

BALUCHISTAN ENERGY COMPANY LIMITED

DEVELOPMENT OF LPG TESTING LABORATORY AT TAFTAN

SPECIFICATION FOR UPS SYSTEM



Office Address:

Balochistan Energy Company Limited
67-A, Main Jinnah Town Quetta,
Balochistan, Pakistan

Phone: 9281-2863711, 2863712

E-mail: cfo@becl.com.pk

shayan.ali.siddiqui@gmail.com

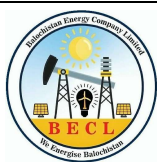
Web: www.becl.com.pk



SPECIFICATION FOR UPS SYSTEM

TABLE OF CONTENT

1.0	GENERAL	3
1.1	Scope	3
2.0	CODES AND STANDARDS	3
3.0	DOCUMENTATION	4
4.0	HANDLING	5
4.1	Packaging and Shipping.....	5
4.2	Preservation and Storage.....	6
5.0	DESIGN/MATERIAL CONSTRUCTION	6
5.1	Particular Definitions	6
5.2	General Requirements.....	7
5.2.1	Basis of Design	7
5.2.2	Unless specified otherwise the following site conditions shall apply:	8
5.2.3	Operating Principle	8
5.2.4	UPS Electrical Loads	10
5.2.5	Mains Electricity Supply.....	10
5.2.6	UPS Configuration and Tie-in	10
5.3	Performance Requirements.....	11
5.3.1	Rectifier.....	11
5.3.2	Battery and D.C. Circuit	13
5.3.3	Inverter.....	14
5.3.4	Static Bypass Switch.....	16
5.3.5	Noise Limits.....	18
5.4	Construction Requirements.....	18
5.4.1	Unit Enclosure and Accessibility.....	18
5.4.2	Converter Components	19
5.4.3	Wiring and Terminations	20
5.4.4	Earthing.....	21
5.4.5	Battery Cells and Containers	21
5.4.6	Marking.....	22
5.4.7	Finish.....	23
5.4.8	Mimic.....	23
5.4.9	Anti-Condensation Heaters	23
5.5	Measurement, Protection and Control Equipment.....	23
5.5.1	General.....	23
5.5.2	Status Indications	24
5.5.3	Measurement.....	24
5.5.4	Protection and Alarms.....	25
5.5.5	Controls.....	26
5.5.6	Battery Diagnostic Facilities.....	27
6.0	TESTING REQUIREMENTS	27
6.1	General.....	27
6.2	Performance Tests.....	28
7.0	GUARANTEES AND PERFORMANCE.....	32



SPECIFICATION FOR UPS SYSTEM

1.0 GENERAL

1.1 Scope

This Specification describes the minimum requirements for the design manufacture, testing and supply of Static AC Uninterruptible Power Supply (UPS) Unit.

2.0 CODES AND STANDARDS

The Static AC UPS Units shall be designed, manufactured and tested in accordance with the latest editions and amendments of the following Codes and Standards.

International Electrotechnical Commission (IEC)

IEC 60051	Recommendations for Direct Acting Indicating Electrical Measuring Instruments and their accessories
IEC 60146	Semiconductor Converters
IEC 60158-1	Low-Voltage Control Gear Part One: Contactors
IEC 60269	Low-Voltage Fuses
IEC 60408	Low-Voltage Air-Break Switches, Air-Break Disconnectors, Air-Break Switch Disconnectors and Fuse-Combination Units
IEC60445	Identification of Apparatus Terminals and General Rules for a Uniform System of Terminal Marking. Using an Alpha-Numeric Notation
IEC 60478	Stabilized Power Supplies D.C. Output
IEC60529	Classification of Degrees of Protection Provided by Enclosures
IEC 60801-3	Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment. Part 3 : Radiated Electromagnetic Field Requirements
IEC 60896	Stationary Lead Acid Batteries; General Requirements and Methods of Test
IEC 60947	Low Voltage Switchgear and Control Gear
Engineering Equipment Materials Users Association (EEMUA) EEMUA Spec. NO140 Noise Procedure Specification	
German Standard (VDE)	
VDE 0875 Specification for Radio Interference Suppression of Electrical Appliances and Systems.	
European Standards (EN)	
EN 55014	Limits and Methods of measurement of Radio Interference Characteristics of Household Electrical Appliances, Portable tools and Similar electrical Apparatus



SPECIFICATION FOR UPS SYSTEM

3.0 DOCUMENTATION

The MANUFACTURER shall at least supply the following documents. The language used shall be English.

- General Arrangement drawings;
- Main and control circuit schematic diagrams;
- Equipment lists;
- Recommended spare parts lists for two years operation;
- Test reports and performance curves;
- Operating manuals incorporating installation, commissioning, operating and maintenance instructions, and fault-finding procedures.

In addition to the instructions in standard forms, the MANUFACTURER shall comply with the following additional requirements for Installation, Operating and Maintenance Manuals:

- The front cover, spine and inside page shall state the purchase order number and reference number;
- The inside front page shall carry an index listing the contents of each section of the manual;
- Individual sections shall be complete and shall refer to equipment actually supplied;
- Published data shall also be included, including published data for bought-in items;
- Full details of any special equipment shall be clearly set out in separate sections;
- A punch list of "do's" and "don'ts" shall be included;
- Full details for installation and setting up shall be included;
- Recommended test data shall be stated, covering initial and also regular testing, i.e. values for high voltage, AC. or D.C. etc. shall be given;
- Items requiring regular inspection, checking, testing and maintenance shall be listed and the time scale clearly indicated;



SPECIFICATION FOR UPS SYSTEM

- Important items shall be cross referenced to other parts of manual as necessary.

Comments made by contractor on drawing submittal shall not relieve vendor or sub vendors of any responsibility in meeting the requirements of the specifications. Such comments shall not be construed as permission to deviate from requirements of the Purchase Order unless specific and mutual agreement is reached and confirmed in writing.

Each drawing shall be provided with a title block in the bottom of right-hand corner incorporating the following information.

- Official trade name of the VENDOR;
- VENDOR'S drawing number;
- Drawing title giving the description of contents whereby the drawing can be identified;
- PO number and item tag numbers.

Revisions to drawing shall be identified with symbols adjacent to the alterations, a brief description in tabular form of each revision shall be given, and if applicable, the authority and date of the revision shall be listed. The term "Latest Revision" shall not be used.

4.0 **HANDLING**

4.1 **Packaging and Shipping**

Preparation for shipment shall be in accordance with the VENDOR'S standards and as noted herein. VENDOR shall be solely responsible for the adequacy of the preparation for shipment provisions with respect to materials and application, and to provide equipment at the destination in ex-works condition when handled by commercial carriers.

Adequate protection shall be provided to prevent mechanical damage and atmospheric corrosion in transit and at the jobsite.

