snowy hydro Limited renewable energy	
Snowy Technical Standards	
SHL-ELE-156 (L)	***Annexure L - Uninterruptable Power Supplies General Low Voltage Electrical Requirements***
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This annexure forms part of the General Low Voltage Electrical Requirements Standard (SHL-ELE-156).

1. Scope

This Annexure sets out the requirements for Uninterruptible Power Supplies (UPS).

UPS must be designed and constructed confirming to the General Electrical Requirements and this Annexure.

1.1. Applicable Standards

The design, manufacture and testing of equipment and components detailed in this annexure must comply with the requirements of all relevant Australian Standards or in the absence of appropriate Australian Standards, with relevant IEC, ISO or International Standard, together with the requirements of competent authorities having jurisdiction over all or part of the manufacture, installation or operation of the equipment, except where modified by this specification.

All works must comply with the requirements of the most recent releases of the regulations and standards noted in Snowy Standard SHL-ELE-156. In the event of a conflict between different Codes, Standards or Regulations, the highest requirement must apply.

2. Safety Requirements

UPS must be designed, manufactured and test with the safety requirements detailed in the General Electrical Requirements.

3. Technical Requirements

3.1. UPS Requirements

3.1.1. General Requirements

The UPS system must be designed for unattended operation and be fully automatic in operation and incorporate all solid state controls

The UPS components must use modern proven digital technology with high-speed industrialised microprocessors. All components used must be highly reliable and of high quality standards that satisfy the requirements of secure AC and DC power systems that are vital for a reliable operation of power stations. Controls that rely on a potentiometer to set control level are unacceptable.

The complete UPS design must be of low maintenance, highly reliable with at least a twenty year design life.

Each UPS system must have indications, alarms and meters on the front panel to operate and maintain the system in an efficient manner.

The UPS system must be able to be bypassed to allow the supply of power from a common installation supply. The bypass switch must be make-before-break. When the switch is in the 'Bypass' position, there must be no hazardous voltages present anywhere inside the UPS cabinet. An appropriately rated line conditioner or surge arrester is required from common installation supply to supply the feed to the Emergency AC board.

The UPS must have full galvanic isolation between the input and output.

The UPS systems must be specifically designed with a standard two separate incoming feeders system, one for the main incoming and the second to the static bypass being capable of being connected to two separate sources of supply.

The rectifier, inverter and static bypass switch must each have its own logic power supply and microprocessor controls.

Internal UPS communications must be carried out over an "EMC" immune bus system designed for industrial applications (CAN bus).

The UPS systems must have built-in protection against surges, sags, and overcurrent from the AC source and load switching and circuit breaker operation in the distribution system.

The UPS systems must be protected against sudden changes in output load and short circuits at the output terminals.

The UPS systems must have built-in protection against permanent damage to itself and the connected load for all predictable types of malfunctions.

Fast-acting current limiting devices must be used to protect against cascading failure of solid-state devices.

Internal UPS malfunctions must cause the module to trip off-line with minimum damage to the module and provide maximum information to maintenance personnel regarding the reason for tripping off line. The load must be automatically transferred to the bypass line uninterrupted.

Instrumentation must be provided with the UPS, including ammeters and voltmeters on each supply and incoming and outgoing frequency. .

Suitable testing access, links and terminals must be provided for the connection of various measurement and test equipment. Use of such facilities must not require shutdown of the UPS or interrupt power to the AC bus.

Unless otherwise specified, the UPS must be sized to no less than 100% of connected maximum connected load.

3.1.2. Technical requirements

The UPS system must be capable of the following:

- Protect connected loads against all mains or grid disturbances continuously, with the UPS output voltage fully isolated from input power.
- The UPS must comply with AS IEC 62040 classification VFI SS 111.
- At full load output power the supply input current harmonics must not exceed 10% THD.
- Voltage regulation must be +/- 1% maximum between No load and 100% Load with the input voltage at 415 VAC (phase to phase) +/- 10%.
- Voltage transients must be limited to + 5% when 100% load is applied or removed instantaneously. Under these conditions, the output voltage must return to normal within 20 milliseconds.

- Rated for a crest factor of 3:1
- The frequency of the generated supply must be within + 0.05% and under transient conditions must not deviate by more than + 1%.
- The output must be capable of sustaining a 125% load for 10 minutes and maintain a ±2% output voltage regulation.
- The output frequency and phase relationship must be synchronised with the input frequency and the switching break time must be a maximum of 1 millisecond.
- Feed 100% unbalanced load while keeping the output voltages and the phase angle within the tolerances.

