TECHNICAL DIRECTORATE

Material and Workmanship Specification: Mechanical, Electrical and Public Health JV32 Uninterruptible Power Supply

Document Number: CRL1-XRL-M-RSP-CR001-50043

Document History:

Version:	Date:	Prepared by:	Checked by:	Authorised by:	Reason for Revision:
1.0	21/08/2013	Nick Dibben	Derek Tyner	Rhys Williams	
2.0	02/09/2013	Nick Dibben	Paul Kerrigan	Derek Tyner	Clauses 1301 & 1312 amended

JV32 UNINTERUPTIBLE POWER SUPPLY

Table of Contents

JV32.1000 FORMAT, SYSTEMS, PERFORMANCE AND MATERIALS

JV32.1100 SPECIFICATION TYPE AND FORMAT

JV32.1101 Specification Type

a) This is a Descriptive Specification where the *Contractor* shall complete the Detailed Design, manufacture, supply, install and warrant the works associated with this equipment as indicated on the Design Drawings and criteria stated in the Specification.

b) Where a particular material, product or supplier is indicated in the Specification, such material, product or supplier shall be deemed indicative representing the *Project Manager*'s design intent only. The *Contractor* may complete the installation using that product or equivalent as acceptable by the *Project Manager* in writing but shall remain fully responsible for the Detailed Design and performance of the works.

JV32.1200 SYSTEM DESCRIPTIONS

System Description, Functional Requirements and Interfaces

a) This section specifies the requirements to design, supply, install, test and commission, and put to work Uninterruptible Power Supply (UPS) Systems and associated LV distribution for life-safety systems/ equipment of the works.

JV32.1300 PERFORMANCE REQUIREMENTS

JV32.1301 General

a) The *Contractor* shall provide UPS systems for emergency power and power conditioning to the following loads as appropriate:

i) Station East

- UPS-1 Emergency Lighting
- UPS-2 Communications

ii) Station West

- UPS-3 Emergency Lighting
- UPS-4 Communications

iii) Shafts and Portals

- UPS-1 Emergency Lighting
- UPS-2 Communications

b) The autonomies of each UPS shall be:

i) 3 hours Emergency Lighting.
ii) 4 hours Communications.

Note 1: The provision of 24 hours automony for the PAVA system in quiescent mode followed by 30 minutes load is being provided within the equipment by the C660 Contractor..

Note 2: Mechanical plant loads shall not be connected to either the Emnergency Lighting or Communications UPS

Note 3: The connection of UPS supplies for the OHLE tripping supply and tunnel ventilation damper controls to the UPS units shall be agreed with the relevant system wide contractor

c) The Emergency Lighting UPS shall operate in on line mode. The Communication UPS shall be a single on line, double conversion type, continually providing conditioned power to the loads and shall be connected such that it is powered from the normal mains when both A&B supplies are present and only transferring to UPS when both A&B supplies have failed.

d) Each UPS system shall be complete with an input rectifier, batteries, inverter, internal by-pass and static switch. An independent external bypass, and an external switchboard shall also be included as part of the UPS installation. The UPS shall provide galvanic separation between input and output under all conditions, if separate supplies are provided at the Rectifier and internal static bypass.

e) The UPS shall be located in a dedicated Emergency Switchroom (ESR) room, with the batteries located remotely in a separate room.

f) The UPS systems shall be in accordance with Network Rail, Product Specification for UPS Ref: NR/ PS/ ELP/ 00007 for Signalling Applications in service conditions defined in Clause 4.11.1 c) except where specifically stated otherwise in this Specification.

g) The UPS battery charge system shall be capable of recharging a fully discharged battery to 80% fully charged within 8 hours and to 95% capacity in a further 12 hours. Note: this requirement replaces that contained in NR/ PS/ ELP/ 00007 Clause 4.9.3.

h) The UPS battery and charging system for the emergency lighting shall also be designed so that on a partial discharge test of 20% load for 1 hour, the battery shall have the required 3 hour automony after 3 hours recharge.

i) The UPS inverters & batteries shall be sized accordingly to ensure adequate fault current is generated (after autonomy of batteries is exceeded) to trip the down-stream protective devices.

j) UPS protection model to be prepared to demonstrate all faults can be cleared within maximum disconnection times.

