

Category 1 Standard

S1940 630/750 V Direct Current Indoor Switchboards for Use on The System

(formerly Powerlink Technical
Specification SP80302 Rev 4)

Issue No.: A1

Issue date: August 2013
Review date: November 2017

MAYOR OF LONDON



Contents

1	Purpose	5
2	Scope	5
3	Requirements	5
4	Responsibilities	5
5	Supporting Information	6
5.1	Background	6
5.2	Safety, Environment and Customer Considerations	6
6	References	6
6.1	References and Abbreviations	6
6.2	Definitions	6
6.3	Person Accountable for the Document	7
6.4	Document History	7
7	Attachment - Technical Specification SP80302 Rev 4 (Ex Powerlink)	8
1	Introduction	8
2	Purpose	8
3	Scope	8
4	Definitions	9
5	Abbreviations	12
6	References	12
7	Description of the Operational Environment	12
8	General Clauses	12
8.1	Legislation and Regulations	12
8.2	PSC Clause - The System (as modified) to Comply with PSC	13
8.3	Safety	13
8.4	Design, Manufacture and Workmanship	14
8.5	PL Asset Database	14
8.6	Co-ordination with Building Design	14
8.7	Spare Parts and Consumables	14
8.8	Operation and Maintenance Manual	14
8.9	Delivery	15
9	Compliance with Standards	15
9.1	European, International and British Standards	15
9.2	LUL Engineering Standards	16
9.3	Order of Precedence	16
10	Main Performance and Technical Requirements	16
10.1	General	16
10.2	Noise Emission	17
10.3	Reliability and Availability	17
10.4	Maintainability	17
10.5	External Paint Finish	18
10.6	Internal Parts of Filled Chambers	18
10.7	Service Life	18
10.8	Interchangeability	18
10.9	Effects on the Environment and Disposal at End of Service	18
10.10	Whole Life Costs	19
10.11	Fire Safety of Materials	19



10.12	Electrical Performance	19
10.12.1	Switching Duty and Performance	19
10.12.2	Rated Characteristics	20
10.12.3	Current Interruption	20
10.12.4	Operating Sequence	21
10.12.5	Circuit Breakers for Use as Points of Isolation	21
10.13	Auxiliary Supplies	21
10.14	Ingress Protection	22
10.15	Electromagnetic Compatibility (EMC)	22
10.15.1	General	22
10.15.2	Immunity from Electromagnetic Interference	23
10.15.3	Electromagnetic Emissions	23
11	Other Performance and Technical Requirements	23
11.1	Resistance to Corrosion and Deterioration	23
11.2	Enclosures and Compartments	23
11.2.1	Auxiliary Equipment Compartments	24
11.3	Safe Working Platform	24
11.4	Labelling and Special Marking	24
11.4.1	General	24
11.4.2	Electrical Warning Signs for Equipment	25
11.4.3	Operational Labelling and Marking	25
11.4.4	Designation Labels	25
11.4.5	Fuse Labels	26
11.4.6	Rating Plates	26
11.4.7	Switchboard Line Diagrams	26
11.4.8	Lifting	26
11.5	Cooling	26
11.6	Monitoring Equipment	26
11.6.1	Transducers	27
11.7	Auxiliary Wiring	27
11.7.1	Provision for Testing	27
11.7.2	Terminals and Terminal Blocks	27
11.7.3	Segregation of Wiring	28
11.7.4	Prevention of Contact with Live Conductors	28
11.8	Circuit Protection of Auxiliary Supplies, Wiring and Equipment	28
11.9	Locks, Padlocks and Keys	28
11.10	Security of Isolation	29
11.11	Earthing and Bonding	29
11.12	Insulation Level	29
11.13	Operating Mechanisms	29
11.13.1	Anti-pumping device	29
11.13.2	Trip Circuit Supervision	29
11.14	Interlocking, Safety Features and Shutters	30
11.15	Control of Circuit Breaker Operation	30
11.15.1	Local Control at the Switchboard	30
11.15.2	Supervisory Control	30
11.15.3	Control of Closing Supply	30
11.15.4	Intertripping	31
11.15.5	Tunnel Telephone Trip	31
11.16	Alarms and Indications	31
11.16.1	Track Alive Indication	33
11.17	Testing Facilities	33
11.18	Main Circuit Terminal Arrangements	33
11.19	Protection Systems	34
11.20	Metering	34
11.21	Offline Circuit Breaker Test Unit	35
11.22	Special Tools, Test Equipment, Lifting Equipment and Loose Appliances	35



