

WATER SUPPLIES DEPARTMENT
STANDARD SPECIFICATION E-61-03
UNINTERRUPTIBLE POWER SUPPLY EQUIPMENT

1. **GENERAL**

This Specification covers the design, manufacture and testing of static online uninterruptible power supply (UPS) equipment to provide continual and uninterrupted a.c. power supply for computer and instrumentation systems in case of mains supply failure. The UPS equipment shall include all functional units and components to form a complete working system.

The UPS equipment shall comply with the energy efficiency requirements for power quality as stipulated in the Code of Practice for Energy Efficiency of Electrical Installations issued by the Electrical and Mechanical Services Department.

2. **SYSTEM DESIGN**

2.1 **General**

UPS equipment shall be of solid state and designed in compliance with IEC 62040. The equipment shall consist of rectifier, battery charger, standby battery cells, inverter, static bypass switch and manual bypass switch (if applicable) to form a complete working system. The UPS equipment shall meet the following performance requirements :-

(a) **Input**

- (i) **Voltage** : 220V ($\pm 15\%$) 50Hz ($\pm 5\%$) 1-phase 2-wire or
380V ($\pm 15\%$) 50Hz ($\pm 5\%$) 3-phase 4-wire
- (ii) **Maximum total harmonic distortion (THD) of input current** : Requirements as stipulated in the Code of Practice for Energy Efficiency of Electrical Installations
- (iii) **Power factor** : 0.95 or better

(b) **Output**

- (i) **Voltage** : 220V 1-phase 2-wire or
380V 3-phase 4-wire
- (ii) **Frequency** : 50 Hz $\pm 0.1\%$ (free-running)
50 Hz $\pm 2.0\%$ (synchronized)

- (iii) Voltage regulation : $\pm 1.5\%$ at balanced load
 $\pm 2.0\%$ at 100% unbalanced load (3-phase UPS)
 $\pm 3.0\%$ at 100% load step change, settling time <20 ms
- (iv) Wave form : Sinusoidal
- (v) Maximum THD of output voltage : < 3% for linear load
< 5% for non-linear load
- (vi) Crest factor : 3:1 or better
- (vii) Load power factor range : Capacitive to inductive over the entire range, rated at 0.8 lagging
- (viii) Output efficiency : 88% or above at 50 - 100% load under online operation
- (ix) Overload capability : 125% for 10 minutes
- (x) Electromagnetic emission : Class A - UPS to IEC 62040-2
- (xi) Maximum noise level : 50 dB(A) at 1 metre : UPS \leq 7.5 kVA
60 dB(A) at 1 metre : UPS > 7.5 kVA
- (xii) Cold starting : Start up of UPS by standby battery in the absence of mains supply input

2.2 Rectifier

The rectifier shall be used for supplying d.c. power to the inverter and for charging the standby battery. The a.c. mains shall be converted to the required voltage by means of a full-wave controlled thyristor bridge. Twin thyristor bridge providing a 12-pulse output shall be equipped for 3-phase UPS equipment rated at 30 kVA or above. Harmonic and electromagnetic interference(EMI) smoothing devices shall be provided to limit the maximum total harmonic distortion of input current and prevent spikes and electrical noise present in the mains from affecting the UPS load. Double wound isolation transformer shall be provided for the a.c. mains.

2.3 Battery Charger

The battery charger shall have constant voltage boost charge and float charge modes with current limiting and battery temperature compensation to prevent excessive charging of the battery. Switching between the two charge modes shall be automatically to provide fast recharging without affecting the service life and performance of the battery. The battery shall be fully charged in less than 10 hours after a stored energy time discharge. Harmonic smoothing devices shall be provided for reducing the harmonic contents in the battery charging current.

2.4 Standby Battery

The standby battery shall be integrated with the UPS equipment to provide at least 30 minutes stored energy time. The battery cells shall be maintenance free sealed type battery cells to IEC 61056 or IEC 60898. The minimum working life of the battery cells at 20°C shall be as follows :

- (a) Charge/discharge cycles at 100% depth of discharge : 300
- (b) Continuous float charging : 10 years

2.5 Inverter

The inverter shall convert d.c. to a.c. voltage utilising power transistors switching at high frequency under pulse width modulation. Harmonic filter shall be provided to limit the maximum THD of the output voltage. The inverter shall be short-circuit proof with a short-circuit current limited to 3 times the rated output value.

2.6 Static Bypass Switch

A static bypass switch shall be provided to facilitate uninterrupted and automatic transfer of the UPS load to an alternative bypass source in the event that the UPS is overloaded or faulty. The transfer of the load back to the UPS output shall be automatic when the fault is cleared and the UPS is in normal services. The UPS output and the alternative a.c. mains shall be synchronized in frequency and phase to ensure the operations of the static bypass switch will be continuous. Double wound isolation transformer shall be provided for the alternative a.c. mains. UPS equipment of rating less than 7.5 kVA may have one common input for the normal and alternative a.c. mains. The static bypass switch shall be fuse protected with an overload withstand capability of 500%.