Preparation for shipment and packing will be subject to inspection and rejection by COMPANY'S/CONTRACTOR'S inspectors. All costs occasioned by such rejection shall be to the account of the VENDOR.

After inspection and test, equipment shall be completely free of water and dry before start of preparation for shipment.

Equipment shall be packed, securely anchored, and skid mounted when required. Bracing, supports, and rigging connections shall be provided to prevent damage during



SPECIFICATION FOR UPS SYSTEM

transit, lifting, or unloading. All temporary bracing/supports shall be marked "REMOVE BEFORE EQUIPMENT COMMISSIONING AND STARTUP."

Separate, loose, and spare parts shall be completely boxed. Pieces of equipment and spare parts shall be identified by item number and service and marked with CONTRACTOR'S order number, tag number, and weight, both inside and outside of each individual package or container. A bill of material shall be enclosed in each package or container of parts.

Special tools and equipment required for erection, commissioning, and maintenance shall form part of the order and shall be shipped together with the assembly. One complete set of the installation, operation and maintenance instructions shall be placed in the boxes or crates with the equipment. This is in addition to the number called for in the purchase order.

4.2 Preservation and Storage

Equipment and materials shall be protected to withstand ocean transit and extended period of storage at the jobsite for a minimum period of 18 months. Equipment shall be protected to safeguard against all adverse environments, such as: humidity, moisture, rain, dust, dirt, sand, mud, salt air, salt spray, and sea water.

5.0 DESIGN/MATERIAL/CONSTRUCTION

5.1 Particular Definitions

Vital Service - is a service which, when failing in operation or when failing if called upon, can cause an unsafe condition of the process and/or electrical installation, jeopardize life, or cause major damage to the installation.

Rated Output - is the apparent power, expressed in kVA, which can be continuously delivered by the unit over the range of conditions of service and electrical loading specified in this document, without exceeding component ratings and any of the required output tolerances.

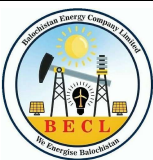
Power Factor - is the power factor of the fundamental wave, $\cos \phi$ (sometimes referred to as the displacement factor).

$$\text{i.e. } \cos \phi = \frac{\text{active power of the fundamental wave}}{\text{apparent power of the fundamental wave}}$$

Relative Harmonic Content - is the ratio of the r.m.s. value of the harmonic content to the r.m.s. value of the total non-sinusoidal periodic waveform.

$$\text{i.e., relative harmonic content} = \sqrt{1 - (g_1/g)^2} : \text{ where}$$

$$g_1 = \text{r.m.s. value of the fundamental component of current or voltage}$$



SPECIFICATION FOR UPS SYSTEM

g = r.m.s. value of the total waveform of current current or voltage

Crest Factor - is the ratio of the peak value to the r.m.s. value of the total non-sinusoidal periodic waveform.

Partially Discharged Condition - of a battery is the condition reached when the battery has been discharged to the point that the inverter can no longer deliver its rated output within the permissible output tolerances.

Float Charging - is the passing of an electric current through a battery by applying a constant voltage from a charger, such as to maintain the battery in a state of charge.

Rapid Charging - is the passing of an electric current through a battery by applying a controlled voltage from a charger, such as to restore the battery to a predetermined state of charge in a limited time span.

VRLA- is a Valve Regulated Lead Acid battery.

5.2 General Requirements

5.2.1 Basis of Design

The UPS unit shall be of the electronically regulated type. Units incorporating magnetic stabilizers (e.g. constant voltage transformers) are not acceptable.

AC UPS system shall be of transistor controlled type (not thyristors) with less noise and heat.

The design of the UPS shall be such as to minimize the risk of short circuits and shall ensure personnel and operational safety at all times.

The design and selection of equipment and components shall be based on achieving the following minimum lifetimes when operating in an average room ambient temperature of 25°C:

- 20 years for rectifier, inverter, static switch and associated auxiliaries;
- 20 years for vented as well as VRLA battery cells.

All components shall be of a quality and reliability that satisfies the requirements of a secure A.C. source of power to vital equipment performing a controlling, monitoring and safeguarding function in continuously operating petrochemical process units, production facilities and utility installations.

Components shall be capable of withstanding the thermal and dynamic stresses resulting from internal and external short circuits and circuit switching operations etc. Damage arising from component failure should be confined to the component concerned.



SPECIFICATION FOR UPS SYSTEM

The UPS components shall be suitably protected for operation in tropical climates. Component materials shall be moisture and fungus proof, and non-flame propagating wherever practical.

Capacitor electrolytes shall be non-toxic and totally free from polychlorinated biphenyls.

Additional requirements regarding the quality and lay-out of the vital power supply for specific applications are considered to be outside the scope of this specification.

5.2.2 Unless specified otherwise the following site conditions shall apply:

Ambient temperature, min/max	:	32°F/ 108°F
Relative Humidity , min/max	:	9/93%
ICE/snow	:	None
Wind velocity	:	Maximum 100 mph (44.7m/s)
Seismic Load	:	UBC zone 28
Maximum sound pressure level	:	≤ 85 dBA
Altitude	:	2087 ft (above mean sea level)

The UPS shall be installed in Air Conditioned environment. However, it shall operate satisfactorily for 4 hours on failure of air conditioning and maximum ambient temperature.

5.2.3 Operating Principle

Single Static UPS Unit

The single static UPS unit comprises of single rectifier, inverter, static switch and bypass.

The output of the rectifier shall continuously supply the power requirements of the load via the inverter, while simultaneously maintaining the battery charge in the float charge mode. In the event of an interruption or depression in the A.C. mains voltage to the rectifier, the battery shall supply the power requirements of the load, via the inverter, for not less than the autonomy time as specified in the requisition.

Upon restoration of the AC. mains voltage, the rectifier shall supply the power requirements of the load, via the inverter, while simultaneously recharging the battery. The rate of recharging the battery shall be such as to restore it to the required capacity within the time specified.

The output of the inverter shall be maintained within the voltage and frequency tolerances. The output voltage of the inverter shall also be controlled to maintain



SPECIFICATION FOR UPS SYSTEM

synchronism and phase with the bypass supply voltage, provided the latter is within the tolerances specified for the load transfer conditions. If the bypass supply voltage exceeds these tolerances, then the inverter shall revert to unsynchronized operation at its own internally set frequency. The inverter shall automatically resume synchronous operation with the bypass supply when the voltage and frequency of the latter returns within the specified tolerances.

Under synchronous operating conditions, the static switch shall initiate uninterrupted transfer of the load to the bypass supply in the event of deviation in the inverter output voltage or frequency outside the permissible tolerances specified in (3.4), or the switching off of the inverter unit.