12	Quality Management	36
12.1	Quality Assurance	36
12.2	Inspection and Testing	36
12.2.1	Type Tests	37
12.3	Factory and Routine Test Certificates	37
12.4	Drawings	37
12.4.1	Design Stage	37
12.4.2	As Installed Drawing	38
12.5	System and Equipment Records	38
Appendix A	Reference Documents	39
	PL and LUL documents	39
	European and other standards	39
Appendix B	Works Tests	41
Appendix C	Site Tests	43
Appendix D	Guidance on Inductance and Track Time Constants	44

Copyright London Underground Library
Provided by IHS
No reproduction or networking permitted without license from IHS
Full document details: LUL S1940 2013



1 Purpose

- 1.1 The purpose of this LU Standard is to apply technical requirements for equipment and systems on the LU power system through the inclusion of a technical specification, previously owned and managed by the Power Service Contractor, UK Power Network Services (UKPNS) Powerlink, as an attachment to this standard.

2 Scope

- 2.1 This Standard applies to equipment and systems on the LU power system.

3 Requirements

- 3.1 The mandatory requirements of this standard are set out in Section 7 as an attachment to this document.
- 3.2 Where an attachment refers to the 'Contractor' it should be taken to mean LU and LU Suppliers following the termination of the Power Service Contract.
- 3.3 Where the attachment refers to the 'System' it should be taken to mean the LU power system including its associated SCADA system and the operational properties.

Note: It is the intention to fully re-work this LU standard into the standards format over a period of time. While the content of the ex-Powerlink specification should not conflict with the remainder of the LU standards suite, should any discrepancies occur, these should be brought to the attention of the LU technical authority.

4 Responsibilities

- 4.1 **The Head of Power Engineering** is responsible for the technical content of this standard. Concessions in relation to this standard shall be directed to the Head of Power Engineering who has overall accountability for compliance with this standard. The Head of Power Engineering may request support from the other technical authorities when reviewing concessions or queries arising from the application of this standard.
- 4.2 **LU and LU Suppliers** shall be responsible for compliance with the requirements of this standard.
- 4.3 **Heads of Profession** are the LU technical authorities for each asset group, and shall be responsible for auditing technical compliance with this standard in accordance with the engineering asset grouping of LU Standard S1041 and with respect to the assurance of assets to which they are accountable for. They shall provide support to the Head of Power Engineering, if requested, with regard to any technical issues arising from concession requests or other queries to this standard.



5 Supporting Information

5.1 Background

- 5.1.1 From the 16th August 1998 through to the 15th August 2013 the LU power system was operated, maintained, renewed and upgraded by UKPNS Powerlink under the Power Services Contract. The contract was a Private Finance Initiative contract where UKPNS Powerlink were responsible for setting the detailed technical requirements for the LU power system.
- 5.1.2 At the start of the Power Service Contract on 16th August 1998 LU transferred its detailed technical standards for the LU power system to UKPNS Powerlink. Powerlink has owned and managed these technical standards as Powerlink technical specifications for the duration of the Power Service Contract.
- 5.1.3 The Power Service Contract ceased on the 16th August 2013 and the UKPNS Powerlink technical specifications for the LU power system were transferred back into LU as Category 1 standards.

Note: At the time this standard was produced, it was deemed necessary to utilise a non-standard for standard format. This however, does not diminish the mandatory requirements contained within the attachments.

5.2 Safety, Environment and Customer Considerations

- 5.2.1 Safety, environment and customer considerations relevant to this engineering standard are covered within the text of the attachment.

6 References

6.1 References and Abbreviations

- 6.1.1 Where references and abbreviations are used in this engineering standard they are given within the text of the attachment.

6.2 Definitions

- 6.2.1 Where definitions are used in this engineering standard they are given within the text of the attachment.
- 6.2.2 The following topic specific definitions are created:
- a) Within London Underground's Glossary of Terms (1-622)
(a Category 1 Standard);

Term	Definition	Source
LU	London Underground is the operating company of the former London Underground Limited.	a
Supplier	Supplier to London Underground, the primary organisation or individual that is selected to deliver a product, service or facility to London Underground and contracting directly to London Underground. This includes Consultants, Contractors, Infracos and PFI Contractors and excludes organisations or individuals selected by and contracting directly to them.	a



6.3 Person Accountable for the Document

Person accountable for the document
Phil Carmichael - Head of Power Engineering

6.4 Document History

Issue no	Date	Changes	Author
A1	Aug 2013	Incorporation of UKPNS Powerlink technical specification SP80302 Rev 4 as Category 1 LU standard following the termination of the Power Services Contract as per DRACCT No. 01934. No technical requirements have been changed.	G Bloch



7 Attachment - Technical Specification SP80302 Rev 4 (Ex Powerlink)

1 Introduction

This specification is for use only within the scope of the London Underground Limited (LUL) Power Service Contract (PSC). It is one of a series of specifications which mandate EDF Energy Powerlink (PL) technical and associated requirements for equipment for use on The System.

