Superseded by T HR EL 23001 SP v1.0, 15/07/2021

Transport Asset Standards Authority

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Subject: Amendment to EP 23 60 00 01 SP *Online Dual Conversion Uninterruptible Power Supply Specification for Railway Signalling Loads*

This technical note is issued by the Asset Standards Authority (ASA) as an update to EP 23 60 00 01 SP *Online Dual Conversion Uninterruptible Power Supply Specification for Railway Signalling Loads*, version 1.0.

This update includes amendments to requirements for the type of battery used.

1. Section 4.1 Battery type

Replace the contents of Section 4.1 with the following:

The battery type shall be suitable for the specified operating temperatures as given in Section 3.3.6 and designed for a minimum life of 10 years.

In selecting a battery type, non-technical issues shall be addressed in consultation with the operations and maintenance AEO as follows:

- identification of the battery type
- system spares
- operation and maintenance requirements
- whole-of-life asset costs

The Lead Electrical Engineer, ASA shall be consulted if an alternative battery type to valve regulated lead acid (VRLA) is proposed to be installed.

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Engineering Specification
Electrical

EP 23 60 00 01 SP

ONLINE DUAL CONVERSION UNINTERRUPTIBLE POWER SUPPLY SPECIFICATION FOR RAILWAY SIGNALLING LOADS

Version 1.0

Issued September 2012

Reconfirmed 10 July 2019

Owner:	Chief Engineer, Electrical		
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NSW Transport RailCorp

Engineering Specification

Superseded by T HR EL 23001 SP v1.0, 15/07/2021

Document control

Version	Date	Summary of change
1.0	September 2012	First Issue

Superseded by T HR EL 23001 SP v1.0, 15/07/2021

Contents

1 Scope and Application 5
2 References 5
2.1 Australian Standards 5
2.2 International Standards 6
2.3 RailCorp Documents 6
2.4 RailCorp Reference Drawings 6
3 UPS 6
3.1 Modes of Operation 7
3.1.1 Normal 7
3.1.2 Emergency 7
3.1.3 Recharging 7
3.1.4 Bypass 7
3.1.5 Maintenance Bypass 7
3.2 Electrical Requirements 7
3.2.1 Autonomy 7
3.2.2 Standard Configurations 8
3.2.3 Rectifier / Charger 8
3.2.3.1 Input Protection 8
3.2.3.2 In-rush 8
3.2.3.3 Capacity 8
3.2.3.4 Automatic Restart 8
3.2.3.5 Voltage Ripple Filtering 8
3.2.3.6 Total Harmonic Distortion of Input Voltage 8
3.2.3.7 Total Harmonic Distortion of Input Current 8
3.2.3.8 Battery Charging 9
3.2.3.9 Battery Test 9
3.2.4 Inverter 9
3.2.4.1 Overload 9
3.2.4.2 Inverter Protection 9
3.2.4.3 Frequency Synchronisation and Phase Locking 9
3.2.4.4 Phase Balance 9
3.2.4.5 Total Harmonic Distortion of Output Voltage 10
3.2.5 Static and Maintenance Bypass Switch 10
3.2.5.1 Transfer to Bypass Supply 10
3.2.5.2 Transfer to Inverter Supply 11
3.2.5.3 Maintenance Bypass Switch 11
3.2.5.4 Padlocking 11
3.2.6 Battery Start Up 11
3.2.7 Output Performance 11
3.2.8 Technical Requirements 13
3.2.9 Operator Interface 13
3.2.10 Interfaces 15
3.2.11 Isolation Transformer 15

Superseded by T HR EL 23001 SP v1.0, 15/07/2021

3.2.12 Electromagnetic Compatibility and Immunity....15
3.2.13 Earthing....15
3.3 Physical Requirements....16
3.3.1 Construction....16
3.3.2 Degree of Protection....16
3.3.3 Colour....16
3.3.4 Marking....16
3.3.5 Cable Entry....16
3.3.6 Environment....16
3.3.7 Ventilation and Heat Dissipation....16
3.3.8 Noise and Vibration....17
3.3.9 Transportation....17
4 Battery....17
4.1 Battery Type....17
4.2 Battery Rack....17
5 Testing....18
5.1 Type Tests....18
5.2 Routine Tests....18
5.3 Site Tests....18
6 Reliability, Availability and Maintainability....18
6.1 RAM Targets....18
6.2 RAM Requirements....19
7 Quality Management System....19
7.1 Supplier's Accreditation....19
7.2 Inspection and Test Plan....19
8 Integrated Support Requirements....20
Appendix A Technical Schedule – UPS....21
Appendix B Technical Schedule – Battery....24
Appendix C Request For Tender Checklist....26
Information to be supplied to tenderers....26
Information to be supplied by tenderers....26
Information to be supplied by the successful tenderer....27
Test Certificates....27
User Training....27
UPS Manuals....27
UPS Interface....27
Appendix D Requirements for Technical Aspects of Tender Evaluation....28
Evaluation of tenders....28
Acceptance of product....28
Record Keeping 28

Superseded by T HR EL 23001 SP v1.0, 15/07/2021

1 Scope and Application

The low voltage AC supplies feeding signalling locations are critically important for the safe operation of rail services on the RailCorp network. The loss of supply, even momentary, can severely impact the operations of the signalling system. Uninterruptible power supplies are used to feed signalling locations where zero 'dead' time is required. This document identifies the minimum technical requirements for the supply of an online dual conversion uninterruptable power supply (UPS) system primarily for use in maintaining the integrity of supply to signalling loads.

2 References

Latest issue of the following references should be referred to.