In the event of automatic transfer of the load to the bypass circuit and subsequent restoration of the inverter output quantities to within the permissible tolerances, the inverter shall automatically resume synchronous operation with the bypass supply and shall initiate uninterrupted retransfer of the load to the inverter.

A make before break maintenance bypass switch shall be provided for each unit to allow the load to be transferred manually to the bypass supply whilst the UPS unit, including the static switch, is voltage free to allow maintenance to be carried out safely without exposure to live components (assuming the battery isolation switch is also opened).

Facilities shall be provided with clear instructions, adequate warnings and built-in safeguards to enable manual initiation of uninterrupted transfer of the load from the inverter supply to the bypass and from the bypass to the maintenance bypass and back again.

The UPS shall be capable of energizing the load within the permissible tolerances and of achieving the uninterrupted load transfer requirements via the static switch, without the battery connected.

Single UPS units shall also be suitable for future upgrading for parallel operation, if required.

Parallel Static UPS Unit

In this arrangement, two identical fully segregated 100% rated UPS units operate in parallel to energize a single switchboard to which the load circuits will be connected. Dual redundant control circuits shall be included to facilitate equal sharing of the load between the two units. The load sharing controls shall not be subject to common mode failure and any failure of the load sharing controls shall not result in the loss of vital power. Each unit shall have a static switch connected to a separate bypass circuit, the rating of which shall be the same as that of each unit. The two bypass supplies shall be connected in parallel from the same mains supply bus bar.



SPECIFICATION FOR UPS SYSTEM

Suitable protection shall be incorporated to safeguard against loss of synchronism during bypass supply deviations which could result in short circuiting of the UPS output.

The operation is as described above for single UPS except for following:

Each unit shall effectively run at 50% duty. Failure or switching-off of any one inverter shall result in uninterrupted acceptance of the complete load by the other inverter, and thereafter to the bypass circuit in the event of subsequent failure or switching-off of the second inverter.

5.2.4 UPS Electrical Loads

The electrical loads energized by the UPS shall consist principally of computer and/or digital electronic equipment incorporating switched-mode power supply units.

5.2.5 Mains Electricity Supply

Unless specified otherwise on the data sheet(s), supply system will be 415V, 3 phase, 4 wires, 50 Hz, neutral solidly earthed.

The system supply voltage and frequency will not normally vary more than:

Voltage : plus or minus, 10%

Frequency : plus or minus, 2%

Transient variations will occur as follows:

Voltage : plus 10% minus 20%

Frequency : plus, or minus 5%

The extremes of voltage and frequency variations are not to be considered to coincide. Inverters shall not changeover to their bypass supplies during any one transient as defined above.

In addition to the above variations, the input voltage may be subjected to transient comprising of voltage depressions up to 20% of the nominal voltage during motor starting, and to voltage interruptions during system short circuits. Transient, high frequency voltages of up to 2kV may also be superimposed on the input voltage as a consequence of system switching operations etc.

5.2.6 UPS Configuration and Tie-in

Details of the system shall be in accordance with the single line diagram and data sheet attached with the material requisition. Each UPS system shall essentially comprise two



SPECIFICATION FOR UPS SYSTEM

UPS units, two stabilized bypass supplies, two AC distribution boards and all necessary interconnections.

The MANUFACTURERS shall specify the current rating of MCCB which are required to be provided in the mains supply switchboard energizing the rectifier and bypass circuits.

Cables connecting the batteries to AC UPS units shall be single core, flexible, 600/1000V grade PVC insulated. These shall be sized and supplied by UPS VENDOR. The cable length required will be specified in the requisition.

The MANUFACTURER shall provide a suitable molded-case circuit breaker with the UPS unit to facilitate on-load isolation of the battery for the purpose of performing battery maintenance. Molded-case circuit breaker shall be category B, in accordance with IEC 60947-2. The switching device shall be installed adjacent to the battery, inside the battery room.

When the nominal output voltage of the UPS unit is different from that of the mains supply, the MANUFACTURER shall provide a double wound transformer in the bypass circuit. For single phase units the transformer shall be connected across two phases of three phases, in both cases the secondary of the transformer shall be earthed.

A manual bypass switch, make before break, shall be provided to enable the load to be connected to the bypass circuit.

The manual bypass switch shall in the same operation disconnect the inverter and static changeover switch to ensure safe operating conditions for maintenance purpose.

A warning label shall be provided to warn the operator against operating the manual bypass switch if the "out of synchronization" warning indicator is showing. Isolation of the inverter shall only be possible if an alternative supply is connected to the load bus.

The bypass transformer/stabilizer output rating shall match the inverter output rating.

The transformer shall be a double wound air cooled type with an earthed screen between the primary and secondary windings.

5.3 Performance Requirements

5.3.1 Rectifier

In addition to the requirements herein, the rectifier shall comply with the applicable sections of the Design General Specification DGS 1630 025.

MANUFACTURERS shall include in their rectifier design charge voltage compensation for the battery operating temperature. This is to ensure that the recommended minimum and maximum charge voltages are maintained over the operating temperature range to achieve optimum battery service life.



SPECIFICATION FOR UPS SYSTEM

The rectifier shall operate according to the constant voltage, current limiting principle and shall incorporate a 'soft start' feature to gradually accept load on initial energizing. The rectifier shall restart automatically upon restoration of the mains power supply following a mains supply interruption.

The rectifier shall be rated to simultaneously:

- Fulfill the inverter input requirements when the inverter is delivering its rated output at 0.8 power factor lagging;
- Recharge the battery, within a period of 8 hours, from the partially discharged condition to a capacity that will enable it to fulfill the inverter input power requirements, for the duration as specified in the requisition, when the inverter is delivering rated output at 0.8 power factor lagging.

The above recharge performance shall be achieved irrespective of the type and method of battery recharging employed.

Where VRLA battery cells are specified, the rectifier shall perform battery charging only at the single-rate corresponding to the battery float-charge mode of operation. No rapid charge facilities shall be provided.

For all other (vented) types of battery, the rectifier shall perform battery charging at the dual-rate corresponding to the float-charge and rapid-charge modes of operation.

Switched diodes or supplementary battery cells as a means of limiting D.C. voltage variations are not acceptable. The D.C. supply shall not be utilized to energize loads other than the inverter.

Battery Float-Charge Operation

The rectifier steady-state D.C. output voltage variations shall be controlled to within plus 1% and minus 1% of the set value (corresponding to the battery float-charge voltage) during load variations between zero and the rated output of the rectifier, and during steady-state input voltage and frequency variations specified.

Short-time mains supply voltage depressions of not more than 20%, which may be the result of motor starting activities, shall not result in a trip of the rectifier or the initiation of battery discharge.

On-line adjustment of the set value of float-charge voltage shall be possible by means of a potentiometer on the relevant control circuit card, or by an appropriate menu driven software change.