3.1.3. Required modes of operation

Normal

In this mode the UPS inverters must continuously power the critical AC load. The battery chargers must derive power from the mains AC power supply source converting this to DC power to supply the inverters, while simultaneously float charging the battery system. Power supplied by the inverter must be in accordance with the relevant technical standards described in this Technical Specification, at rated voltage and frequency;

Emergency

In this mode, upon failure of the mains AC power supply source, the critical AC load must be powered by the inverter, which without any switching; must obtain power from the battery system. There must be no interruption of power to the critical load upon failure or restoration of the mains AC power supply source. The inverter must be able to commence its operation without external AC supply;

Recharge

In this mode, upon restoration of the mains AC power supply source, power to the battery chargers initially must be restricted by a gradual power walk-in. Following this relatively short power walk-in period, the battery chargers must power the inverters and simultaneously recharge the battery. This must be an automatic function and must cause no interruption to the critical load;

Bypass

In this mode, if the UPS system was taken out of service for maintenance or repair, or if the inverter fails, the static bypass switch in UPS module must transfer the load on its inverter to the bypass source. The transfer process must cause no interruption to the critical load; and

Off-battery

In this mode, if the battery system only is taken out of service for maintenance, it must be disconnected from the battery charger and inverter by means of an external disconnect breaker, the UPS must continue to function and meet all of the specified steady-state performance criteria, except for the power outage back-up time capability.

3.2. UPS system configuration

The major components of the UPS may include:

- Rectifier/Battery Charger.
- Battery unit.
- Static Inverter
- An AC Distribution panel.

- Static Transfer switch
- Manual bypass switch
- Control panel including mimic and alarm indication.

Control switches must be provided to allow independent isolation of controls for each rectifier, inverter and static transfer switch for maintenance, without affecting operation of the remaining equipment.

The AC distribution board must comply with the requirements of Annexure M – Lighting and Power.

Where multiple UPS are connected to a single distribution board (eg Essential AC boards) then each UPS should supply a separate bus section coupled by an automated bus tie circuit breaker. Facilities must be provided to allow paralleling of supplies to ensure maintenance can be carried out on either UPS without interrupting essential supply.

3.2.1. Construction

The UPS must be designed for 40ºC ambient. If fan cooling is required they must be 100% redundant and filters must be able to be replaced safely without taking UPS out of service.

The noise level of the battery charger and inverter must be 85dB or less at one metre.

The UPS must have a minimum degree of protection of IP41 in accordance with AS 60529.

Enclosures must be provided with lockable doors and with labels for plant identification and for safety messages.

Construction of the UPS must comply with Annexure C – Electrical Enclosures and Junction Boxes.

3.2.2. Battery charger

The battery charger must be a constant voltage current limiting type. The battery charger must include a circuit to limit AC input current to 100% of the full input current rating. The battery charger must be designed such that the input caused by the complete UPS at any load must not exceed 5% total harmonic distortion, 3% individual odd harmonic and 1% individual even harmonic line to line and line to neutral.

On powering up, the battery charger must limit and minimize inrush current by digitally controlling a smooth rise in current and voltage to a maximum of 100% normal full load input current. The battery charger input must be three phase four wire neutral earthed 415V supply. The battery charger must have an output voltage regulation of 1% maximum from 0 to 100% load.

Surge suppression must be provided for protection against AC line voltage transients from switching or lightning induced surges. The battery charger must have an input isolator and must be fuse protected. Each AC phase must be individually fused with fast acting fuses so that loss of any semiconductor must not cause cascading failures. Input and output isolators must be lockable.

The battery charger must have an output filter to minimise ripple current into the battery. The AC ripple voltage of the rectifier DC output must not exceed 2% RMS of the float voltage. The filter must be adequate to ensure that the DC output of the battery charger must meet the input requirements of the inverter without the battery connected. The battery charger must be capable of operation with the battery disconnected and must maintain the performance limits.

The battery charger output must be fitted with a fully rated isolator for isolation purposes. In addition to supplying power to the load, the battery charger must typically be set with a battery charging current capable of recharging

the batteries at the present rate of recharge. Float and boost voltages must be independently and continuously adjustable. These voltages once set must remain within +/- 1% of the set voltage for all steady loads between the limits of no load and full load. A changeover switch must be provided on the front of the battery charger cubicle to select either float or boost mode.

The battery charger must have facilities for indicating, verifying and adjusting float voltage, current limit, and control and alarm settings via the front panel human-machine interface (HMI). The battery charger enclosure must be provided with continuous indication of input and output voltage and current, and alarms on the outside of the panel.

Where multiple UPS are installed, the battery chargers must be capable of operating in parallel without issue.

Battery chargers must include the following adjustable modes:

- Initial charge
- Float charge
- Boost charge
- Equalising charge

All components must be rated to the maximum voltage which the system can be charged at (ie Boost mode).

3.2.3. Inverter

Each inverter must be solid-state and capable of providing rated output power.

The inverter must be a pulse width modulated (PWM) design and utilise insulated gate bipolar transistors (IGBTs), switching at high frequency in order to minimise output voltage distortion. Through the use of digital signal processing (DSP), the inverter must be capable of responding to dynamic load changes (including a short circuit) very fast. The output voltage must be maintained at close tolerance without detrimental effect on loads connected.

Each inverter must be able to operate either with battery charger output only or battery supply only.

Each inverter must have an input isolator and must be fuse protected. This isolator must be of the frame size to supply full rated load. Each pole must be individually fused with fast acting fuses to prevent cascading failures. Each inverter must also be fitted with a fully rated isolator at the output for isolation purposes. All isolators must be lockable.

