

Category 1 Standard

S1915 Specification for the Requirements for Substations and Other Similar Buildings for Use on the System

(formerly Powerlink Technical
Specification SP82102 Rev 3)



Please read the Written Notices
attached to this standard

Issue No.: A1

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MAYOR OF LONDON



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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 as 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 SP82102 Rev 3 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

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7 Attachment - Technical Specification SP82102 Rev 3 (Ex Powerlink)

1 Introduction

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

These specifications are supported by Powerlink Work and Operating Instructions, and shall be read in conjunction with Powerlink Conceptual and Outline Design documentation, as appropriate. This Specification shall also be read in conjunction with Powerlink Document SP80001 "Common and General Requirements for Fixed Installation Power Supply Equipment".

2 Purpose and Scope

This Standard sets out details relating to the design and construction of new traction substations, distribution substations, switch-houses, transformer-rooms, and other similar buildings for use on the System. It is similarly applicable to significant modifications and/or extensions to existing buildings.

3 Definitions and Abbreviations

For full definitions (where they are available), please refer to the PSC Schedule 1 – Definitions. For the purposes of this Specification, simplified definitions have been provided.

3.1 HEADROOM

The height of the ceiling above normal floor level.

3.2 SUBSTATION

A building for the purpose of Transformation, Switching, or Conversion of electrical energy. Unless the context requires otherwise, this definition shall not include Track Paralleling Huts, or Transformer Rooms.

3.3 TRACTION SUBSTATION:

A designated building, or other similar enclosure, normally providing accommodation for HV (and possibly LV and signal) switchgear, transformers, rectifiers, DC switchgear and other equipment, installed for the purposes of providing supplies of electrical energy and compressed air for traction, signalling and other ancillary purposes.

3.4 SWITCH-HOUSE / DISTRIBUTION SUBSTATION:

A designated building, or other similar enclosure, normally providing accommodation for switchgear, transformers, and other equipment, installed for the transmission and distribution of electrical energy supplies to other substations and for other ancillary purposes. A switchhouse may be co-located with, or incorporate, a traction substation.

A distribution substation contains similar equipment to a switch house but does not include power (coupling) transformers.



3.5 BULK SUPPLY / INTAKE POINT

A designated building at the boundary between the national public network (DNO) and the London Underground system containing both DNO and Powerlink equipment taking supplies at 132kV (66kV or 33kV) and transforming them down to 22kV or 11kV for onward distribution throughout the System.

3.6 TRANSFORMER-ROOM:

A designated building, or other similar enclosure, providing accommodation for HV and/or LV switchgear, transformers, and other equipment installed for the purposes of providing supplies of electrical energy for station loads and other ancillary purposes. These buildings do not contain DC traction equipment (i.e. rectifiers or DC switchgear).

3.7 TRACK PARALLELING ROOM/HUT:

A building, or other similar enclosure, providing accommodation for DC switchgear and other equipment installed for the purposes of switching DC supplies for coupling traction supplies.

3.8 HIGH VOLTAGE (HV):

Any voltage exceeding LOW VOLTAGE.

3.9 LOW VOLTAGE (LV):

In relation to alternating current, a voltage exceeding 50 volts but not exceeding 1000 volts, in each case measured between phase conductors taking the square root of the mean of the squares of the instantaneous values of voltage during a complete cycle.

In relation to direct current, a voltage exceeding 120 volts but not exceeding 10500 volts.

3.10 SYSTEM:

The electrical conductors and apparatus for the distribution and control of electricity from any Bulk Supply Points (as well as Greenwich Generating Station) to and including the Delivery Points. It includes the Electrical Control Equipment and the interests in and rights in respect of the Properties granted under the Power Service Contract but excludes LUL's Distribution System and the interface with the System where set out in the Performance Specification and as altered by the Contractor, any Variation, any Third Party Works Adoption Variation or any Known Third Party Adopted Works;

3.11 DELIVERY POINT:

- (a) for electricity, the outgoing terminal of the relevant switchgear for LVAC, DC, signalling equipment, LVDC, Docklands Light Railway 11kV and LV Emergency Power supplies; and
- (b) for compressed air, the reduction valve output isolation cock within each relevant Substation in accordance with the Performance Specification;