The D.C. output current of the rectifier, when operating under constant current-limiting conditions, shall be controlled to within plus 2% and minus 2% of the set value.



SPECIFICATION FOR UPS SYSTEM

Battery Rapid Charge Operation (not applicable to VRLA Batteries)

Facilities shall be provided to initiate battery rapid-charge operation by manual and automatic means.

Automatic initiation of battery rapid-charge operation shall occur following any period of battery discharge exceeding 10 seconds.

Battery rapid-charge operation shall be automatically controlled according to a constant current I constant voltage characteristic.

The duration of battery rapid-charge operation shall be controlled by an adjustable timing relay. The relay shall be activated on detection of battery voltage and current conditions which indicate the restoration of the battery to an appropriate state of charge. After the elapsed time, the timing relay will re-instate the rectifier output voltage to that corresponding to continuous float-charge operation. When operating under constant current-limiting conditions, the D.C. output current of the rectifier shall be controlled to within plus 2% and minus 2% of the set value.

When operating under constant output voltage conditions, the voltage shall be controlled to within plus 1% and minus 1% of the set value.

On-line adjustment of the set value of the final voltage applied to the battery shall be possible by means of a potentiometer on the relevant control circuit card, or by an appropriate menu driven software change.

5.3.2 Battery and D.C. Circuit

The battery voltage and capacity shall be such as to fulfill the inverter input power requirements when the inverter is delivering its rated kVA output at 0.8 power factor lagging, for the duration specified in the requisition.

The battery discharge performance shall be fulfilled.

- Throughout the range of service conditions specified, including that corresponding to the minimum cell temperature specified;
- Repeatedly, each discharge performance being preceded by restoration of the battery to the required capacity by means of a recharge operation not exceeding eight hours;
- Following a prolonged period (i.e., not less than one year) of battery float-charge operation.

The nominal ampere-hour capacity of the battery supplied with the UPS shall include all necessary allowances required to compensate for aging effects that result in the progressive loss of capacity. However, the nominal ampere-hour capacity of the new



SPECIFICATION FOR UPS SYSTEM

battery shall be not less than 110% of the nominal ampere-hour capacity required to fulfill the performance criteria stated above.

The UPS shall be capable of energizing loads between zero and its rated output, and of performing load transfer switching, in accordance with the requirements of this specification, without the battery being connected.

The current ripple limits specified by the battery MANUFACTURER, for the battery supplied with the UPS, shall not be exceeded during at least normal standby operating conditions.

The MANUFACTURER shall specify the r.m.s. value of the actual, and the maximum permissible, ripple current through the battery, as a percentage of the battery nominal ampere-hour capacity, when the UPS is operating under normal standby conditions.

The D.C. circuit earthing arrangement shall be in accordance with the MANUFACTURERS standard.

5.3.3 Inverter

The inverter shall be transistorized type PWM (Pulse Width Modulated) with microprocessor based controls. The inverter shall be of the current limiting type (short circuit proof) and have nominal output voltage and frequency as specified in the requisition. The inverter output voltage and frequency shall not exceed the operational tolerances, as measured at the output terminals of the unit, during the following conditions of UPS loading:

- Load variations between zero and the rated output of the UPS;
- Load power factors over the range 0.7 lagging to unity;

Load current waveform having a relative harmonic content varying between zero and 50%, the latter waveform having a crest factor not exceeding 2.5 and individual harmonics not exceeding the following values:

3rd harmonic	44% of fundamental
5th harmonic	33% of fundamental
7th harmonic	18% of fundamental
9th harmonic	7% of fundamental
11th harmonic	10% of fundamental

- D.C. input voltage over the range corresponding to battery rapid charge and battery discharge operation during the specified discharge times.

The inverter shall control the output voltage of the UPS such as to maintain synchronism with the mains bypass voltage during variations in mains frequency up to



SPECIFICATION FOR UPS SYSTEM

the limits specified. During variations in mains bypass frequency exceeding these limits, the inverter shall revert to internal frequency control.

Automatic synchronizing to maintain output frequency within ± 5 degrees of the external reference signal, (provided the reference frequency stability is within ± 1 Hz), shall be supplied.

Upon failure of this reference, the inverter shall maintain the frequency within the tolerances quoted until the external reference returns. The inverter shall then automatically re-synchronize to the external reference. The rate of frequency change during synchronizing shall not exceed 0.1 Hz per second when changeover is by the static switch.

Loss of synchronizing signal between the inverter and the bypass supply shall:

- Not block automatic actuated transfers from normal to bypass supply;
- Not block automatic actuated transfers from bypass to normal supply;
- For solid-state transfer switches, block manually actuated transfers to either supply.

Output Voltage Static Regulation

The output voltage static regulation shall be maintained within plus 2% and minus 2% of rated output voltage. For 3-phase inverters, the phase and line voltages shall not exceed plus 2% and minus 2% of rated voltage when the load current in any two phases differs from the rated output current by up to 50%.

Output Voltage Dynamic Response

The dynamic output voltage variations shall not exceed plus 10% and minus 10% of rated output voltage in the event of instantaneous load changes of 100% rated output. The output voltage shall be restored to within the steady state limits of plus 5% and minus 5% of rated output voltage within 0.1 seconds.

Frequency Deviation

The frequency of the output voltage shall be maintained within plus 1 % and minus 1 % of rated frequency when operating on internal frequency reference.

Output Voltage Waveform

The waveform of output voltage shall be sinusoidal. Inverters shall provide power from zero to full rated output without exceeding the specific 5% total harmonic distortion of the output voltage wave shape. The plant load typically includes non-linear loads which can introduce harmonics in the inverter output current. Inverters shall be capable of supplying the plant load without sustaining damage to any of their components due to such harmonics.



SPECIFICATION FOR UPS SYSTEM

Output Voltage Symmetry

For 3-phase inverters, the angular displacement of the phase voltages shall not exceed 1200 ± 1 % when supplying a balanced, linear load at rated output, 0.8 power factor lagging, and 1200 ± 1 % when the load current in any two phases differ by 50% from the rated output current.

Short Circuit Current

The inverter shall be capable of delivering sufficient short circuit current to cause main output circuit fuse links/circuit breakers, rated nearest to 10% of the UPS rated output current, to interrupt the short circuit current within 3 millisecons when the UPS is not synchronized with the mains bypass supply. The main output circuit fuse links shall be of the slow-acting type g1, in accordance with IEC 60269.

5.3.4 Static Bypass Switch

Circuit Rating

The load transfer switching devices may consist of either continuously rated static element in both inverter and bypass circuits, or continuously rated electro-mechanical switching devices with short-time rated static elements. The bypass circuit shall have a continuous current rating equivalent to the rated output of the UPS unit and be capable of conducting a current of ten times the rated output for not less than two seconds.