The inverter must be capable of supplying at least 300% current for short circuit conditions without any damage. If the short circuit is sustained, the load must be transferred to the bypass source and each inverter must disconnect automatically from the Emergency AC board. After an output transient the Inverter output waveform must return to normal values in less than 1.5 cycles.

The inverter must track the bypass mains supply continuously providing the bypass source maintains the rated frequency ±0.5Hz. Each inverter must change its frequency to maintain synchronous operation with the bypass, which must allow make-before-break manual or automatic transfers of the load between the inverter and the bypass mains supply. If the bypass mains supply frequency falls outside of these limits, the inverter must revert to internal oscillator which must be temperature compensated and hold each inverter output frequency to within ±0.005Hz of the rated frequency (50Hz) for steady state and transient conditions. The Static Transfer Switch must be inhibited from operating should this occur.

System logic must provide individual phase voltage compensation to obtain phase balance ±2% under all

conditions including up to 100% load unbalance.

Fault sensing must be provided to isolate a malfunctioning inverter from the Emergency AC board to prevent disturbance of the critical load voltage beyond the specified limits. Each inverter must be provided with monitoring and control circuits to protect the battery system from damage due to excessive discharge. Shutdown of the inverter must be initiated when the battery has reached the end of discharge (EOD) voltage.

Inverter active and passive loads will consist of SCADA load, computers, motors, solenoids, relays, rectifiers and lighting load. Each inverter must have facilities for indicating, verifying and adjusting control and alarm settings via the front panel HMI. Each inverter enclosure must be provided with continuous indication of input and output voltage and current, and alarms on the outside of the panel.

3.2.4. Transfer switches

A bypass circuit must be provided for each UPS system for the time when maintenance is required or when an inverter cannot maintain voltage to the load due to sustained overload, current limiting or malfunction.

An inverter that relies on a static switch on its output for isolation is not acceptable.

Each inverter must be gated-off instantaneously and the static switch on its bypass must operate simultaneously, and instantaneously connect the load to the alternate AC source. The UPS system controls must constantly monitor the availability of the inverter bypass circuit to perform a transfer.

It must be possible to manually initiate a load transfer between the inverter output and the alternate AC source either way from the control panel.

An automatic load transfer between the inverter output and the alternate AC source must be initiated if an overload or short circuit condition is sustained for a period in excess of the inverter output capability or due to a malfunction that would affect the output voltage. Transfers caused by overloads must initiate an automatic retransfer of the load back to the inverter only after the load has returned to a level within the rating of the inverter source. An automatic load transfer must also occur on an inverter loss of power and an inverter output loss of synchronism with ac input or auxiliary supply when supply frequency is within specified tolerance limits

The external bypass supply must be fed through a Line Conditioner or Surge Arrester to the static transfer switch.

The static transfer switch must be a no-break high-speed electronic device rated for continuous operation at 150% of the inverter rated load. It must be designed to fall over to bypass source in the event of a microprocessor failure. It must withstand a 1000 percent surge for 10 seconds for output sub-circuit fault clearance of fuses or circuit breakers.

A manual transfer switch must also be provided that bypasses the Static Transfer Switch. The manual transfer switch must isolate all other components of the UPS. The manual transfer switch must be a two-position, make-before-break type of voltage rating compatible with the system voltage and continuously rated for 150 percent (minimum) full load current of the total ac load. It must withstand 1000 percent surge for output sub-circuits to clear. An electrical and mechanical interlocking facility must be built in with this switch to prevent back-feed of mains to the inverter output and inadvertent out of synchronism operation.

3.2.5. Line conditioners / surge arrester

Line conditions or surge arresters must meet the following requirements:

- have a continuous rating similar to static transfer switch and a surge rating of at least 500% of rated

output for three seconds;
- <+/-3% voltage regulation for input +/- 10%;
- overload protection required for all three phases
- < 3%.total harmonic distortion

3.2.6. Alarms

Alarms must be provided for any maloperation and for parameters moving outside specified limits.

Alarm conditions must raise a local visual indication.

All alarms must latch and require to be reset via a reset button. An ‘alarm acknowledge’ facility must be provided.

All measurement alarms must be internally adjustable over a range of plus or minus 10 percent of the normal setting.

An alarm test button must be provided to check all alarm functions.

The UPS must be capable of communicating annuciated statuses, measurements & alarms to the local PLC for integration into SCADA either via an appropriate communications protocol or via normally open, voltage-free contacts.

3.3. Testing requirements

3.3.1. Type tests

UPS system must be provided with Type Test Certificates outlining successful completion of the type tests specified in AS IEC 62040.3 section 6 and 7.

3.3.2. Routine tests

The following routine tests must be carried out prior to shipping to site:

- Verification of the settings of all adjustable controls;
- Simulation and checking of all protection, alarms and indicators;
- Accuracy check of all instrumentation;
- Verification of system performance of all parameters and limits;
- Input and output harmonic distortion at agreed predetermined loads;
- Operation of all dc and ac controls including circuit breakers, switches, contactors;
- Functional operation of complete ups system; and
- A full load heat run test.