2.7 Manual Bypass Switch

A manual bypass switch of suitable rating shall be provided for equipment maintenance and testing. The manual bypass switch shall be mechanical type with make-before-break mechanism to transfer the UPS loads to the alternative a.c. mains without supply interruption.

2.8 Protection

The UPS shall be provided with integral protective devices and control circuits to protect the equipment against:-

- (a) Voltage surges
- (b) Over-temperature
- (c) Overload, short-circuit and earth faults of input, output and battery supply
- (d) High or low d.c. voltage

- (e) Reverse battery polarity
- (f) Other internal or external faults

In addition, automatic backfeed protection shall be provided for the UPS mains input terminals to prevent electricity backfeed in stored energy mode of operation.

2.9 Control and Monitoring

The UPS equipment shall include the following control and monitoring facilities :-

- (a) Mains on/off switch
(The UPS electronics, a.c. mains inputs and standby battery supply shall be completely isolated at the mains switch 'Off' position)
- (b) Manual bypass switch
- (c) Alarm reset/buzzer mute switch
- (d) Indicating lights for load %, battery charge %, 'UPS On' and 'Mains Available'
- (e) Audio and visual alarms for 'Mains Failed', 'On Battery', 'On Bypass', 'Low Battery' and 'UPS Fault'
- (f) Volt-free output contacts for 'Mains Failed' and 'Low Battery'
- (g) Input contacts for 'Emergency Power Off' for complete shutdown of the UPS
- (h) A RS-232 serial port to transmit all available UPS alarms and status indications to computer (communication and interface software shall be provided if specified in the Particular Specification)

For UPS rated at 7.5 kVA or above, the following additional facilities shall be provided :-

- (i) Volt-free output contacts for 'UPS On', 'On Battery', 'On Bypass' and 'UPS Fault'
- (j) Input contacts for 'Bypass Inhibit' for blocking the static bypass switch in case of an unstable alternative a.c. mains
- (k) Integrated measurement system and backlit LCD display unit with access buttons for display of the following information :-
 - (i) Remaining battery backup time in minute (under current load)
 - (ii) Mains input phase voltages
 - (iii) UPS output phase voltages

- (iv) UPS output frequency
- (v) Battery voltage
- (vi) Battery charge/discharge current
- (vii) Fault diagnostic and alarm messages

3 CONSTRUCTION

The UPS equipment shall be accommodated in a rigid metal framework suitable for floor standing. The enclosure shall have a degree of protection of IP20 to IEC 60529. The UPS equipment shall be natural air cooled or forced air ventilated to suit its output rating. UPS rated at 7.5 kVA or above with forced air ventilation design shall be provided with integrated cooling fans in redundant configuration complete with monitoring instruments for the fan units and output contacts to initiate alarm on 'Fan Failure'.

The UPS equipment shall be suitable for continuous operation without de-rating under ambient temperature of 0°C - 40°C, relative humidity of 0 - 95% and altitude up to 1000 m above sea level. The UPS enclosure shall be fabricated from mild steel sheet with epoxy powder paint finish and lockable access doors.

Unless otherwise specified, UPS equipment of 2.5 kVA or less shall be equipped with two 13A 3-pin output socket outlets to BS1363 and one 2 m detachable power supply cord.

For fixed UPS equipment, a detachable brass cable gland plate shall be provided to facilitate bottom or top cable entry as specified in the Particular Specification.

4 WORKS TEST

The UPS equipment shall be tested at manufacturer's works to demonstrate that the equipment fully complies with the specification and performance criteria.

The contractor shall be responsible for conducting any tests as may be required to clearly demonstrate that the supplied equipment complies with the Specification. Any such tests shall be deemed to have been allowed for in the tender price. The minimum requirements for tests on the UPS equipment are listed below :-

- (a) Tests to verify compliance with IEC 62040
- (b) Demonstrate the output characteristics of the UPS equipment at 0%, 50% and 100% rated load at minimum, nominal and maximum a.c. and d.c. input voltages under online operation and stored energy modes
- (c) Demonstrate the overload capability and automatic bypass switch operations

- (d) Short-circuit test
- (e) Demonstrate the output transient response with a 100% load application and rejection by measuring the output voltage and current with storage oscilloscope
- (f) Measurement test on the maximum THD of input current and output voltage with 0 - 100% load at minimum, nominal and maximum d.c. voltage
- (g) Running test to verify the stored energy time during a complete discharge-charge-discharge cycle
- (h) Operational checks of all alarms, indications, controls and protection facilities