In view of electronic components involved, reliability in terms of high Mean Time Between Failure (MTBF) factors is essential. To achieve this objective, MANUFACTURER is required to examine the rating factors applied to all components used in manufacturing, and guarantee that the ratings for this application will be modified as necessary to ensure long term reliability.

Load Transfer Criteria

Facilities shall be provided to manually and automatically initiate transfer of the load from the inverter to the bypass circuit, and from the bypass circuit to the inverter. The combined detection and switching time required to transfer the load from the inverter to the bypass circuit in the event of instantaneous loss of inverter output voltage shall not exceed 0.5 millisecons.

When the inverter is running with its internal reference frequency and the static switch is blocked, any failure of inverter shall initiate a transfer to bypass supply after a time delay which can be adjusted from 50 to 500 milliseconds.

The criteria for load transfer shall be as follows:

- a. Transfer of the load from the inverter to the mains bypass.

Load transfer shall only be possible when:



SPECIFICATION FOR UPS SYSTEM

- The mains bypass voltage is within $\pm 15\%$ of rated UPS output voltage;
- The mains bypass frequency is within the tolerances specified;
- The inverter output and mains bypass voltages are synchronized.

Automatic transfer of the load shall be initiated when:

- The inverter output voltage drops below 95% of the nominal output voltage. Transfer should be accomplished before the voltage reaches 85% of the nominal value;
- The inverter output voltage exceeds 105% of the nominal output voltage. Transfer should be accomplished before the voltage reaches 115% of the nominal value;
- The inverter output current limit is exceeded.

- b. Retransfer of the load from the mains bypass to the inverter.

Load retransfer shall only be possible when:

- The inverter output voltage is within $\pm 10\%$ of the nominal output voltage for more than 5 seconds;
- The inverter output and mains bypass voltages are synchronized.

Subject to fulfilling the above criteria, retransfer of the load from mains bypass to the inverter shall be initiated automatically following automatic transfer of the load from the inverter to the mains bypass. The automatic retransfer of the load to the inverter shall be inhibited following four automatic transfers of the load to the bypass, if these take place within an interval of 5 minutes. An annunciation shall be provided under this condition.

Subject to fulfilling the above criteria, automatic retransfer of load back to the inverter(s) from the bypass transformer shall operate as follows:

- c. A two-position "AUTO-STANDBY" retransfer selector switch shall be provided for each changeover switch to control the automatic retransfer operation.
- d. When the retransfer selector switch is in the "AUTO" position, retransfer back to the inverter supply shall occur automatically whenever the conditions of Item {b} above are met.
- e. When the retransfer selector switch is in the "STANDBY" position, retransfer back to the inverter supply shall occur automatically only if the bypass supply has been lost and normal voltage is present on the inverter supply.



SPECIFICATION FOR UPS SYSTEM

All transfer switches and the actuating devices for these controls shall be so located or guarded to prevent accidental operation.

5.3.5 Noise Limits

The sound pressure level measured at one meter distance from the UPS unit, at any position, shall not exceed 75 dB(A) at any load between zero and the rated output of the unit.

5.4 Construction Requirements

5.4.1 Unit Enclosure and Accessibility

Unit Enclosure

The rectifier, inverter and static switch shall be installed in one or more freestanding, self-supporting steel cabinets forming an enclosure. Each cabinet shall be suitable for operation and maintenance with its rear panel against a wall and with similar units located immediately on both sides.

All cubicles and equipment shall be fully tropicalized. Enclosure protection shall be not less than IP41 per IEC 60529, without considering the floor as part of the enclosure.

Each cubicle shall be fitted with isolator(s) which can be operated externally.

With the isolator(s) in the "off" position the unit shall be fully isolated for maintenance purposes. Any live terminations which cannot be isolated such as bypass supplies, which must remain "on" to maintain the supply to the load, shall be fully shrouded and adequate warning markings fitted. The terminals shall, as far as possible, be segregated from the isolated circuits.

The distribution section shall be provided within a cubicle unit. The number of ways and the rating shall be as detailed in the data sheets or single line diagram.

Cooling

Internal cooling of the unit shall be by natural or forced air ventilation. The unit shall be capable of continuously delivering rated output with anyone forced air ventilation fan out of service. Under the latter conditions, the maximum continuous temperature of components shall not be exceeded.

The unit shall not incorporate cooling air filters that require periodic cleaning and/or replacement.



SPECIFICATION FOR UPS SYSTEM

Accessibility

Equipment and components located within the enclosure shall not be mounted directly on the walls of the enclosure. The location and grouping of components and auxiliary equipment shall permit easy identification and access for operational, maintenance and repair purposes. Suitable partitioning between individual items shall be provided where necessary to allow adjustment and inspection to be carried out safely.

All live terminals of door-mounted equipment having a maximum (peak) voltage of greater than 24 volts shall be shrouded or otherwise protected by barriers to a degree of protection of at least IP30. Barriers shall be of rigid transparent insulating material to enable the screened components to be identified. Protection relays which can cause tripping of the unit shall not be mounted on the door.

All bare busbars and all live terminals of equipment and components located within the enclosure shall be similarly protected by barriers or shrouds to a degree of protection of at least IP 20, unless adequately recessed within the enclosure to prevent inadvertent contact or short circuit by personnel when performing control circuit adjustments or when resetting/replacing protective devices etc.

Battery Enclosure

Unless specified otherwise in the requisition, batteries shall be installed on freestanding support racks in a separate battery room. Specific requirements will be indicated in the requisition. Battery enclosures shall be naturally ventilated to disperse gaseous products. The battery shall be positioned such that possible leakage of electrolyte or emission of gaseous products shall not cause damage to other equipment, components, or adjacent cells.

Separate, freestanding support racks for batteries having plastic cell containers may be steel or solid wood. Nickel cadmium batteries having steel cell containers shall be supplied in wood crates. Support racks for the latter shall be solid wood. All wood should be retreated to render it non-hygroscopic and acid resistant. Steel racks shall have a plastic or epoxy coating to provide suitable protection against the effects of electrolyte spillage.

5.4.2 Converter Components

Printed Circuit Boards (PCB) shall be installed in standardized electronic equipment frames and be fitted with handgrips for easy removal. The frames shall incorporate card guides to facilitate the correct insertion of PCB's, and allow access to the wiring side of connectors. PCB's shall include visual LED status indications and test connections on the front to facilitate fault diagnosis.



SPECIFICATION FOR UPS SYSTEM

Main circuit switches (mechanical) shall comply with IEC 60408 and be of the independent manually operated air-break type rated for continuous duty. They shall comply with utilization category AC23 and DC23 for AC. and D.C. switches respectively.

Contactors shall comply with IEC 60158-1 and be rated for uninterrupted duty and intermittent duty of at least Class 0.1. The utilization category for D.C. contactors shall be not less than DC-4 and for A.C. contactors not less than AC-3.