3.12 ABBREVIATIONS

[D]	Depth
DNO	Distribution Network Operator
LVAC	Low Voltage Alternating Current
[H]	Height
HEME	Hall Effect Metering Equipment / Hall Effect Sensor
kN	Kilo Newtons
kW	Kilowatts
Lines	Underground train lines forming the London Underground.
LPCB	Loss Prevention Certification Board
MPCC	Main Power Control Centre
MVA	Megavoltamperes
MW	Megawatts
Powerlink	UK Power Networks Services Powerlink
PSC	Power Service Contract (between LU and Powerlink)
SCADA	Supervisory Control and Data Acquisition
SEAP	Security Equipment Assessment Panel
SI	Statutory Instrument
TfL / LU	Transport for London / London Underground
[W]	Width

4 Legislation and Regulations

The construction and 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
(including Electricity, Safety, Quality and Continuity (Amendment) Regulations 2006);
 - (d) Construction (Design and Management) Regulations 2007;
 - (e) The Railways and Other Guided Transport Systems (Safety) Regulations 2006;
 - (f) Fire Precautions (Sub-surface Railway Stations) (England) Regulations 2009;
 - (g) New Regulatory Reform (Fire Safety) Order 2005;
 - (h) European Union directive 2004/108/CE;
 - (i) The Control of Noise at Work Regulations 2005;
 - (j) Health and Safety (Safety Signs and Signals) Regulations 1996;
 - (k) Provision and Use of Work Equipment Regulations 1998;
 - (l) Manual Handling Operations Regulations 1992;
 - (m) Lifting Operations and Lifting Equipment Regulations (LOLER) 1998
 - (n) Control of Substances Hazardous to Health Regulations 2002 (as amended).
- 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 Office of Rail Regulation (HM Railway Inspectorate) Railway Safety Principles and Guidance;
- (ii) The Health and Safety Executive guidance notes and other publications.
- (iii) The Building Regulations 2000 Fire Safety Approved Document B Volume 2 Buildings other than Dwelling houses (Amended 2007).

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

When required by Powerlink, or the designer (if a third party), the supplier shall demonstrate compliance with current relevant legislation and regulations.

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

5 References and Compliance with Standards

Documents are referred to throughout this Specification by title and/or alphanumeric identity. Some are mandatory, others provide information or guidance. Unless specified otherwise, reference should be made to the latest editions.

5.1 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 Powerlink.

5.2 LUL Engineering Standards

The equipment shall comply with the latest edition of applicable LU Engineering Standards where reference is made to them in this Specification.

5.3 Order of Precedence

The order of precedence shall be Powerlink Standards, (including Specifications, work and operating instructions), LU Engineering Standards and then European Standards.



6 Background

Distribution of electrical energy throughout the Underground Network system is provided by a network of high- and low-voltage cables interconnecting a series of substations, switch-houses, transformer-rooms and other similar buildings from which power is supplied to meet particular requirements.

Each of these buildings has requirements in respect of size, constructional features, and the provision of essential facilities. The following sections of this Specification set out relevant details for incorporation into the design and construction of such buildings.

It should be noted that where reference is made in this Specification to typical dimensions, weights, and other measures, these are provided only for the purposes of guidance. Actual values will normally be available for validation at the design stage.

7 Size of Building

7.1 Traction Substations

The floor areas required will vary according to the amount of plant and equipment to be accommodated, but for a typical substation with three indoor-type 2.5MW transformer-rectifier units and associated equipment, the main plant-room shall have an unobstructed floor area of not less than 350 sq.metres, with typical plan dimensions of 35 metres x 10 metres. This shall be the minimum floor size for traction substations.