These specifications are supported by PL Work and Operating Instructions, and shall be read in conjunction with the Conceptual and Outline Design documentation, as appropriate.

2 Purpose

This specification states the technical requirements for the design, manufacture and testing of 750 V rated d.c. indoor switchboards, associated equipment and documentation for providing power supplies to London Underground 630 – 750 V nominal d.c. fourth rail electric traction system and in some cases for lifts and escalators. The supplies operate with both poles insulated from earth except where earthed through high ohmic value Bleed Resistors for monitoring earth faults on the conductor rail system.

The switchgear is used to provide routine switching of the positive and negative poles of the d.c. power supplies, including the making and interruption of light load, load and fault current and the isolation of individual circuits and busbars.

The switchboards typically consist of busbars, incoming rectifier circuits, outgoing track feeder circuits, feeder coupler circuits, busbar coupler circuits and outgoing auxiliary feeder circuits each with circuit breakers in the positive and negative poles.

3 Scope

This specification applies to new 630/750 V d.c. indoor switchboards and extensions of existing equipment, associated equipment and documentation, to be installed on The System.



4 Definitions

The technical definitions given in the European, International and British Standards referred to herein apply to this specification together with the following:

Bleed Resistors	A pair of resistors used to create an earth reference point for the d.c. traction supplies. Typical values are 125/250Ω or 250/500Ω . These resistors are also known as ballast resistors when located on the track.
British Standard	A standard published by the British Standards Institution. Its alphanumeric identity is prefixed by BS.
Circuit Breaker	
Auxiliary feeder circuit breaker	A circuit breaker supplying non traction circuits, for example, lifts, escalators or other ancillary equipment.
Busbar coupler circuit breaker	A circuit breaker coupling together two sections of busbars.
Feeder coupler circuit breaker	A circuit breaker coupling together the outgoing circuit terminations of two track feeder circuit breakers. It enables supplies to be maintained to a specific outgoing track feeder when its normal circuit breaker is out of service.
Rectifier circuit breaker	A circuit breaker connecting the d.c. output of a traction rectifier to the switchboard busbars.
Track feeder circuit breaker	A circuit breaker supplying the London Underground fourth rail electric traction system.
Conceptual and Outline Design documentation	The document(s) issued at the Outline Design stage defining the scope of work, specifying performance, unique operational and design requirements, and identifying service location specific electrical, environmental and interface characteristics.
Detailed Design stage	The stage at which the detailed requirements for equipment and/or work are developed. The proposed design, equipment and/or work are checked at this stage for compliance with the PSC and relevant specifications, and where necessary the concessionary request procedure is initiated.
Equipment	includes all component parts, cables, accessories and appliances.
European Standard	A standard published by the European Committee for Standardisation or by the European Committee for Electrotechnical Standardisation. Its alphanumeric identity is prefixed by EN.



Functional Unit	As described in BS EN 50123 Part 1, clause 3.3.15 Part of a switchgear comprising all the components of the main circuits and auxiliary circuits that contribute to the fulfilment of a single function. Note: Functional Units may be distinguished according to the function for which they are intended, e.g.: incoming unit, outgoing unit, etc.
International Standard	A standard published by the International Electrotechnical Commission. Its alphanumeric identity is prefixed by IEC.
Operational environment	The physical and electrical conditions under which the equipment is to operate.
Outline Design stage	The stage at which the main requirements for the equipment and/or work are specified.
PL Operating Instruction	A document published by PL which provides guidance on the application of the Safety Rules and to direct policy on operational limits and procedures.
PL Specification	A document published by PL which mandates technical and associated requirements for equipment for use on The System. Its alphanumeric identity commences with SP8.
PL Work Instruction	A document published by PL which describes the methods, tools and detailed procedures for the execution of physical work or inspection of PL plant, equipment and buildings.
Power Service Contract	The contract awarded by LUL to PL to deliver low voltage three phase and single phase power; dc power; signalling equipment power; low voltage dc power; Docklands Light Railway high voltage a.c. power; emergency power; and compressed air to prescribed delivery points. Note: The performance requirements of the Power Service Contract are contained in the LUL Standard 1-105.