Transformers and reactors shall be of the air-cooled type and comply with the relevant parts of IEC 60146.

5.4.3 Wiring and Terminations

Internal wiring shall be single core, 600/1000V grade PVC insulated, and have stranded copper conductors. Minimum conductor size for power circuits shall be 2.5 mm². Wiring between terminals shall be continuous and without joints. Wires shall be held in position by means of insulating tubes, channels, cleats or plastic strips, and be routed such as to avoid mechanical damage. Wiring between fixed portions and hinged doors shall be mechanically protected against abrasion or entrapment and shall not be carried over or bent around sharp edges.

Individual wires or cables terminating in fixed (non-plug-in) components which require to be disconnected for the purpose of component testing or replacement, shall be identified by means of color or by ferrules of insulating material marked in accordance with the MANUFACTURER'S drawings

Terminals shall be provided for all external connections. External connections shall not be made directly to component terminals. Terminals shall be of the rail mounted type and have screw connectors suitable for a minimum of 2.5 mm² conductors. Only one conductor shall be terminated in each terminal. Links shall be provided where more connections are required at one point. Insulating shields shall be used to separate terminals belonging to different circuits. For control wiring, pre-insulated crimped terminals shall be used and for powers wiring crimped lugs with heat shrink Pre-shrouds shall be used.

Additional load circuit terminals shall be provided to facilitate connection of a temporary load to test the UPS unit while the permanent load is energized via the external bypass circuit.

The UPS enclosure shall have facilities for the entry of cables from above or below, as specified in the requisition. Cable entries and terminals shall be suitable for the type and size of cables specified on the requisition. Cable glands shall be of the compression type and mounted on a removable gland plate.



SPECIFICATION FOR UPS SYSTEM

The proximity of terminals and gland plates shall be such that ample space is available for terminating the cores of external cables.

Distance between cable entrance and terminals shall be such that ample space is available for terminating the cores of external cables.

5.4.4 Earthing

An earth rail, with a suitable number of earthing bolts or screws, shall be provided in a position close to the external cable glands to facilitate termination of cable earth braids or armoring. Individual connections for all earth wires shall be provided.

A threaded brass earth stud of not less than 6 mm diameter, with nuts and spring washers, shall be provided within the enclosure to facilitate termination of a separate, single-core, earth cable.

Electrical conductivity between the exposed, non-current carrying conductive parts of the UPS unit components and the enclosure, and between the enclosure and the earth rail/earth stud, shall be such as to maintain effective continuity of protective circuits. Earth bonding conductors shall be utilized between enclosures and doors, and where required to achieve effective protection. The neutral of the inverter output shall be earthed by a connection to the earth rail/stud within the enclosure.

5.4.5 Battery Cells and Containers

Unless otherwise specified in the requisition, the batteries shall be VRLA type with 20 years life.

Nickel-cadmium battery cells, if specified, shall be of the pocket plate, sintered plate or fibre plate types. Lead-acid battery cells may be of the Plante type or of the sealed type. Gas recombination battery cells shall be of the flat plate construction incorporating electrolyte absorbed in the plate separators. Terminal pillar seals shall be of a design that prevents the initiation of pillar corrosion.

Cell containers of plastic material are preferred, subject to the material being non-flame propagating and mechanically shock resistant. Steel cell containers are preferred in applications requiring large capacity batteries, if parallel operation of battery cells is thereby avoided. Plastic containers of vented, flooded cells shall permit the electrolyte level to be viewed through the container material. Vented, flooded cells shall be fitted with flame arresting vent plugs.

Inter-cell connectors and terminals shall be insulated or otherwise provided with protective covering to prevent inadvertent short circuiting.



SPECIFICATION FOR UPS SYSTEM

Flooded batteries shall be supplied complete with ready-mixed liquid electrolyte which shall be appropriate for the cell temperatures specified.

5.4.6 Marking

All external operating, measuring and indicating components shall be clearly identified with permanent descriptive labels that facilitate easy recognition by the operator. All components shall be identifiable by labels inscribed in accordance with the system of identification used on the MANUFACTURER'S reference drawings and documents.

Rail mounted terminals of equipment and components shall be identifiable by numerical or alphabetical markings in accordance with the MANUFACTURER'S drawings. Terminals of input and output supply cables shall be clearly and uniquely marked to indicate the nominal system voltage and the phase/polarity of the supply.

The identification of terminals shall be in accordance with IEC 60445.

The following information shall be inscribed on a non-destructive, corrosion-resistant, indelible name/rating plate attached to the unit enclosure:

- Purchaser's order number and equipment No.;
- Year of manufacture;
- Name of MANUFACTURER;
- Type and serial number of unit ;
- Weight of cubicle;
- Dimensions of cubicle;
- Nominal input current and voltage;
- Nominal output current, voltage and frequency.

All labels/nameplates shall be of corrosion resistant material (3 ply white black white Trafolyte) with indelible inscriptions in the English language fixed by stainless steel screws or rivets.

All switches, instruments (meters), transformers, fuse holders, push buttons and indicating lamps shall have labels fixed adjacent to them. The label shall carry a functional description and all essential data including, but not limited to, the following information as applicable:

- Fuse size;
- Ratings (voltage, current, frequency);
- Accuracy (instruments);



SPECIFICATION FOR UPS SYSTEM

- Switch duties.

5.4.7 Finish

The treatment and protection of metalwork may be in accordance with MANUFACTURER'S standard but shall include cleaning, degreasing, rust resisting primers and paint finishes that provide effective protection against corrosion under the functional and climatic conditions specified. Color shade shall be green RAL 6021.

5.4.8 Mimic

Each unit shall have front of panel Mimic/Graphic Diagram showing all major components.

5.4.9 Anti-Condensation Heaters

Anti-condensation heaters shall be provided within the equipment enclosures to limit the effect of changes in temperature and humidity. Supply shall be 240V single phase 50 Hz. An On/Off switch and thermostat shall be provided.

The heating system shall be designed in such a way that the heat is adequately distributed over all functional units. When the heating system is live, this shall be indicated by means of a prominently situated red light.

5.5 Measurement, Protection and Control Equipment

5.5.1 General

The UPS unit shall incorporate all the necessary equipment to enable operation, protection and control of the UPS in accordance with this specification, and to safeguard the unit and its components from the consequences of internal and external short circuits, over voltages and any main or control circuit malfunctions, howsoever caused.

Operating, status and diagnostic indications of light-emitting diodes (LED's) or liquid crystal displays (LCD's) shall be provided.

Each LED/alarm circuit shall have built-in test facilities. Failure of an LED/LCD shall not cause UPS maloperation or affect the correct functioning of the remote common alarm signal. Indication by means of filament lamps is not acceptable.

Microprocessor based protection, control and metering package with serial communication shall be provided for remote control and monitoring of the UPS from the plant control system. This serial interface shall be on RS 485 Modbus R1V protocol.