2.1 Australian Standards

AS1102	*Graphical Symbols for Electrotechnical Documentation*
AS2676.2:1992	*Guide to the Installation, Maintenance, Testing and Replacement of Secondary Batteries in Buildings – Sealed Cells*
AS3011.2:1992	*Electrical Installations – Secondary Batteries Installed in Buildings – Sealed Cells*
AS60146.1.1:2002	*Semiconductor Converters – General Requirements and Line Commutated Converters – Specifications of Basic Requirements*
AS60146.1.2:2002	*Semiconductor Converters – General Requirements and Line Commutated Converters – Application Guide*
AS60146.1.3:2002	*Semiconductor Converters – General Requirements and Line Commutated Converters – Transformers and Reactors*
AS60146.2:2001	*Semiconductor Converters – Self Commutated Semiconductor Converters Including Direct D.C. Converters*
AS60529:2004	*Degrees of Protection Provided by Enclosures for Electrical Equipment (IP Code)*
AS62040.1.2:2003	*Uninterruptible Power Systems (UPS) Part 1.2: General and Safety Requirements for UPS Used in Restricted Access Locations*
AS62040.2:2008	*Uninterruptible Power Systems (UPS) Part 2: Electromagnetic Compatibility (EMC) Requirements*
AS62040.3:2012	*Uninterruptible Power Systems (UPS) Part 3: Method of Specifying the Performance and Test Requirements*
AS/NZS3000:2007	*Electrical installations (known as the Australian/New Zealand Wiring Rules)*
AS/NZS3439.1:2002	*Low Voltage Switchgear and Controlgear Assemblies – Type Tested and Partially Type Tested Assemblies*
AS/NZS4029.2:2000	*Stationary Batteries – Lead Acid, Part 2: Valve Regulated Type*
AS/NZS60950.1:2011	*Information Technology Equipment – Safety – General Requirements*
AS/NZS ISO 9001:2008	*Quality management systems - Requirements*

Superseded by T HR EL 23001 SP v1.0, 15/07/2021

2.2 International Standards

EN 50121-1	*Railway applications – Electromagnetic compatibility Part 1: General*
EN 50121-2	*Railway applications – Electromagnetic compatibility Part 2: Emission of the whole railway system to the outside world*
EN 50121-5	*Railway applications – Electromagnetic compatibility Part 5: Emission and immunity of fixed power supply installations and apparatus*

2.3 RailCorp Documents

EP 00 00 00 12 SP	*Electrical Power Equipment, Integrated Support Requirements*
EP 00 00 00 13 SP	*Electrical Power Equipment, Design Ranges of Ambient Conditions*
EP 00 00 00 15 SP	*Common Requirements for Electric Power Equipment*
SPG 0729	*Signalling Power Systems*
SPG 1250	*Interfaces Between Signalling and Control Systems*
ESG 003	*Signalling Equipment Configuration Standard*
SDG 001	*Circuit Design Standards Standard Signalling Circuits*
EPD 0009	*Reliability, Availability and Maintainability (RAM)*

2.4 RailCorp Reference Drawings

EL0282072 General – Distribution Power Supply – RailCorp & Back Up Power Supply with UPS Standard Schematic Diagram

EL0474470 General – Distribution Power Supply – Signals Power Supply with UPS Standard Schematic for RailCorp Padmount Close to Signals

SDG001 Sheet U115 – General 415V Power Arrangements – Schematic

3 UPS

In compliance with the requirements of RailCorp Signalling Standard *SPG 0729* and *ESG 003*, uninterruptible power supplies (UPS) are to be provided where a source of continuous AC power is required for loads which cannot tolerate even a momentary interruption or at significant interlocking areas where a momentary power disturbance can cause disruptions to the rail service.

UPS systems are to maintain continuous AC power to the supplied signalling load in the event of momentary power supply loss, i.e. when a mains changeover occurs or complete loss of mains supply. The UPS shall have autonomy of 10 minutes minimum at full rated load and recover to 90% of full standby capacity within 10 hours on return of the mains supply. Where exceptional circumstances demand it, the hold up time of the UPS may be longer.

The UPS system shall not be adversely affected by significant intermittent dynamic loads such as during the operation of train stops or point machines or inrush currents contributed by the starting of train stops or point machines.

The UPS system shall not be adversely affected by significant 11^{th}, 13^{th}, 23^{rd} and 25^{th} harmonics of 50Hz which may be present on the UPS input mains supply. These harmonics are produced by 12-pulse uncontrolled rectifiers at RailCorp traction substations.

Superseded by T HR EL 23001 SP v1.0, 15/07/2021

The UPS system shall consist of a rectifier, charger, battery, inverter, internal protection, static transfer switch, synchronizer and phase control circuitry. It shall incorporate all the necessary control required to provide regulated, uninterrupted conditioned power to the load.

The UPS system shall automatically provide continuity of supply within the prescribed limits without interruption upon failure or degradation of the incoming supply.

When the incoming supply is present and within acceptable limits the UPS system shall charge the battery as required while maintaining supply to the load.

3.1 Modes of Operation

The UPS shall be designed to operate in the following modes.

3.1.1 Normal

The load is supplied via the inverter. The rectifier / charger receives an input supply and supplies DC power to the inverter and if necessary charges the battery. The inverter converts the DC power into regulated AC power and supplies the load via the static transfer switch. The inverter and static switch control unit monitors the bypass supply and ensures that the inverter output supply is synchronised with the bypass supply.

3.1.2 Emergency

On failure or degradation of the input supply to the rectifier / charger, the inverter shall draw power from the battery. The inverter output shall not experience any interruptions as a result of the input supply failure.

3.1.3 Recharging

On restoration of input supply to the rectifier / charger, the rectifier /charger shall ramp up and assume load of the inverter and battery charging. The supplied load shall not experience any interruptions as a result of this operation.

3.1.4 Bypass

When the inverter overload capacity is exceeded or when the inverter fails, the static transfer switch shall seamlessly transfer the load from the inverter to the alternate source of supply.

3.1.5 Maintenance Bypass

For the UPS to be taken out of service for maintenance or repair, the UPS shall be provided with a maintenance bypass switch to allow a load transfer from the inverter to the bypass supply with no interruption of supply to the load. Bypass isolation shall be complete; all serviceable components are to be isolated and will be able to be accessed without exposure to live terminals or components.

3.2 Electrical Requirements

3.2.1 Autonomy

The UPS system shall have autonomy of minimum 10 minutes at 100% rated output current. Autonomy significantly greater than 10 minutes may be required under exceptional circumstances and will be determined on a project specified basis.

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3.2.2 Standard Configurations

The following are preferred standard configurations for the UPS systems.