JV32.1302 Functional requirements

a) Stations, Shafts & Portals within the UPS framework shall comply with F943-XRL-E-RSP-CRG03-50001 UPS Performance Specification.

JV32.1303 Interfaces

a) The UPS shall provide power to the Communications Equipment. The performance and details of the UPS required shall be as detailed in the following C 170 Communications documents and agreed with the C660 Contractor:

   i) Room Data Sheet C170-PBF-R3-RDS-CRG03-00001.
   ii) C170 Comms & Controls Systems C170 Heat & Electrical Loads Register Document Number: C170-PBF-R3-TSC-CRG03-00001.
   iii) Un-Interruptible Power Supply Strategy C170-PBF-R3-TSY-CRG03-00001.

b) The UPS shall provide power to the Tunnel Lighting & Power Equipment. The performance and details of the UPS required shall be as detailed in the following C124 documents and agreed with the C610 Contractor:

   i) C124 - Railway systems Electrical Load Schedule Tunnel Lighting & Power C 124-MMD-E-TSC-CRG01-00003.
   ii) C124 - Railway systems Site-Specific Electrical Requirements C124-MMD-E-RRS-CR001-00001.
   iii) C124 - Railway systems Baseline Design Report Tunnel Electrical ServicesC124-MMD-E-RGN-CR001-00002.

JV32.1304 The Uninterruptible Power System (UPS) shall include the following components:

a) Rectifier/ battery charger.

b) Inverter.

c) Internal maintenance bypass switch.

d) Internal static switch.

e) Sealed Lead Acid Batteries or Valve Regulated Lead Acid.

f) Battery monitoring system.

g) External Bypass including static switch.

h) Input/ Output Switchboard (including load shedding).

JV32.1305 The Uninterruptible Power System (UPS) shall comply with the following input requirements:

a) Nominal voltage (V) 400 V three-phase + N.

b) Tolerance on 400V @ 100% load +15 to – 15%.

c) Nominal frequency (Hz) 50 (60 Hz selectable).

d) Tolerance on frequency ± 6%.

e) Input power factor @ nominal voltage > 0.99.

f) Total harmonic distortion (THDi) @ full load < 3%.

g) Total harmonic distortion (THDi) in other conditions < 5%.

h) Engineering Recommendation G5/ 4-1 - Evidence of compliance: Submit evidence for 25%, 50%, 75%, and 100% load.

i) The failure of either supply on the rectifier or the static bypass shall not result in the shutdown of the UPS.

JV32.1306 The Uninterruptible Power System (UPS) shall comply with the following output requirements:

a) Nominal voltage 400 V three-phase + N (380/ 415 selectable).

b) Nominal frequency 50 Hz (60 Hz selectable).

c) Nominal power @ 40°C (kVA) as required.

d) Voltage bandwidth on all conditions ± 10%.

e) Max total harmonic distortion for all load conditions 5%.

f) Automatic adjustment of nominal output power as a function of temperature:

i) @ 25°C = 110%

ii) @ 35°C = 105%
iii) @ 40°C = 100%.

g) Output voltage stability in steady-state condition for input within permitted limits and load variations from 0 to 100 ± 1 %.

h) Stability in dynamic conditions for 100% load step variations - Complies with IEC/ EN 62040-3, Class 1 (VFI, SS, 111).

i) Load crest factor without de-rating - 3:1.

j) Output voltage distortion with 100% linear load < 3 %.

k) Power factor 0.6 lag to 0.9 lead.

l) Output voltage distortion with non-linear load as specified by IEC/ EN 62040-3 < 5%.

m) Output frequency stability in synchronism with mains supply ±1% (± 2 ± 4 selectable).

n) Output frequency stability with internal oscillator ± 0.1%.

o) Frequency slew rate < 1Hz/ sec.

p) Permitted overload

i) 125% for 10 minutes
ii) 150% for 60 seconds

q) Short circuit current

i) 300% for 10ms
ii) 150% for 5s

JV32.1307 The Uninterruptible Power System (UPS) shall comply with the following requirements for the internal electronic static bypass switch:

a) Nominal voltage 400 V (380/ 415 selectable).

b) Electrical Protection shall be provided for the bypass system.

c) Tolerance on voltage ± 5 to ± 15 % selectable.

d) Nominal frequency 50 Hz (60 Hz selectable).

e) Tolerance on frequency ± 2.5%(± 0.2 to ± 6 selectable).

f) Permitted overload

i) 1000% for 500 ms
ii) 125 % for 10 minutes
iii) 150 % for 30 seconds.