SPECIFICATION FOR UPS SYSTEM

5.5.2 Status Indications

At least the following indications, in the form of LED/LCD's and/or measuring instruments, shall be provided on the front outside panel of the unit to enable verification of the operational status of the UPS. The indications shall be superimposed on a mimic diagram of the UPS unit to identify the relevant component or circuit.

- A.C. input supply available;
- Alternative/bypass supply available;
- Rectifier on;
- Inverter on;
- Load on inverter;
- Load on bypass;
- Inverter/bypass synchronized;
- Battery on boost charge (not required for VRLA type).

5.5.3 Measurement

Measuring instruments may have digital or analogue display.

Facilities for obtaining the following information or measurements shall be provided on the front outside panel of the unit:

- Rectifier mains (input) voltage and current (AC);
- Battery voltage and current (charge and discharge) (DC);
- Output voltage, current and frequency (AC);
- Inverter current (AC);
- Bypass mains (transformer output) voltage, current and frequency (AC);
- Total current (DC);
- Output power factor;
- Output peak current.

The accuracy of all measuring instruments shall be not less than that corresponding to Class 1.5 of IEC publication 60051 and shall be of long scale (240° movement).



SPECIFICATION FOR UPS SYSTEM

5.5.4 Protection and Alarms

The status of the alarm and protection functions shall be visually verifiable by appropriate indicators with first failure feature. Alarms associated with trip functions shall be hand reset.

The following alarm and protection functions shall be provided as a minimum:

(1 =alarm; 2=alarm and trip rectifier; 3=alarm and trip inverter)

- | | |
|--|---|
| • A.C. input phase undervoltage | 2 |
| • Rectifier failure | 2 |
| • D.C. overvoltage | 3 |
| • D.C. undervoltage | 3 |
| • Charge failure/battery discharging | 1 |
| • Battery disconnected | 1 |
| • D.C. earth fault(*) | 1 |
| • Inverter failure | 3 |
| • Inverter overcurrent | 3 |
| • Inverter output voltage deviation | 3 |
| • Inverter/bypass not synchronized | 1 |
| • Cubicle fan failure | 1 |
| • Cubicle/inverter stack overtemperature | 3 |
| • Battery Capacity low | 1 |

(*) to be provided on normally unearthed D.C. systems.

Volt free contacts for following alarms shall be wired to DCS in Main Control room:

- Change failure/battery discharging;
- Common Trouble Alarm;
- Detailed status and faults of all outgoing, circuit breakers of the UPS distribution section;
- Load on inverter;
- Load on bypass.

The above mentioned alarm contacts shall be wired to a terminal block such as to provide one normally open and one normally closed, potential-free, contacts for remote



SPECIFICATION FOR UPS SYSTEM

cabling to a common alarm. The operation of the common alarm contacts shall have an adjustable time delay with a range of not less than 4 seconds.

An inverter over temperature alarm shall be provided to give a two-stage alarm indication. The temperature sensors shall be located by the MANUFACTURER at the position of highest temperature within the equipment to ensure full protection. The operating level of the alarms shall be determined by the MANUFACTURER and set to ensure that adequate time is available for corrective measures on operation of the first alarm level.

Operation of the second alarm shall cause the load to be transferred to the bypass circuit and shall isolate the inverter. An alarm indicator shall be provided for both stages.

An alarm indicator shall be provided to indicate that the inverters output and the bypass circuit are out of synchronism.

In addition, a white 'source synchronized' pilot light shall be provided adjacent to the operating handle of the manual bypass switch. The light shall be energized when normal and bypass sources are in synchronism.

Operation of any of the above alarms or relays shall initiate a common fault alarm relay with two sets of changeover contacts wired out to terminals for external connection.

When fault diagnostic modules are available, they shall be made visible through a transparent panel let into the front of the equipment door.

5.5.5 Controls

The following adjustment and control facilities shall be provided:

- Rectifier input isolation switch/MCCB;
- Rectifier on/off control switch;
- Rapid charge initiation switch (not required for VRLA batteries);
- Rapid charge duration timer (not required for VRLA batteries);
- D.C. output voltage adjustment;
- D.C. current limit adjustment;
- Inverter on/off control switch;
- A.C. output voltage adjustment;
- Synchronizing range adjustment;
- Load transfer initiating control switch;



SPECIFICATION FOR UPS SYSTEM

- Battery isolation switch;
- Battery Diagnostic facilities.

5.5.6 Battery Diagnostic Facilities

The AC UPS unit shall be provided with an on-line battery cell monitoring and battery discharge test facility to determine battery condition without having to disconnect the AC UPS unit from the load.

The monitoring facility shall measure voltage levels of blocks of cells within a battery by means of a permanently installed monitoring device connected to the battery control panel and wired to the battery cells. The monitoring device shall have an alarm at a preset voltage level (high and low) indicating under performance of a particular block of cells.

The on-line discharge test facility shall be such that a short duration battery discharge into the load can be affected which can be pre-programmed. Battery terminal voltage and load current shall be measured during such a discharge and, by comparing these measurements with the preprogrammed discharge characteristics of the particular battery, shall be able to predict time left until end of discharge down to the final discharge voltage at the particular load current. It shall also indicate whether the battery capacity deviates by more than a certain, adjustable, value from its nominal capacity. The battery monitoring system shall be microprocessor based, programmable with liquid crystal display (LCD), built-in diagnostic facility and serial communication facility to the IPCS. Data to the DCS shall be through the IPCS serial link.

The above test facilities shall be mounted on the front of the rectifier cabinet.

6.0 TESTING REQUIREMENTS

6.1 General

Prior to dispatch, the MANUFACTURER shall verify by test that the operation of the assembled UPS unit complies with the requirements specified on the purchase order documents, and shall submit a report incorporating measurements and results of all tests performed.

All equipment including SUBVENDOR'S equipment shall be subject to inspection and witness of tests at the MANUFACTURER'S works by the CONTRACTOR or his appointed representative. The MANUFACTURER shall provide a minimum of ten working days' notice of inspection and test dates.



SPECIFICATION FOR UPS SYSTEM

All equipment shall be subject to shop tests in accordance with applicable engineering standards and codes. Compliance with the requirements of this specification, the material requisition and associated documents shall also be demonstrated.

The equipment shall not be dispatched by the MANUFACTURER/NENDOR until material and equipment test certificates have been approved by the CONTRACTOR at the time of the shop test acceptance.

Unless otherwise specified, testing of the assembled UPS unit at the MANUFACTURER'S works will not include the battery that forms part of the purchase order. UPS tests shall be confined to verifying the performance of the rectifier, inverter, static switch assembly and related auxiliaries (hereafter referred to as the converter).