UPS Rated Output	Input Voltage	Output Voltage
10 kVA	1 phase 240V	1 phase 240V
25 kVA	1 phase 240V	1 phase 240V
25 kVA	3 phase 415V	3 phase 415V
40 kVA	3 phase 415V	3 phase 415V

The use of other ratings is subject to RailCorp Engineering approval.

3.2.3 Rectifier / Charger

3.2.3.1 Input Protection

The rectifier / charger shall be protected by individual fuses on each phase. Protection fuses shall not blow or suffer degradation due to UPS switching on current surges.

3.2.3.2 In-rush

A two step start up function shall be provided within the UPS unit to limit high in-rush starting currents. Alternate proposals will be considered on merits.

3.2.3.3 Capacity

The rectifier shall be capable of maintaining full rated output current while simultaneously recharging a fully discharged battery.

3.2.3.4 Automatic Restart

The rectifier / charger shall on restoration of input supply be capable of seamlessly assuming the inverter and battery recharge loads.

3.2.3.5 Voltage Ripple Filtering

The rectifier / charger shall feature a filtered output that shall limit ripple voltage to less than 2% RMS.

3.2.3.6 Total Harmonic Distortion of Input Voltage

The UPS shall not be adversely affected and operate correctly with an input total harmonic distortion voltage (THDV) of up to 8%.

3.2.3.7 Total Harmonic Distortion of Input Current

The total harmonic distortion of input current (THDI) at the input terminals of the UPS system shall be limited by the UPS to less than 5%.

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3.2.3.8 Battery Charging

The battery charging system shall be suitable, and designed for the batteries supplied. The battery charging system shall be capable of charging the battery from full discharge to 90% of full charge within 10 hours whilst meeting specified output performance.

The UPS shall include automatic over voltage cut off and temperature compensation for float voltage to minimise degradation of the batteries at high ambient temperature.

3.2.3.9 Battery Test

At selectable periodic intervals, a short time discharge of the battery will be made to confirm that all the battery blocks and connecting elements are in good working order. An alarm shall be raised if the battery is defective. The battery test shall not adversely affect the lifespan of the battery system or pose any risks to the user.

3.2.4 Inverter

3.2.4.1 Overload

The inverter shall be capable of withstanding overloads of:

- 125% nominal rating for 10 minutes
- 150% nominal rating for 1 minute

3.2.4.2 Inverter Protection

The inverter shall be protected by internal current limiting circuits and current limiting devices. If a short circuit occurs on the UPS output and the bypass supply is available, the UPS shall divert to static bypass in order to increase the available fault current. Upon clearance of the fault, the UPS shall revert to the inverter after a proving time delay.

On occurrence of a short circuit fault when the bypass supply is unavailable, the UPS inverter shall operate in current limiting mode until the fault is cleared externally. If the fault is not cleared within 5 seconds, the UPS shall shut down in compliance with the requirements of AS/NZS 3000 Clause 1.5.5.3(d)(ii) for disconnection times.

3.2.4.2.1 DC Protection

The inverter shall be automatically protected when the DC voltage is out of tolerance.

3.2.4.3 Frequency Synchronisation and Phase Locking

The incoming mains supply for signalling loads may be subject to significant phase shifts due to automatic changeover of supply upstream. The inverter shall be immune to phase changes and shall be capable of maintaining output frequency between specified limits. The inverter shall be capable of frequency synchronisation and phase locking to the input mains supply frequency.

3.2.4.4 Phase Balance

Each phase of the output shall be regulated such that an unbalanced load (up to 100%) shall not cause the output voltage to go outside the specified limits. This is to accommodate single phase loads on three phase UPS systems.

Superseded by T HR EL 23001 SP v1.0, 15/07/2021

3.2.4.5 Total Harmonic Distortion of Output Voltage

The inverter shall limit total harmonic distortion (THDV) of output voltage to less than 3% for linear loads and less than 5% for non-linear loads through methods of filtering and neutralisation.

3.2.5 Static and Maintenance Bypass Switch

Each UPS shall incorporate static bypass and maintenance bypass facilities which allow the rectifier, DC link and inverter to be bypassed. The static switch shall be a solid state transfer device rated for continuous full load operation and temporary overload operations as per Section 3.2.4.1.

During operation of the UPS system, the inverter output shall remain synchronised with the static bypass. In the event that changeover to the bypass is initiated, either automatically or manually, an electronic switch shall connect the static bypass in parallel with the inverter output and then disconnect the inverter, thereby achieving uninterrupted transfer of the load to the static bypass.

When the load is being supplied from the static bypass and the rectifier and inverter are healthy, the inverter output shall remain synchronised with the static bypass so that uninterrupted transfer to inverter is possible. Upon initiation of transfer, either automatically or manually, the electronic switch shall connect the inverter output in parallel with the static bypass, and then disconnect the static bypass, thereby achieving uninterrupted transfer of the load to the inverter.

The static bypass and maintenance bypass shall operate in a make before break manner for switching between the inverter and the bypass supply and vice versa.

The static transfer switch shall be so configured as to prevent back feed to the incoming mains.

The static transfer switch shall incorporate circuitry to ensure full and automatic frequency synchronisation and phase locking between the inverter output and the bypass supply.

The static transfer switch shall not be adversely affected and shall remain within voltage tolerances, maintain supply synchronisation and phase locking when the inverter is under overload conditions.

Failure of the static transfer switch shall not affect the operation of the UPS system and the failure shall raise an alarm.

3.2.5.1 Transfer to Bypass Supply

The static transfer switch shall automatically and seamlessly transfer the load from the inverter to the bypass supply under the following conditions:

- DC voltage out of limits
- Inverter failure
- Load current exceeds inverter overload rating
- Inverter over temperature
- Bypass is manually selected

The bypass supply shall be automatically inhibited whenever the condition of the bypass supply is outside of allowable conditions or the inverter output and the bypass supply are not synchronised and phase locked.