JV32.1308 The Uninterruptible Power System (UPS) shall comply with the following requirements for the External Bypass Switch:

a) Physically separate from the UPS in an external cubicle.

b) Able to be completely removed without disturbing the UPS from operation, whilst the UPS is continuing to supply the load.

c) The UPS shall be able to be completely removed without causing any disruption to the external Bypass, whilst the Bypass is continuing to supply the load.

d) The Bypass shall be mechanically/ electrically interlocked and isolated such that no supplies can be simultaneously operated or any back-feeds from the UPS can be present.

JV32.1309 The Uninterruptible Power System (UPS) shall comply with the following general requirements:

a) The noise level measured @ 1 meter at any point and in any direction and @ 100% load according to ISO 3746, shall be the following:

i) < 65 (20 to 100 kVA)
ii) < 70 (100 -300 kVA).

b) AC/ AC efficiency - double conversion mode @ 100% load is to be 95%.

c) Efficiency in digital interactive mode @ 100% load is to be 98%.

d) EMC compatibility as per EN 50091-2 Class C3 and the Crossrail EMC Control Plan .

e) Emergency Power OFF button shall be included.

f) The UPS shall be able to operate normally while disconnecting faulty LV circuit's on-battery source. This shall be achieved by supplying sufficient fault currents to trip the largest Circuit Breaker downstream of the UPS (a 32A type C MCB) within half a cycle (10ms).

JV32.1310 The Uninterruptible Power System (UPS) shall comply with the following Battery requirements:

a) Free standing open rack type in dedicated battery rooms complete with battery lifting device to remove and maintain battery blocks from the highest point on the racks. The battery lifting device shall also be suitable for transporting the battery blocks out of the station.

b) Sufficiently segregated from the UPS.

c) Electrically shrouded battery blocks.

d) Each parallel string shall be electrically segregated so as to allow maintenance of one string whilst the other is still in service.

e) The battery shall meet the required autonomy over the service life of a minimum of ten years.

f) Type: Lead-acid valve regulated (VRLA) to BS 6290-4, BS EN 60896-21 and BS EN 61056-1.

g) Voltage: maximum single string voltage 600 Volts (Float).

h) Fused parallel battery strings: as required, minimum 2.

i) Impact resistant plastic shields to interblock terminal and output terminals.

j) Battery supply DC circuit breaker with overload and short circuit protection.

k) Ripple free battery charger with automatic temperature and float voltage compensation.

l) The system shall alarm and record the following:

   i) Alarm and detection of faulty battery
   ii) Alarm and detection of excessive temperature
   iii) Volt free contacts on alarms for other interface.

JV32.1311 The Uninterruptible Power System (UPS) shall comply with the following RAMS requirements:

a) UPS, single module: minimum MTBF of 175,000 hours (as per NR/ PS/ ELP/ 00007 Section 3.7, signalling applications) in continuous operation, excluding batteries. In addition MTBF of 80,000 hours is required at each LV output of UPS distribution board for conditioned power supply (including batteries).

b) Provide Fault tree analysis using MIL standards or equivalent shall be provided in order to demonstrate the achievement of MTBF

targets and assess on demand availability of back-up mode. RAM Data to be used are :

i) Field data from statistically significant populations of existing assets already in operation in environments similar to Crossrail.
ii) Data from technical specifications or requirements applicable to components or results from RAM calculations or simulations.

c) The UPS shall be designed to allow the mean active time to repair to be equal to or less than 4 hours.

d) The UPS shall be provided with facilities and functions to allow safe maintenance of equipment and provide electrically segregated and isolated parts to allow other areas to be energised.

e) Remote monitoring shall allow immediate detection of UPS being by-passed or in battery back-up mode.

f) NR/ PS/ ELP/ 00007 Section 3.7 specify MTBF for a module in normal on-line mode (Continuous operation). Batteries are excluded from MTBF. Only components involved in this mode shall be considered in the MTBF calculations and demonstration.

