regulated DC voltage, in order to supply power to the inverter, and to simultaneously charge the battery.

6.2 Capacity - The rectifier/charger shall have sufficient capacity to support a fully loaded inverter and at the same time maintain the battery in a fully charged condition. If the battery is fully discharged, the rectifier/charger shall recharge the battery to 95% of its fully charged condition preferably within twelve (12) hours and at the same time supplying full load current to the system. Otherwise the UPS supplier shall specify the charging time required.

6.3 Walk-in - The rectifier/charger must contain a timed walk-in circuit to limit the inrush current. The allowable initial inrush surge and the walk-in time should be adjustable and not exceed 30 sec.

- 6.4 Sequential power walk-in - a sequential walk-in of every single rectifier/charger shall be automatically executed in case of the start up of a parallel system in order to limit the inrush current to the value of one single system.
- 6.5 Current and Voltage Limit - The rectifier/charger output current and voltage shall be limited to the battery supplier's recommendation.

7. Inverter

- 7.1 General - The conversion of DC to AC must be accomplished by power transistors of the IGBT type controlled with a SVM (Space Vector Modulation) strategy. Failure of any components or power stage shall not interrupt the AC output instead it shall disconnect itself from the configuration while transferring the load to the static transfer switch and then activate an alarm.
- 7.2 Standard Control Battery - A control battery shall be provided to furnish logic power which is independent of the inverter input or output power. The battery shall provide the power required to operate the inverter logic until the load is transferred to the alternate source and the inverter is shut down in an orderly manner in the event of a failure of the logic solid- state power supply. In addition, the battery shall provide power to the alarm system to maintain event records after a UPS failure and shutdown.
- 7.3 Output - The inverter output wave form shall be controlled by microprocessor-based software (software generated sine wave) to ensure that the voltage THD is being limited especially for non-linear loads.
- 7.4 The wave form shall be fed through a filter circuit and protected by fast fuses.
The inverter shall be able to handle short-circuit conditions without any damage.
- 7.5 Neutral - The neutral of the inverter output shall be electrically isolated from the UPS system chassis.
- 7.6 Frequency Control - The output frequency of the inverter shall be controlled by an oscillator which can be operated as a free running unit or in synchronised operation with a separate AC source or the future redundant inverter.
- 7.7 If the external synchronising source deviates from the pre-set frequency by $\pm 1\%$ or 4% (selectable), the oscillator shall automatically revert to free-running, and the microprocessor controlled accuracy shall be $\pm 0.01\%$.
- 7.8 Capacitor Discharge - Output filter capacitors shall be provided with a quick discharging circuit which shall automatically discharge the capacitors to safe value within a short time after the shutting down of the inverter.

8. Electronic bypass switch

- 8.1 The electronic bypass shall consist of a static SCR-switch, used to provide an uninterruptible transfer of the load to the utility in case of remarkable variation of the output voltage.
The electronic bypass shall be equipped with two contactors in series which provide to supply the load from utility or inverter.
- 8.2 The electronic bypass switch must have continuous 150% overload rating capacity. In addition the static transfer switch shall support 200% overload for 5 minutes and 1000% overload for 10 milliseconds (non repetitive).
- 8.3 The electronic bypass switch shall return the load automatically to the UPS when the malfunction or overload is cleared.

- 8.4 The electronic bypass switch shall consist of a pair of microprocessor controlled thyristors and a contactor in series avoiding a backfeed energy into the mains (backfeed protection).
- 8.5 The electronic bypass switch shall be able to be activated manually by a switch/push button to affect the transfer. The switching time from inverter to reserve and vice-versa shall be of No-Break when synchronised.
- 8.6 Automatic retransfer delay time back to inverter from bypass after a transfer from inverter to bypass shall be 10 seconds.
- 8.7 The number of automatic transfer/re-transfer from bypass to inverter when the status of the inverter logic signals an alarm conditions, shall be selectable.

9. Maintenance bypass

On each UPS the maintenance bypass shall be based on a pair of manually operated circuit breakers which allow the electrical isolation of the UPS from the load, while still supplying the load with power directly from the utility.

10. Battery / battery test

- 10.1 A battery shall provide the UPS system with a stored energy source.
The battery shall be of a heavy duty industrial type designed for standby power service.
The cells shall be completely sealed maintenance free.
- 10.2 The ampere-hour rating of the battery shall be sufficient to support the inverter for the protection time of ___ minutes with the inverter operating at full rated load at power factor ____.
- 10.3 Tenderer shall submit full technical data of the battery offered under the tender and shall provide calculation to show the number of cells required and their capabilities which shall match the load requirement and the charging characteristics of the UPS requirement being offered.
- 10.4 Tenderer shall specify the recommended voltage per cell for float charging and recharging, acceptable electrolyte specific gravity when fully charged at 25 degrees C.
- 10.5 The design life span of the battery shall not be less than ___ years and only batteries with proven field applications of not less than ___ years shall be accepted.
- 10.6 The battery shall be mounted on shelves/cabinet with the following dimensions:
___ x ___ x ___ mm.
- 10.7 The UPS system must be provided with a manual and automatic battery test (pre-selectable by day of the week, time of day, date of the month).
The test operates by slowly initiating a linear decrease of the rectifier output voltage.
If a battery fault is detected, the rectifier voltage will return to nominal avoiding to transfer the critical load on bypass.
Automatic battery test by simply shutting down the rectifier is not permitted.