Superseded by T HR EL 23001 SP v1.0, 15/07/2021

3.2.5.2 Transfer to Inverter Supply

The static transfer switch shall automatically and seamlessly transfer supply from the bypass supply to the inverter under the following conditions:

- Inverter output voltage is within specified limits
- Load current drops to within inverter overload capacity

3.2.5.3 Maintenance Bypass Switch

The maintenance bypass shall comprise of manually operated switch preferably mounted external to the UPS enclosure. The maintenance bypass switch shall be operable without opening the enclosure of the UPS. The maintenance bypass shall allow all electronics to be isolated and the load to be fed from the incoming mains supply. The battery shall be isolated from the DC link. Transfer from the static bypass to maintenance bypass and vice versa shall be achieved without interruption of supply to the load. Necessary safety interlocking shall be provided.

3.2.5.4 Padlocking

All AC and DC circuit breakers and isolating switches including the battery isolating switch shall be provided with facilities for padlocking in the open position.

3.2.6 Battery Start Up

The UPS system shall be capable of starting up on battery supply only and operate on batteries when the input mains supply is unavailable.

3.2.7 Output Performance

Each UPS system shall meet the output performance classification VFI-SS-222 defined in *AS62040.3* Annex D10 as a minimum (See table below). Additionally output voltage deviations and duration shall be no greater than those defined by the Classification 2 characteristic of AS62040.3 for all transient loading situations outlined in Section 3 (See figure of Output Dynamic Performance Classification 2 below).

Steady state voltage regulation shall be ±3% of nominal for all steady state linear and non-linear loads with 0 and 100% of UPS rating and with power factor in the range 0.6 lagging to unity.

The above mentioned performance shall be maintained both whilst the UPS is supplied from an AC source which is within the specified range and when the UPS is operating from batteries which are charged within the design range.

Output voltage shall be adjustable by operator over the range ±5% of nominal in integer steps of 1.

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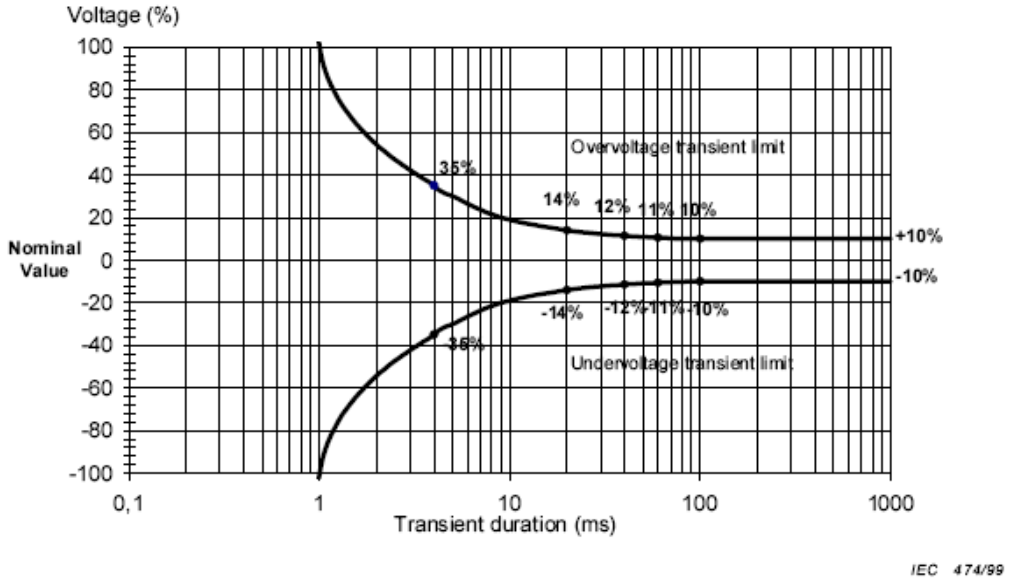
Classification Code		
VFI	SS	222
Output Dependency	**Output Waveform**	**Output Dynamic Performance**
In normal mode of operation only	First Character: Normal or bypass mode Second Character: Stored energy mode	First Character: Change of operation mode performance Second Character: Step linear load performance in normal / stored energy mode (worst case) Third Character: Step reference non-linear load performance in normal / stored energy mode (worst case)
Classification Option	**Classification Option**	**Classification Option**
VFI: Where the UPS output is independent of supply (mains) voltage and frequency variation. The supply voltage is assumed to be within *IEC 61000-2-2* limits. This is because the supply voltage is not controlled, and according to NOTE below this table, *IEC 61000-2-2* only defines normal levels of harmonics and distortion, and nothing about frequency variation	**S**: Generated waveform is sinusoidal with total harmonic factor D < 0.08 and harmonics within *IEC 61000-2-2* under all linear / reference non-linear load conditions	**2**: ≤ figure 2 in 5.3.1. of *AS62040.3* (zero in output up to 1 ms duration)
NOTE – *IEC 61000-2-2* defines normal levels of harmonics and distortion that can be expected from public low voltage supplies at the consumer terminals before connection of a given installation.		

The above is an extract of Table D.1 of *AS62040.3*



The above is Figure 2 of *AS62040.3* – **Output Dynamic Performance Classification 2**

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3.2.8 Technical Requirements

Description	Requirements
Configuration	Double conversion single UPS
Autonomy	10 minutes at full load
Input Voltage Range	240V (1 Ph), 415V (3 Ph) ±10%
Input Frequency Range	50Hz ±5%
Input Power Factor	0.8
Input Current Distortion	< 5% THDI
Inrush Current	< 8 x Nominal Current (In)
Intermediate DC Voltage	< 500VDC
DC Voltage Ripple	< 2% RMS
Output Frequency	50Hz
Output Frequency Variation	±0.5%
Maximum Output Frequency Synchronised Phase Error at Change of Mode	8 degrees
Nominal Output Voltage	240V (1 Ph), 415V (3 Ph)
Output Voltage Variation	±1% Balanced loads ±3% 100% Unbalanced loads
Output Voltage Variation Due to Load Changes (From 10% to 90% load step)	±5%
Total Output Voltage Distortion with Non Linear Load	< 5% THDV
Phase Displacement	120^{o} $\pm1^{o}$ Balanced loads 120^{o} $\pm2^{o}$ 100% Unbalanced loads
Output Performance Classification	VFI-SS-222
Overload Capability (without bypass)	125% Rated current for 10 minutes, 150% rated current for 1 minute
UPS Efficiency Excluding Isolation Transformers	> 90% at 100% load, > 80% at 25% load
Minimum Surge Withstand Voltage	5kV r.m.s for 1 minute

UPS technical requirements shall be met under installation environment as per Section 3.3.6 of this specification.