JV32.1312 The Uninterruptible Power System (UPS) shall provide the following controls, indicators and alarms connections to BMS.For the avoidance of doubt, the JV32.1312 section vii) takes precendents over the Framework clause F944 JW60.1267 items I to vii :

a) Controls, Indicators and Alarms:

i) Indicator type: LCD display
ii) Controls: Display select button
iii) Status indicators

- Normal operation
- Time of load on battery autonomy.

iv) Faults:

- Supply voltage
- Frequency faults
- Local audible alarm system
- Fan failure alarms.

v) Emergency Power Off (EPO) Button:

- Disable converter output
- Inhibit bypass system output.

vi) Data Log:

- Provided Continuous data log, record all events inclusive of all alarms with non-volatile memory
- Must be downloadable from UPS.

vii) BMS Interface points (volt free contacts) shall include:

- UPS Fault (Common alarm)
- Inverter Operation
- SBS Operation
- Rectifier Falut / Rectifier Mains Fault
- Battery Undervoltage
- Rectifier Mains Fault
- SBS Mains Fault
- Battery Operation
- UPS Fan Fault
- UPS Overload
- Battery Temperature High
- Battery Disconnected (via indervidual Battery MCCB status)
- External Manual Bypass Operation (via External Manual Bypass)
- Emergency Stop Button status(via additional volt free contacts)

The UPS shall have serial interface for use by the SCADA systemwide contractor. The serial interface points to be agreed with C660 and may differ from the BMS volt free interface points. SCADA will pick up volt free contacts on the MCCB to identify if the Battery MCCB is energised. The BMS will pick up volt free contacts on the MCCB to identify if the indervidual breaker is on, off or tripped.

JV32.1400 MATERIALS

JV32.1401 Materials shall have been found acceptable by the Materials Compliance Process and included in the Materials Compliance Record (MCR).

JV32.1402 Enclosures

a) Minimum degree of protection to BS EN 60529: IP20 - for internal plant rooms - Reference shall be made NR standards and all applicable LUL standards.

b) Material and construction: Welded mild steel. Assemble to prevent distortion when the complete enclosure is lifted or transported.

c) Finish RAL7016.

d) Lockable access doors.

e) Cable entry with removable gland plates: For top and bottom entry cables.

f) Duplicate forced ventilation fans are required.

g) Internal and External interlocking, padlocking, earthing, insulation, screening and enclosing.

h) Protection against natural corrosion and galvanic corrosion of dissimilar metals.

END OF 1000 SERIES

JV32.2000 SUBMITTALS AND TESTING

JV32.2100 SUBMITTALS

Samples, Mock-ups, Prototypes and Quality Benchmarks

JV32.2101 Post Contract Samples

a) Not required

JV32.2102 Mock-up Requirements

a) Not required

JV32.2103 Prototype Requirements

a) Not required

JV32.2104 Benchmark Requirements

a) Not required

JV32.2105 General arrangement drawings shall include:

a) Weight of each UPS unit.

b) Weight of separate battery (including enclosure or racks).

c) Rating and connection plate details.

d) Enclosure base details.

e) Arrangement and connection drawings for ancillary equipment.

JV32.2106 Batteries

a) Submit design life details.

b) Submit service life details.

JV32.2107 Type test certificates:

a) Temperature rise.

b) Sound level in normal mode.

c) Sound level in battery mode.

d) Rated input current.

e) Maximum continuous input current (curve of current against time).

f) Inrush current expressed as a percentage of normal rated current.

g) Harmonics: Full details of input current harmonic distortion at 25%, 50%, 75% and 100% load.

h) Overall efficiency: Submit details at 25%, 50%, 75% and 100% load.

i) EMC compliance certificate

JV32.2108 Mean time between failures

a) Provide RAMS report including MTBF.

JV32.2109 Service Conditions

a) Altitude: Less than 1000m above sea level, and below ground level.

b) Ambient service temperature for UPS equipment:

i) Minimum: 0 °C
ii) Maximum: 40°C

c) Ambient relative humidity for UPS controls: up to 90% non-condensing.

d) Ambient relative humidity for batteries: up to 90% non- condensing.

e) Environmental conditions: Normal indoor.

f) Area of use: Restricted access area.

g) Operation and maintenance instructions: Submit.

h) Record drawings: Submit.