The System

the electrical conductors and apparatus for the distribution and control of electricity from any Bulk Supply Points (and for the avoidance of doubt, excluding any assets belonging to any Regional Electricity Company) and from and including the Generating Stations to and including the Delivery Points and for the production of compressed air all as at the Starting Date and includes the Electrical Control Equipment, the interests in and rights in respect of the Properties granted under this Contract (PSC) but excludes LUL's Distribution System, the IT Systems (other than the SCADA System) and the Telephony Systems the Waterloo and City Line, the District Line from Putney Bridge to Wimbledon and Gunnersbury to Richmond, the Bakerloo Line from Queens Park northwards and the interface with the System for each such part as is set out in the Performance Specification and as altered by the Contractor, any Variation, any Known Third Party Works or adoption of Third Party Works.



5 Abbreviations

LUL	London Underground Limited
PSC	Power Service Contract
SCADA	Supervisory Control and Data Acquisition
PL	EDF ENERGY Powerlink Limited

6 References

Documents referred to by title and/or alphanumeric identity within this specification are listed in Appendix A. Some are mandatory, others provide information or guidance. Unless specified otherwise, reference shall be made to the latest editions.

7 Description of the Operational Environment

Details of the physical and electrical environment of the power systems are provided in PL Specification SP82603 'Physical and Electrical Environment of The System'.

8 General Clauses

8.1 Legislation and Regulations

The equipment shall comply with the requirements of all relevant legislation, acts, rules, regulations or orders and amendments thereto, including:

- (a) Health and Safety at Work Act 1974;
- (b) Electricity at Work Regulations 1989;
- (c) Electricity Safety, Quality and Continuity Regulations 2002;
- (d) Construction (Design and Management) Regulations 2007;
- (e) Railways (Safety Case) Regulations 1994;
- (f) Railway Safety (Miscellaneous Provisions) Regulations 1997;
- (g) Fire Precautions Act 1971;
- (h) Fire Precautions (Sub-surface Railway Stations) Regulations 1989;
- (i) The Regulatory Reform (Fire Safety) Subordinate Provisions Order 2006 (SI 2006 No.484);
- (j) Fire Precautions (Workplace)(Amendment) Regulations 1997
- (k) Railways and Other Transport Systems (Approval of Works, Plant and Equipment) Regulations 1994;
- (l) European Union directive EMC 2004/108/CE;
- (m) Noise at Work Regulations 1989;



- (n) Health and Safety (Safety Signs and Signals) Regulations 1996;
- (o) Provision and Use of Work Equipment Regulations 1998;
- (p) Manual Handling Operations Regulations 1992
- (q) Control of Substances Hazardous to Health Regulations 1999.

For substances falling within these regulations the supplier shall provide a risk assessment covering the life of the equipment and its eventual disposal. Materials containing asbestos, chlorinated fluorocarbons (CFCs) or polychlorinated biphenyls, (PCBs) shall not be used.

Cognisance shall be taken of relevant sources of guidance, for example:

- (i) The HM Railway Inspectorate Railway Safety Principles and Guidance;
- (ii) The Health and Safety Executive guidance notes and other publications.

This information is not exhaustive and does not modify the legal obligations of the supplier.

When required by PL, the supplier shall demonstrate compliance with current relevant legislation and regulations.

The Contractor shall provide advice to enable PL to comply with all relevant legislation for the installation, operation, maintenance and eventual removal of the equipment, including as necessary, but not limited to, provision of safety signs, ancillary or emergency equipment, and appropriate procedures.

8.2 PSC Clause - The System (as modified) to Comply with PSC

Parties who have an applicable contract, which requires compliance with the LUL Standard 1-105, shall ensure that The System and installation(s) incorporating equipment(s) complying with this and other EDF Energy Powerlink specifications comply with all relevant requirements, including performance requirements, of the LUL Standard 1-105.

8.3 Safety

The existing d.c. traction power distribution system has a high degree of integrity and provides for local short time outages for maintenance and faults. However, long outages caused by the failure of the equipment may disrupt train services and give rise to risk to persons and property. Loss of power supplies to an Underground Railway system is of critical importance to the safety of the travelling public.

The equipment when installed shall ensure that the existing high degree of integrity of the traction power distribution system is maintained and where practicable enhanced.