10.8 Recommended Battery: Exide Batteries

11. Instrumentation

- 11.1 A back-lit 4 x 20 alpha-numeric character Liquid Crystal Display (LCD), controlled by push buttons shall be provided.
- 11.2 The UPS system main control panel with LCD back-lit display shall include the following measurements indications:
- Rectifier: input voltage (Ph-Ph), input frequency, number of rectifier mains failure.
 - Battery: voltage, temperature, charge/discharge current in Amperes, remaining autonomy time.
 - Inverter: output voltage, output frequency, inverter temperature, operating hours.
 - Bypass: input voltage (Ph-N), input frequency, number of bypass mains failure.
 - Load: load level in % (each phase), load current/phase in A, Load power in kVA/kW.
 - UPS: serial number, software version, number of overload condition, operating hours.
- 11.3 The UPS system main control panel with LCD back-lit display shall include the following events indications with date and time:
- Rectifier: mains rectifier OK, rectifier ON/OFF.
 - Battery: start battery test, end battery test, no conditions for battery test.
 - Inverter: inverter cannot be switched ON/OFF, inverter ON/OFF.
 - Bypass: mains bypass OK, bypass power insufficient, bypass locked, bypass free.
 - Load: load-OFF, multiple load transfer, load on bypass/inverter, no more overload condition.
 - General: maintenance bypass ON/OFF, inverter and mains synchronised/not synchronised, input circuit breakers open/closed.
- 11.4 On the system alarm panel, a common audible alarm and the respective indicating LED's shall be initiated when any of the following conditions are present:
- Rectifier: mains out of tolerance; control logic failure.
 - Battery: low voltage; high voltage; earth fault; contactor closing or opening failure; insufficient power.
 - Inverter: fuse failure; contactor closing or opening failure; voltage out of tolerance; output power insufficient; overload.
 - Bypass: mains out of tolerance; contactor closing or opening failure.
 - Load: overload; load locked on inverter; load locked on bypass.
 - General: load off for overload; battery low and over-temperature conditions; inverter and mains not synchronised; UPS overload.
- 11.5 The UPS, through the LCD, must be able to store up to 256 alarms or events with date and time.
- 11.6 Mimic Panel - A mimic panel shall incorporating LED indicators depicting the complete single line diagram of the UPS system shall be silk-screened to display the following:
- A synoptic diagram of the UPS representing actual operational status with integrated LED's and power flow indications.
 - Emergency load shutdown (LOAD OFF) push button with protective cover.
 - Signal SERVICE CHECK (LED) to indicate the that maintenance is required.
 - COMMON ALARM, visual signal (LED) and acoustic signal (internal buzzer).

- e) Signal STOP OPERATION (LED), visual and acoustic warning approximately 3 minutes (programmable) before complete automatic load disconnection (for example when the battery is at minimum voltage or inverter is over-temperature).
- f) LED indication for the remaining back-up time and load level.
- g) Command button keys for INVERTER ON and INVERTER OFF.
- h) Command button key for LED functionality test.
- i) Command button key (MUTE) to reset general alarms and buzzer.

Tenderer shall provide detailed information for the above-mentioned together with their tender submission.

12. Communication

In a standard version the UPS shall be equipped with a customer interface card which provide:

- 12.1 6 output dry contact available on terminal blocks (NO/NC) and Delta connector these contacts shall be programmable out of 24 different alarms or events directly from the keyboard mounted on the front panel of the UPS
- 12.2 Input Connections for customer provided signals must be available for "generator on" (reduces battery charging current during mains failures) and "emergency power off" (to shutdown UPS and load in the event of an emergency).
- 12.3 RS232 port for the following purposes:
Serial communication for advanced remote monitoring communication via PC.
Serial printer connection.
Modem connection.