JV32.2200 TESTING

JV32.2201 General

a) Testing shall be carried out to the manufacturers' instructions and recommendations.

b) Stations, Shafts & Portals within the UPS framework shall comply with F943-XRL-E-RSP-CRG03-50001 UPS Performance Specification.

Off-Site Testing

a) Off site testing is not required for proprietary and standard equipment.

b) Standard manufacturers test certificates shall be provided.

On-Site Testing

a) On-site testing of each system is required.

b) Commissioning of each system is required

JV32.2202 Tests in accordance with BS EN 62040-3.

a) Routine tests: Undertake.

b) Type test documentation: Submit.

c) Product Acceptance: Compliance with the Network rail standard NR/ PS/ ELP/ 00007 "Requirements for Signalling Applications".

d) Special tests:

i) Balanced load test
ii) Efficiency test
iii) Harmonic components test
iv) Input voltage and frequency test
v) Inrush current test.

e) Test equipment calibration certificates: Submit.

f) Witnessing: Arrange for factory testing to be witnessed by 4 persons nominated by the *Project Manager*.

g) Test report: Submit.

JV32.2203 Commissioning testing shall include but not be limited to:

a) Method statement: Submit.

b) Phase rotation: Verify.

c) Emergency and safety circuits: Check.

d) Correct operation of alarms and controls: Confirm.

e) Insulation resistance tests

f) Test interconnecting cables

g) Test forced cooling fan motors

h) Test interconnecting cables

i) Tests in accordance with BS EN 62040-3

j) Operational tests:

i) AC input failure test
ii) AC input return test
iii) Acoustic noise test
iv) Battery ripple current measurement
v) Current division test
vi) Earth fault test
vii) Overload capability test
viii) Rated restored energy time
ix) Rated stored energy time test
x) Restart test
xi) Short circuit test
xii) Short circuit protection device test
xiii) Simulation of parallel redundant UPS fault test
xiv) Synchronization test
xv) Transfer test
xvi) UPS efficiency test
xvii) UPS auxiliary devices test
xviii) Ventilation test

k) Output tests:

i) Harmonic components measurement
ii) Frequency variation test
iii) Output over voltage test
iv) Output frequency slew rate test
v) Periodic output voltage variation test
vi) Radiofrequency interference and conducted noise test
vii) Light load test (as JV32.1301 h)
viii) Unbalanced load test
ix) Balanced load test
x) Full load test.

END OF 2000 SERIES

JV32.3000 FABRICATION AND WORKMANSHIP

JV32.3100 FABRICATION

JV32.3101 General

a) Stations, Shafts & Portals within the UPS framework shall comply with F943-XRL-E-RSP-CRG03-50001 UPS Performance Specification.

JV32.3200 WORKMANSHIP

JV32.3201 General

a) Workmanship Tolerances and UPS Installation.

b) The UPS installation shall be designed to expedite rapid servicing using safe methods of working to minimise down time.

c) The following factors shall be considered:

i) The delivery of all component parts to site and their movement within the built premises. UPS systems contain very heavy components and full risk assessments shall be carried out prior to site works commencing.
ii) Ample space around the modules to work, to remove subassemblies such as drawers, and more heavy components such as transformers and battery cells.
iii) Ample space adjacent to the UPS room to store spare parts, manuals, test equipment, and maintenance records.
iv) Facilities to connect portable dummy loads to test modules before returning them to service.
v) The UPSs and their batteries shall be able to be fully isolated for maintenance or replacement whilst maintaining the power supply to the load via the by-pass. All isolators and circuit breakers shall be padlockable in the "On" and "Off" positions to prevent unauthorised or inadvertent operation.

END OF 3000 SERIES

JV32.4000 SYSTEMS INTEGRATION AND HANDOVER

JV32.4100 SYSTEMS INTEGRATION

JV32.4101 General

a) The *Contractor* shall ensure full integration of the equipment into all the interfacing systems.

b) Stations, Shafts & Portals within the UPS framework shall comply with F943-XRL-E-RSP-CRG03-50001 UPS Performance Specification.

JV32.4200 HANDOVER

JV32.4201 General

a) The *Contractor* shall provide all documentation as required by the *Project Manager* at completion of the works.

b) Stations, Shafts & Portals within the UPS framework shall comply with F943-XRL-E-RSP-CRG03-50001 UPS Performance Specification.

END OF 4000 SERIES

END OF SECTION JV32