3.2.9 Operator Interface

Operator controls, indications, alarms, displays and signal contacts provided with each UPS shall include, but not be limited to those listed below.

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Controls

- Rectifier On / Off
- Inverter On / Off
- Inverter / Static Bypass Selector
- Static Bypass / Maintenance Bypass Selector
- LED Test
- Accept Alarm
- Reset Alarm
- Output Voltage Adjustment
- Battery Discharge Test Initiate

Alarms

- Mains Supply Failure
- Bypass Failure
- Bypass Wrong Phase Sequence
- Rectifier Fault
- Inverter Fault
- Static Switch Fault
- Control (microprocessor) Fault
- Battery Overvoltage
- Battery Undervoltage
- Battery Earth Leakage
- Battery Isolated
- Battery End of Discharge
- Battery Defect
- Output Overload
- Output Overfrequency
- Output Underfrequency
- Output Overvoltage
- Output Undervoltage
- Overtemperature

Indications

- UPS Healthy (drops out with any UPS alarm)
- UPS on Mains Supply (Fail safe indication)
- Rectifier On (Fail safe indication)
- Inverter On (Fail safe indication)
- UPS On Static Bypass (Fail safe indication)
- UPS On Maintenance Bypass (Fail safe indication)
- UPS on Standby Battery (Fail safe indication)

Operating Data

- Mains Supply Voltage L-L (if 3 phase) and L-N
- Battery Voltage
- Battery Current
- Battery Temperature
- Total Battery Autonomy
- Battery Autonomy Time
- Output Voltage L-L and L-N
- Output Current (per phase)
- Output Frequency
- Output Power
- Output Power Factor
- Output Energy
- Inverter Hours Run

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The above alarms are to be displayed on the front panel of the UPS and are not required to be transmitted. Alarm and warning events shall be logged and time-stamped for duration of at least 7 days to allow for later retrieval for diagnostic purposes.

The above operating data are to be accessible and displayed live via the user interface.

Protection equipment and circuitry shall be provided to produce alarms and shut down the UPS if necessary on occurrence of fault conditions. A Common Fault Alarm indication shall be immediately visible to personnel and details of each fault shall be available by interrogation via the operator interface.

After shutdown due to fault, it shall not be possible to put the UPS into service without correcting the fault and resetting the alarm.

3.2.10 Interfaces

Voltage free contacts shall be wired to a terminal block for extension of the following signals to a SCADA RTU and shall be in the fail to safe mode:

- UPS On Static Bypass – Normally Open, Closed in Bypass
- UPS On Maintenance Bypass – Normally Open, Closed in Maintenance Bypass
- UPS On Standby Battery – Normally Open, Closed in UPS Battery Supply
- UPS Healthy – Normally Open, Closed in normal operation

Contacts shall be suitable for resistive, low current duty at voltage in the range 12 – 130VDC and 140VAC. Particular attention shall be given to ensuring contact wetting by means of gold-plated contacts, wiping contacts or other suitable means.

In addition, the UPS system shall have the following electronic interfaces.

- RS232 Port
- RS485 Port
- Interface for TCP/IP protocol

Necessary Windows based software (preferably Windows XP compatible) and or hardware required to interface with the UPS system shall be provided and shall not require intervention from the manufacturer.

The UPS system should also provide facility for temporary remote off site monitoring by mobile 3G/4G connection or similar.

3.2.11 Isolation Transformer

Isolation transformers for the input and output of the UPS are not required.

3.2.12 Electromagnetic Compatibility and Immunity

The UPS system shall meet minimum emission and immunity requirements for UPS Category C3 as per the designation and requirements of AS62040.2.

The UPS system shall operate as intended and not adversely affect nearby equipment within the electrified rail environment. *EN 50121* may be used as a guide for compliance.

3.2.13 Earthing

The earth through the UPS system shall be continuous. The earth through the UPS system shall not be switched.

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3.3 Physical Requirements

3.3.1 Construction

The UPS system shall be enclosed in sheet steel enclosure or similar suitable for floor mounting and front access. Door panels shall be fitted with removable pin hinges and locking handles. Doors shall be fitted with stops.

In addition, physical requirements in accordance with Section 7 of *AS62040.1.2* shall apply.

3.3.2 Degree of Protection

The UPS system enclosure shall have a minimum internal protection (IP) rating of IP21.

3.3.3 Colour

The paint colour of the UPS system shall be as per Section 4.2.1 of RailCorp Standard *EP 00 00 00 15 SP*. Manufacturer standard colours may be accepted subject to RailCorp Engineering approval.

3.3.4 Marking

Marking and labelling of the UPS system shall be as per the requirements of Section 4.9 of *AS62040.1.2* and Section 4.9 of RailCorp Standard *EP 00 00 00 15 SP*. Where there are discrepancies, requirements specified in the RailCorp Standard shall apply.

3.3.5 Cable Entry

The UPS enclosure will be designed to accommodate cable entry from the back. Side entry is not permitted.

3.3.6 Environment

The installation ambient air temperature shall be: -5^{o}C to 50^{o}C as per the requirements of Section 4.1 of RailCorp Standard *EP 00 00 00 13 SP*.

Humidity shall be 20% - 95% non-condensing.

Installation altitude shall be < 1000m. Where installation altitude is above 1000m, appropriate de-rating factor shall be applied.

The installation may be located in a naturally ventilated trackside equipment room that is subject to significant vibrations. The UPS system shall not be adversely affected when operating under these environments.

3.3.7 Ventilation and Heat Dissipation

The UPS system shall be designed for natural air ventilation/cooling alone. However, forced air cooling may be allowed if it is required for heat dissipation to ensure all components operate within their specification. Air intake shall be through the bottom of the UPS and shall exhaust through the top of the enclosure.