13. Mechanical design

- 13.1 Colour - The UPS cabinet colour shall be RAL 9010 (white).
- 13.2 Ventilation - Forced air cooling shall be provided to ensure that all components are operated within specifications with air entry in the base and exit in the top.
The air volume and fan speed must be microprocessor controlled in relation to the load.
And the inverter's heatsink temperature
- 13.3 Cable Entry - Input to the system and outgoing cables shall be from the top/bottom front or top/bottom rear of the cabinet.
- 13.4 Modular Construction - The UPS system shall be modular in construction for ease of maintenance and to minimise downtime.
- 13.5 Power Connections - Adequate space for termination shall be provided for incoming and outgoing cables. The cables for interconnecting the UPS and battery cubicles shall be supplied for side by side installation.
- 13.6 Personal Safety - High voltage, low voltage and DC section of the system shall be adequately separated to ensure safety during maintenance and testing.
The equipment shall meet the requirements of protection index IP 20.

14. Acceptance

- 14.1 The tenderer shall submit a detailed acceptance procedures and checklist which shall be designed to verify the full compliance of the installed system with this specification.
- 14.2 The acceptance test shall be carried out by the contractor's engineer and witnessed by the end-user's Project Engineer.

- 14.3 _____ copies of the test report and commissioning certificate stating that the system has been installed and commissioned to the requirement of the specification shall be submitted to the end-user on handing over the commissioned system.

15. Documentation

- 15.1 All documentation shall be written in good, simple and concise English using accepted technical terms, symbols and nomenclatures.
For submission, all documentation shall be bounded with hard covers.
- 15.2 The document shall be updated regularly as the installation progresses.
All changes in the installation layout, wiring, cabling and design shall be incorporated in its final edition. _____ copies of this final edition shall be handed over to end-user upon commissioning of the system.
- 15.3 The final edition of the hand-over documents shall cover design, installation, commissioning, operation and maintenance aspects of the system.
- 15.4 One set of basic consumable spare parts shall be supplied under the contract.

16. Maintenance

- 16.1 The tenderer shall be responsible for the maintenance of the system after the expiring of the warranty period. In the tender submission, the tenderer shall include a maintenance agreement for the subsequent maintenance of the system for consideration by the end-user.
- 16.2 The agreement shall include a fixed sum proposed for five years to perform regular testing and up-keeping of the system.
- 16.3 The tenderer shall submit a checklist on the activities to be carried out for the system regular maintenance.
- 16.4 The tenderer shall provide evidence and undertake that round the clock on-call service is available to attend to system failure.

17. Options for ups input configurations

- 17.1 Input-Filter for 5th Harmonic to reduce input current THDI to <10% and improve input power factor to >0.9 at full load.
The filter must never present a capacitive load to the mains.
- 17.2 Active Filter (DCU) (available for 40-500 kVA) stepped filter for 5th, 7th, 11th and 13th harmonics to reduce reflected current harmonics THDI to a value of less than 5% and to improve input power factor to 0.98 at full load.
The filter must never present a capacitive load to the mains.
- 17.3 Input isolation transformer for galvanic separation of UPS from mains/utility supply to improve noise immunity but primarily as a safety device to prevent back-feed of DC voltage onto the mains.
- 17.4 Twelve-pulse rectifier (available for 40-500 kVA) for significant reduction of input current harmonics (THDI<9.6%).
Can be equipped with galvanic separation.

18. Options for communications and monitoring

- 18.1 Remote Signalling System consists of a remote mimic panel with LED indicators and audible alarm.
- 18.2 Remote Software Control allows remote monitoring, management and control of up to (numbers) of UPS of different capacity, different configurations and at different locations by means of modems from one central location.
The software shall allow the user to fully control the operational parameters of the UPS (e.g.: Inverter ON/OFF; etc.) from the PC.
The system shall also allow the manufacturer or it's nearest regional service centre to gain access to the UPS installed at the user's premises for remote on-line diagnostic and operational purposes.
- 18.3 Intelligent Energy Management - A energy management software shall be provided for programming of system operational parameters.
The software shall allow the user to program the operating hours of each UPS in the system during low load conditions so that each UPS is operating at its optimum efficiency (i.e. if four (4) UPS are in parallel redundancy mode and the total load is less than 50% of the UPS capacity, the software will shut down two (2) units(inverter) during off-peak hours in order to save energy and thereby the overall operating cost).
If during off-peak condition, one UPS fails, the software shall be able to switch ON one of the two non-operating UPS in order to achieve the redundancy requested, this in max. 30 seconds time.
However, the functional requirement of the system must be maintained during this period (i.e. redundancy is maintained)
- 18.4 SNMP card - It shall be possible to connect the UPS to a TCP/IP network using SNMP (simple network management protocol) using the international standard UPS MIB.
- 18.5 UPS Data Protection Software - The UPS have available data protection software compatible with Windows/95, Windows/98, Windows/NT, UNIX, Novell, OS/2 and other common operating systems.
- 18.6 Internet Information and Alarm transmitting - The UPS shall be able to communicate relevant data and alarms via the Internet to multiple addresses as E-mail, FAX and SMS. The remote access to the UPS shall be protected.