The equipment shall be safe at all times, including in the event of an internal fault. Provision shall be made to ensure the safety of persons concerned in its installation, operation, maintenance, repair, testing and its eventual disposal. All items and connections for the safe operation, control and protection of the equipment shall be provided whether or not specifically mentioned. The equipment shall be capable of being operated in compliance with PL document MSP/SRP/020 'Safety Rules Relating to Work/Testing on LV Equipment' and, where appropriate, LUL practices and procedures.

The equipment shall be earthed, insulated, screened, enclosed, shielded and provided with interlocking, locking and padlocking facilities, as necessary for safety. Safe and appropriate access shall be provided for installation, operation and maintenance purposes. The equipment shall provide protection against electric shock in accordance with BS EN 61140 and electrical values after isolation shall comply with Clause 8.2 of BS EN 61140.



8.4 Design, Manufacture and Workmanship

The equipment shall be designed, manufactured, installed and tested in accordance with best current practice, taking into account the environment and electrical distribution system in which it is to be installed and operated. All materials shall be of the quality and of the type most suitable for working under the conditions specified for the full service life of the equipment.

8.5 PL Asset Database

When equipment is commissioned, re-commissioned or substantially modified, the installer and/or supplier shall provide the information required by PL to enable the Asset Database to be updated.

8.6 Co-ordination with Building Design

Data for heat loss from the equipment when operating at full load shall be provided.

8.7 Spare Parts and Consumables

The manufacturer (or supplier) shall ensure that spare parts and consumables considered necessary to ensure that the equipment complies with this specification are available in sufficient quantities for a period of 10 years following delivery of the equipment. The manufacturer (or supplier) shall give PL 12 Months notice of any proposal to cease production or supply of spare parts and consumables for the equipment supplied.

The extent of commonality with equipment previously supplied or in service shall be indicated.

The manufacturer shall indicate expected service life or rate of replacement.

Operational spare positive and negative circuit breakers shall be provided for each dc switchboard or portion of a switchboard on an individual floor.

Operational spare positive and negative buscoupler breakers must be provided when:

- (a) the track breakers are not interchangeable with the bus coupler; and
- (b) a switchboard, or that portion of the switchboard on an individual floor, has a bus coupler; and
- (c) a switchboard, or that portion of a switchboard on an individual floor, does not have a normally open buscoupler.

All operational spare breakers shall be fitted with robust dust covers.

8.8 Operation and Maintenance Manual

One electronic copy, in unprotected PDF format, two paper copies and one paper copy per service location, of a comprehensive operation and maintenance manual shall be supplied to PL. The manual shall include all aspects necessary for installation and the safe and effective testing, operation and maintenance of the equipment throughout its specified service life.

The manual shall contain only relevant information and shall include:

- (a) a description of the equipment and major components, including construction, functioning and rating;
- (b) the method of installation;



- (c) operating instructions, including isolation, earthing and safety procedures to satisfy PL Safety Rules;
- (d) recommendations for condition monitoring to assist in optimising maintenance intervals;
- (e) maintenance instructions including any special or safety precautions, fault finding, measurements of wear, testing and overhaul procedures and their frequency;
- (f) operating, maintenance, testing and disposal, safety instructions and warnings required to ensure continuing compliance with current safety and other applicable legislation;
- (g) setting ranges and adjustments for the equipment, including its protective devices;
- (h) drawings and data enabling component parts to be identified for future procurement;
- (i) a list of installed locations with associated serial numbers. (Information to be provided by installer)

The operation and maintenance manual shall be of size A4 loose leaf design with sturdy hard covers. Where practicable, drawings shall be of size A4. Drawings in excess of size A4 shall be accommodated in protective holders within the manual. Drawings reduced in size shall be clearly legible.

Typical manuals shall be submitted to PL at the equipment type approval stage. Any modifications required by PL shall be made and revised copies made available to PL prior to delivery of the equipment.

At the end of the warranty period, any necessary modifications shall be made and sufficient copies provided for incorporation in each of the manuals previously supplied.

8.9 Delivery

The equipment shall be suitably prepared and protected to withstand, without damage or deterioration, the method of transport, cranning, storage and positioning during delivery to the service location. The equipment shall be protected, as necessary, against the weather.

Any special handling or lifting requirements and any dimensional, weight, access or other limitations, which may affect delivery to, and the installation of the equipment at, the service location shall be advised to PL and shall be taken into account during installation.

9 Compliance with Standards

9.1 European, International and British Standards

The equipment shall comply with relevant European Standards whether or not reference is made to them.

Where European Standards are absent, International Standards or national standards having currency within the European Community shall apply subject to the prior agreement of PL.

Unless specified otherwise, the latest editions of standards shall apply.