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3.3.8 Noise and Vibration

The UPS system shall not generate noise emissions or vibrations which may have an adverse effect upon itself or other equipment and equipment operators within the room. The UPS shall be vibration tolerant in accordance with the requirements of Section 7 of *AS62040.1.2*.

3.3.9 Transportation

Transportation conditions of the supplied UPS system shall conform to requirements of Section 4.1.4 of *AS62040.3*.

4 Battery

The battery shall be an integral part of the UPS system. A circuit breaker shall be provided for battery short circuit protection and battery isolation. Battery capacity shall have the following design margins applied:

- Design margin of minimum 20%
- Temperature correction margin
- Aging factor

The battery shall be possible to be maintained or replaced without powering down the UPS system.

4.1 Battery Type

The battery shall be valve regulated lead acid (VRLA) type designed for a minimum of 10 years at the specified operating temperatures as per Section 3.3.6.

The battery shall be suitable for mounting in the upright position.

4.2 Battery Rack

The battery rack/enclosure shall be floor mounted and shall be made of flame retardant material. The battery terminals, connections, cabling and all live parts shall be adequately shrouded to prevent accidental contact by operating or maintenance personnel.

The battery rack shall be designed for access from one side only. Cable entry shall be from above or from the ends. The battery rack shall be designed such that removing, replacing and lifting the batteries shall be possible without placing excessive strain on the user and without the use of any special lifting equipment.

The rack shall be corrosion proof to sulphuric acid and vapours by virtue of its construction material and/or painting.

The battery isolator and protection shall be provided and suitable for wall-mounting when the batteries are not integral with the UPS.

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5 Testing

5.1 Type Tests

Type tests listed in Table 3 and Section 6.7.1 of *AS62040.3* shall be performed. Type test certificates of the performed tests shall be provided by the manufacturer.

Non-electrical tests in addition to the above shall be performed in accordance to Section 7.1 and Section 7.2 of *AS62040.3*.

5.2 Routine Tests

Routine tests listed in Table 4 and Section 6.7.1 of *AS62040.3* shall be performed. In addition, the following tests shall be performed:

- Output Overvoltage Test to 6.6.22 of *AS62040.3*
- Harmonic Components Test to 6.6.26 of *AS62040.3*
- Full Load Test to 6.7.5 of *AS62040.3*
- Rated Stored Energy Time Test to 6.6.15 of *AS62040.3* (May be performed on site)
- Rated Restored Energy Time Test to 6.6.16 of *AS62040.3* (May be performed on site)

Relevant tests listed in Section 6.2 of RailCorp Standard *EP 00 00 00 15* SP shall also be performed on the UPS system.

5.3 Site Tests

Site testing shall be carried out by the supplier and shall include, but not limited to the following:

- Check of all functions
- Full Load Test (additional test) to 6.6.10 of *AS62040.3*
- Ventilation Tests to 6.6.28 and 6.7.12 of *AS62040.3* using actual loads
- Input Current and Voltage Total Harmonic Distortion (THD) to 6.6.26 of *AS62040.3*
- Brown Out Test – The UPS input AC supply is initially maintained at 100% nominal voltage at full load. The input source voltage is then gradually reduced to 40% nominal voltage over 2 seconds and maintained at 40% for a duration of 4 seconds. The input source voltage is then gradually restored to 100% nominal voltage over 2 seconds. During the brown out test, supply shall be maintained to the load and on completion of the brown out test, the UPS shall be able to revert to its original state.

The Regional Electrical Asset Engineer or his representative shall witness the tests and sign the commissioning sheet prior to handover of the UPS.

The Manufacturer shall be responsible for rectifying any defect or non-conformance that may become apparent during Site Testing at the Manufacturers expense.

6 Reliability, Availability and Maintainability

6.1 RAM Targets

The UPS system shall have a minimum availability target of 99.99%.

Superseded by T HR EL 23001 SP v1.0, 15/07/2021

6.2 RAM Requirements

The UPS system shall exhibit a high level of reliability, consistent with the achievement of availability targets specified for the equipment. Manufacturers shall provide details of the reliability claimed for each major element of the UPS system in the specified operating environment including the source of reliability data. If claimed reliability performance is based on calculation, the basis and methodology for the calculation should be quoted. If based on actual field operating performance, the source of the data, including details of the installation and, where possible, methods of verification should be provided.

Reliability performance is to be expressed in the form of a mean time between failures (MTBF), where a failure is defined as a condition which will prevent the item performing its intended primary functions.

Manufacturers are to also to provide information on specific maintainability features included in the design and are to provide typical and average times needed to replace major replaceable items (including test where necessary) and to perform routine inspection and replacement of consumable items.

Estimates should include a clear statement about whether the mean time to repair (MTTR) quoted include any allowance for response times and waiting times to obtain suitable spares and other equipment necessary for the task.

7 Quality Management System

7.1 Supplier's Accreditation

The Supplier must have obtained accreditation to *AS/NZS ISO 9001* or other relevant standard from a recognised authority for its manufacturing procedures and quality management systems. These procedures and systems shall be applied to manufacture and testing of each UPS.

Details of quality management certificates held shall be provided with the Tender, including the accreditation authority, document registration number and year.

The quality management documentation shall be made available for review by RailCorp if requested during tender evaluation.

7.2 Inspection and Test Plan

RailCorp shall have the right to make inspections during the manufacturing period and to witness works testing.

A draft Inspection and Test Plan (ITP) and associated Inspection and Test Checklist (ITC) shall be submitted with tenders for assessment. The ITP must nominate hold points for witness tests and inspections by RailCorp.

Manufacture shall proceed according to an agreed version of the ITP and ITC negotiated prior to awarding the contract.

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8 Integrated Support Requirements

The integrated support requirements are a significant deliverable in the procurement of new UPS units. Manuals, training, documentation and other support deliverables shall be provided in accordance with selected clauses of RailCorp Specification EP 00 00 00 12 SP. The following clauses are relevant:

Clause Number	Clause Title
4.1	Integrated Support Objectives
4.2.1	Scheduled Maintenance
4.3.2	Recommended Spares List
4.3.3	Packing, Storage and Handling
4.4	Operation and Maintenance Manual
4.5	Training
4.6	Facilities, Equipment and Special Tools
Appendix A	Technical Schedule (items related to the above clauses only)

In addition to the above requirements for training, a training and competence assessment kit shall be provided to RailCorp and shall be the intellectual property of RailCorp. This kit is to allow RailCorp to carry out the necessary training to staff via RailCorp's training facilities in the future.