Tests shall, however, be performed using a D.C. supply of equivalent capacity to the battery that will be supplied with the converter. Tests to verify the capacity of the purchased battery shall be performed by the CONTRACTOR as part of the commissioning procedure after site erection.

Prior to the commencement of tests, the MANUFACTURER shall make all relevant adjustments to the protection and control circuit components of the converter, as necessary to fulfill the requirements of the purchase order and this specification. The rectifier output voltage and current limits shall be set to the appropriate values for the type and number of battery cells to be supplied with the converter, and to the relevant cell temperatures specified.

6.2 Performance Tests

Insulation Tests

The voltages specified in the following table shall be applied for one minute to the circuits indicated.

Table of Withstand Voltages	Control Electronics < 60 V	Power Electronics Unit	Auxiliary Circuits Un2
To earth	700V D.C.	2 X Un1 + 1000V	2 x Un2 + 1000V
To control electronics	-	2 X Un1 + 1000V	2 x Un2 + 1000V
To power electronics	2 X Un1 + 1000V	-	2 x Un1 + 1000V
To auxiliary circuits	2 x Un2 + 1000V	2 X Un1 + 1000V	-



SPECIFICATION FOR UPS SYSTEM

D.C. test voltages may be applied instead of A.C. The magnitude of D.C. test voltages to be applied shall be $\sqrt{2}$ times the above mentioned A.C. (r.m.s.) values.

Load Duration Test

All converters to be supplied as part of the purchase order shall be subjected to a load-duration test performed at rated voltage for a period of not less than 48 hours prior to the execution of functional tests.

At least one converter of each group of identical converters shall be loaded to its rated output, at 0.8 power factor lagging, throughout the 48-hour test period. If an appropriate load is not available to conduct the test, then it shall be carried out using a resistive load. The load resistance shall then be such that the inverter D.C. input current is the rated value.

All other converters to be supplied as part of the purchase order may be energized under partial load or zero load current conditions throughout the test period.

MANUFACTURER'S test reports shall state the dates and times on which the load duration test was performed and shall record details of load currents and any circuit or component malfunction identified during the test period.

Functional Tests

Functional tests shall be performed on all converters. If, during the execution of functional tests, an electronic component of the converter is required to be replaced, e.g. due to converter malfunction or failure of the unit to fulfill the performance requirements of the specification, then the converter load-duration test shall be repeated at rated current following which the functional tests shall be carried out.

The MANUFACTURERS standard test protocol will be acceptable provided it is no less stringent than that specified below.

Tests and measurements marked (**) may be omitted subject to the MANUFACTURER submitting with the tender, details of the availability of test records (including dates and location of tests) which verify the specified performance values.

Rectifier Load Test at Constant Output Voltage

Measurements shall be carried out in the rectifier float-charge operating mode and in the rapid-charge operating mode (if applicable). In each mode, measurements shall be carried out at nominal AC. supply voltage and at zero, 50% and 100% of rectifier full load direct current. Measurements at 100% full load current shall be repeated at 90% and 110% of nominal AC. supply voltage.



SPECIFICATION FOR UPS SYSTEM

- Measurements shall comprise of:
- Input phase voltage and frequency;
- Input phase current;
- Input power;
- D.C. output voltage;
- D.C. output current.

Rectifier Load Test at Constant Output Current Limit

Measurements shall be carried out in the rectifier float-charge operating mode and in the rectifier rapid-charge operating mode (if applicable).

In each mode, measurements shall be carried out when the rectifier is operating under D.C. output current-limiting conditions with the D.C. output voltage between zero and the set value corresponding to constant voltage operation.

Measurements shall comprise of:

- D.C. output voltage;
- D.C. output current.

Inverter static load tests

a. 1-Phase Inverters

Measurements shall be carried out at zero, 50% and 100% of inverter rated output current and shall be repeated for inverter D.C. input voltages corresponding to battery float-charge operation and the rated maximum and minimum inverter input voltage.

Measurements shall comprise of:

- Input voltage;
- Input current;
- Output voltage, frequency and waveform distortion;
- Output phase current(s);
- Output power;

b. 3-Phase Inverters

- Balanced Load Test:



SPECIFICATION FOR UPS SYSTEM

The static load test described in (a) for 1-phase inverters shall be carried out on 3-phase inverter, the load being a balanced 3-phase load.

- Unbalanced Load Test:

Measurements shall be carried out under unbalanced load conditions such that the current in one phase of the inverter differs from that in the other two phases by 50% of the rated output current.

Measurements shall be carried out for inverter D.C. input voltages corresponding to battery float-charge operation and the rated maximum and minimum inverter input voltage.

Measurements shall comprise of:

- Input voltage;
- Input current;
- Output voltages;
- Angular displacement of output phase voltages;
- Output currents.

Inverter dynamic load tests ()**

Measurements of inverter output voltage variations shall be recorded in response to:

- Instantaneous load changes of 100% rated output;

Measurements shall be recorded when the load is switched to/from the inverter via the static bypass switch and via the load circuit switch.

- Application of a short circuit to the inverter output via a slow-acting (type g1) fuse link having a current rating nearest to 10% of the UPS unit rated output, the bypass circuit being isolated.

Static Bypass Switch Tests

Measurements shall be carried out to verify the correct functioning of the bypass circuit voltage and frequency monitors, and the inverter/bypass synchronous operating controls.

Measurements of the load voltage waveform(s) shall be carried out during the following load transfer tests which shall be performed with the UPS unit delivering any load between zero and its rated output, and with the inverter operating in synchronism with the bypass circuit supply:



SPECIFICATION FOR UPS SYSTEM

- Load transfer bypass initiated by manual operation of load transfer switch;
- Load transfer to bypass initiated by simulating inverter malfunction;
- Load transfer to bypass initiated by short circuiting of fuse protected load circuit (**);
- Load retransfer to inverter initiated automatically and manually;
- Lock-out of automatic load retransfer on sustained and recurring fault.

Auxiliary Equipment and Control Circuit Tests

The correct functioning of all measuring instruments, alarms and indications, protection and controls specified, shall be verified.

Battery Discharge Test

A battery discharge test shall be performed at a current corresponding to the inverter input current when the inverter is delivering its rated output kVA at 0.8 power factor lagging.

The following measurements shall be recorded:

- Battery voltage after the specified discharge time;
- Battery discharge duration at the instant of inverter shutdown initiated by the D.C. circuit low-voltage monitor.

7.0 GUARANTEES AND PERFORMANCE

The MANUFACTURER shall guarantee, in accordance with general conditions, that the equipment shall meet the performance conditions specified in this specification and the data sheets.

The MANUFACTURER shall provide 12 months repair or replacement guarantee.



SPECIFICATION FOR UPS SYSTEM

APPENDIX A

BLOCK DIAGRAM FOR PARALLEL STATIC UPS SCHEME