The training kit should include:

- Power Point Presentations
- Course notes in soft copy format
- Trainers instruction notes
- Competency assessment criteria

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Appendix A Technical Schedule – UPS

The information and guaranteed performance figures listed below shall be supplied with the tender of the UPS system.

Characteristic of equipment		Manufacturer's declared values	
Construction			
Model catalogue reference		.....	
Model rating		.....	W or VA
Dimensions length × depth × height			mm
Weight		.....	kg
Weight with batteries if integrated		.....	kg
Environmental			
Ambient storage temperature range		.....	ºC
Ambient service temperature		.....	ºC
Altitude		.....	m
Relative humidity range		.....	%
Degree of protection in accordance with *AS60529*		.....	IP
Acoustic noise at 1 m: – Normal mode – Stored energy mode		.....	dBA dBA
Electrical characteristics – Input			
Rated input voltage and voltage tolerance			V
Rated input frequency and frequency tolerance		.....	Hz
Rated input current		.....	A r.m.s
Maximum input current		.....	A r.m.s
Maximum continuous input voltage distortion		.....	% THD
Maximum permitted input voltage distortion for 10 minutes		.....	% THD
Input current distortion at rated input current		.....	% THD
Input power factor			
Inrush current	(% of rated current)	.....	%
Number of phases		.....	Phase(s)
Electrical output characteristics – Static characteristics – Normal mode			
Rated output voltage		.....	V r.m.s
Output voltage variation (Balanced and unbalanced loading)		.....	V r.m.s
Output frequency (nominal)		.....	Hz
Output frequency variation (synchronized if applicable)		.....	Hz
Output frequency synchronized phase error at change of mode		.....	degrees
Output phase displacement (Balanced and unbalanced loading)		.....	degrees

Superseded by T HR EL 23001 SP v1.0, 15/07/2021

Rated output apparent power	.....	VA
Rated output active power across linear load	.....	W
Rated output active power across a reference non-linear load	.....	W
Total voltage distortion across a linear load	.....	%
Total voltage distortion across a reference non-linear load	.....	%
Individual harmonics voltage	.....	
Short-circuit capability	.....	
Overload capability	.....	
Range of load power factor permitted – Linear load	.....	
Number of output phases	.....	Phase(s)
Output voltage unbalance at reference unbalance load (multiphase only)	.....	%
Maximum phase angle variation (multiphase only)	.....	degrees
Output voltage d.c. component – linear load	.....	%

Electrical output characteristics – Dynamic characteristics – Normal mode

Output voltage dynamic variation during transfer normal/stored energy mode of operation and vice versa	.....	
Output voltage dynamic variation due to load changes	.....	
Maximum rate of change of output frequency	.....	Hz/s

Electrical output characteristics – Static characteristics – Stored energy mode

Rated output voltage	.....	V r.m.s
Output voltage variation (Balanced and unbalanced loading)	.....	V r.m.s
Rated peak output voltage	.....	V
Rated peak output voltage variation	.....	V
Output frequency	.....	Hz
Output frequency variation	.....	Hz
Rated output apparent power	.....	VA
Output phase displacement (Balanced and unbalanced loading)	.....	degrees
Rated output active power	.....	W
Rated output active power non-linear load	.....	W
Total output voltage distortion	.....	% THD
Individual harmonic voltage-linear load	.....	
Individual harmonic voltage-non-linear load	.....	
Short-circuit capability	.....	
Overload capability	.....	

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Range of load power factor permitted	…….....	
Number of output phases (multiphase only)	…….....	Phase(s)
Electrical characteristics – Dynamic characteristics – Stored energy mode		
Output voltage dynamic variation during transfer from stored energy mode to normal mode	…….....	
Output voltage dynamic variation due to load changes	…….....	
Efficiency		
Efficiency input/output	…….....	%
Synchronization	…….....	
Acceptable voltage difference	…….....	%
Range of frequency synchronization	…….....	Hz
Maximum phase error	…….....	degrees
Bypass characteristics		
Type of bypass	Manual / Automatic	
Mechanical/static	Mechanical / Static	
No break transfer/break transfer	No break / Break	
Break time/make time	…….....	ms
Maintenance bypass	Yes / No	
Bypass protection fuse or circuit-breaker rating	…….....	A
Galvanic isolation fitted	Yes / No	
Electromagnetic compatibility		
Immunity see *AS62040.2*		
Emission see *AS62040.2*		
Reliability, Availability & Maintainability (RAM)		
Mean Time Between Failures	…….....	
Mean Time To Repair	…….....	
Availability / Uptime	…….....	
Failure Modes	…….....	
Critical Components / Spare Parts	…….....	
Other Relevant Information	…….....	

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Appendix B Technical Schedule – Battery

The information and guaranteed performance figures listed below shall be supplied with the tender of the UPS system.

Characteristic of Battery	Manufacturer's declared values	
Model catalogue reference	.....	
Manufacturer	.....	
Manufacturing Plant Address	.....	
Model Number	.....	
Battery Type	.....	
Battery Construction	.....	
Total Number of Cells Used in Each Battery	.....	
Nominal Capacity @ C10	.....	Ah
Nominal Voltage of Battery	.....	V
End of Discharge Voltage	.....	V
Charging Voltage	.....	V
Type of Intercell Connection	.....	
Maximum Voltage Drop Across Intercell Connectors	.....	V
Maximum Operating Ambient Temperature	.....	ºC
Minimum Operating Ambient Temperature	.....	ºC
Recharge Time	.....	Hrs
Short circuit current	.....	A
Design Life	.....	Yrs
Operation of Safety Vent	.....	mbar
Number of Positive Plates Per Cell	.....	
Number of Negative Plates Per Cell	.....	
Type of Positive Plate	.....	
Internal Resistance of Cell	.....	Ω
Electrolyte Full Charge Density	.....	
Electrolyte Density Range	.....	
Electrolyte Litres/Cell	.....	L
Self Discharge Rate @ 25 ºC	.....	
Rated Capacity on First Discharge	.....	%
Time on Float to Achieve 90% of Rated Capacity	.....	Hrs
Time on Float to Achieve 100% of Rated Capacity	.....	Hrs
Container Material	.....	

Superseded by T HR EL 23001 SP v1.0, 15/07/2021

Separator Material	…….....	
Dimensions (L x W x H)	…….....	mm
Total Weight (Wet)	…….....	kg
Total Weight (Dry)	…….....	kg
Total Weight of Leads (Including Connectors)	…….....	kg

Superseded by T HR EL 23001 SP v1.0, 15/07/2021

Appendix C Request For Tender Checklist

Information to be supplied to tenderers

The following information shall be provided to tenderers:

- Input Voltage
- Output Voltage
- Autonomy
- Rated Output Power
- Number of Phases (Input and Output)
- Drawings showing – Power Room layout, site layout showing possible sources of radiated electromagnetic disturbances, schematic diagram of proposed distribution system
- Installation altitude
- Delivery Location
- Delivery Date
- Special transport or unloading requirements
- Special installation requirements
- Reliability, availability and maintainability targets
- Number of RailCorp staff to be given Operator Training
- Number of RailCorp staff to be given Maintenance Training
- Location for offsite training or on site training
- A statement stipulating that type testing, routine testing and site testing will be at the suppliers cost and that the purchaser reserves the right to witness tests carried out
- A statement stipulating that the purchaser reserves the right to inspect the UPS at any time during the manufacturing process

Information to be supplied by tenderers

The following information shall be provided by tenderers:

- Completed Technical Schedules (see Appendix A and Appendix B)
- Technical catalogues of all equipment tendered
- Complete Bill of Materials
- Schematics and physical cross sectional drawings of the proposal
- Type Test Certificates
- Details of manufacturers' quality management system
- Proposed delivery schedule
- Information associated with reliability, availability and maintainability (see section 6.2)
- Integrated support documentation as per Section 8 of this Specification
- List of emergency spares that should be stocked by RailCorp
- Proposal for maintenance of the UPS system during warranty and beyond
- Reference list where similar equipment has been installed and is under satisfactory operation for the past two years as a minimum
- Detailed training proposal as per the requirements of "User Training" in the following section. The proposal shall include the recommended time required to complete training. A separate price for training may be provided.
- Whole of Life Cost – Selection of the UPS shall be made on the basis of the whole of life cost. The following factors shall be considered in determining this:
  - Initial purchase price
  - Estimated lifetime of equipment
  - Cost of inventory spares

Superseded by T HR EL 23001 SP v1.0, 15/07/2021

- Cost of special tools
- Cost of replacement parts
- Cost of manuals
- Cost of staff training
- Electrical losses with the UPS supplying the maximum steady loads stated in the RFT
- Cost of installation
- Cost of maintenance
- Cost of decommissioning and disposal
- Cost of modifications to other parts of the installation
- Cost of changes to the Technical Maintenance Plan (TMP) & Service Schedules or the creation of new TMP & schedules
- Cost of consequential damage after failure taking reliability into account

Tenders are required to provide all necessary information as required by RailCorp to estimate the whole of life cost

Information to be supplied by the successful tenderer

Test Certificates

Copies of certified test certificates covering type tests and routine tests shall be provided prior to delivery of the UPS.

User Training

The successful tenderer shall provide training for the operation of the UPS system.

The training shall include the following aspects:

- Technical specification and application
- Schematic diagram and interlocking features
- Operation – normal operation and emergency procedures
- Fault finding – diagnostic and trouble shooting
- Maintenance – minor routine maintenance procedures

The training shall include both classroom lectures and hands on with the equipment.

A complete training and competence assessment kit shall be provided to RailCorp to conduct training using RailCorp resources in the future.

Refer to Section 8 of this Specification

UPS Manuals

The successful tenderer shall provide installation, user operation and maintenance manuals. Refer to Section 8 of this Specification.

UPS Interface

The successful tenderer shall provide the necessary software and or hardware required to interface with the UPS system. Training shall be provided as a part of the user training program.

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Appendix D Requirements for Technical Aspects of Tender Evaluation

Evaluation of tenders

The Chief Engineer Electrical requires that persons evaluating the technical aspects of this tender have sufficient technical competence for the task.

Tender evaluation committees shall forward details of persons evaluating the technical aspects of the tender to the Chief Engineer Electrical for concurrence. This will normally be in the form of an email and is to include sufficient detail of the tender and the person to enable the Chief Engineer Electrical to satisfy themself of the merits of the evaluating person. A minimum of 4 weeks notice is required prior to the evaluation of the Tenders.

The Chief Engineer Electrical will advise only if the person is considered unsuitable for the technical evaluation.

Acceptance of product

A number of the specifications require acceptance of product at both the factory and at site. The purchaser is to advise the Chief Engineer Electrical the details of the person carrying out the acceptance testing for the concurrence of the Chief Engineer Electrical. A minimum of 4 weeks notice is required prior to the evaluation of the acceptance testing.

The Chief Engineer Electrical will advise only if the person is considered unsuitable for the acceptance testing.

The Chief Engineer Electrical reserves the right to nominate a representative to review and/or attend such acceptance.

Record Keeping

Where product is purchased against this specification, the Chief Engineer Electrical requires that relevant detail be provided so that it can be logged against this specification.

For RailCorp purchases, the tender evaluation committee shall advise the Chief Engineer Electrical the RailCorp registered file details containing the tender evaluation for future referencing. This is normally a TRIM reference.

Where this specification is utilised by parties external to RailCorp (Alliance parties, etc) then copies of all relevant technical information and evaluation shall be forwarded to the Chief Engineer Electrical for filing against the specification. In addition copies of selected commercial information pertaining to the ongoing support of the product as follows is also required.

- Warranty details
- Spare parts and associated availability
- Product support information.