The headroom shall not be less than 5 metres, although a reduction to 3.6 metres throughout, or over part of the area, may be admissible in certain circumstances. Such circumstances may include the following:-

- i) sites where equipment which produces significant levels of rejected heat can be accommodated external to the main building, (e.g. transformers housed in external bays not requiring special ventilation facilities, or accommodated on outdoor plinths. etc.), and where there are no requirements for the provision of lifting, or maintenance, headroom, or for the accommodation of high-level cable runs.
- ii) sites where levels of rejected heat are not significant and where there are no requirements for forced ventilation, the provision of lifting, or maintenance, headroom, or the accommodation of high-level cable runs.

A building outline of rectangular form with a minimum width/depth of not less than 5 metres is preferable, since additional floor area may be required for the main plant-room if the available space is of an irregular shape.

A cable basement, having a headroom of not less than 2.5 metres, shall normally be provided under the whole of the main plant-room floor. At locations where this requirement cannot be accommodated, either in whole or in part, or is specifically not required, a solid floor with cable trenches may be admissible, however such an arrangement may necessitate an increase in the floor area required for the main plant-room.

Where liquid cooled Auxiliary and Rectifier Transformers are employed, there shall be sufficient space for the accommodation of engineering brick bunds to contain 10% more than the volume of fluid from the largest item within that bund. Additionally, if these liquid filled items are outdoors, they shall be auto-drained with oil/water separators.



Irrespective of which form of accommodation is adopted, sufficient space shall be provided to permit renewal and replacement of equipment as well as a future increase in the total number of cables to be installed. Such provision shall allow an increase for each category of cable, (ie high-voltage, low-voltage, and DC cables, signals, communications, and pilot cables – segregated as appropriate), of not less than one cable, or one-third of the total number of cables to be installed at the outset, whichever is the greater.

Space shall also be provided for the addition of at least one extension panel of switchgear at both ends of each switchboard, as well as storage areas for ladders, spare DC circuit breakers, and test equipment.

7.2 Switch-Houses / Distribution Substations

7.2.1 22kV/11kV Transformer Switch-houses

The requirements specified for a typical traction substation under sub-section 7.1 shall generally apply, together with additional provisions necessary for accommodation of the 22kV/11kV power (coupling) transformers.

Accommodation for these transformers shall normally take the form of segregated outdoor bays, including appropriate provision for catchment of leaked insulating fluid. The number of bays, and the additional space required for these, will vary according to the number of units to be accommodated.

For a typical switch-house with two 15/20 MVA power transformers, an unobstructed area of not less than 75 sq.metres with a headroom of at least 6.5 metres shall be available for the accommodation of two segregated bays, each having dimensions not less than 5m [W] x 7.5m [D] x 6.5m [H].

For 25MVA power transformers, bays of 6m (W) x 9.0m (D) x 6.5m (H) will prove more suitable. It should be noted that, at some locations, additional space may be required for the accommodation of earthing transformers or earthing resistors/reactors, and associated insulating fluid containment (+10%). A typical earthing transformer of 100kVA will be 2100mm (W) x 1100mm (D) x 2150mm (H) of 2750kg weight, containing 800 litres of insulating fluid, and will require a transformer bay of 3000mm x 3500mm with the necessary insulating fluid catchment according to the volume (+10%). In some cases, earthing/auxiliary transformers of increased rating (e.g. 500kVA) may be installed to supply higher auxiliary loads, with correspondingly larger space/containment requirements.

7.2.2 Distribution Substations

The requirements specified for a typical traction substation under sub-section 7.1 shall generally apply, except that the main plant-room shall have an unobstructed floor area of not less than 450 sq.metres, with typical plan dimensions of 30 metres x 15 metres to allow for additional HV switchgear.



7.3 Bulk Supply / Intake Points

These by their very nature have to accommodate the DNO equipment. This equipment will include relays (in separate rooms), tap changing grid transformers with exposed bushings, battery rooms, metering areas, and auxiliary LVAC switchboards. Also likely to be provided are fire suppression systems (at least for oil immersed transformers). Proper building provision for all this equipment shall only be made in liaison with the DNO and/or their appointed design agent for the site concerned.

7.4 Transformer Rooms

Transformer Rooms may not necessarily include cable basements. Where there is no cable basement, the ceiling height must be at least 3600mm to allow top access cabling, otherwise cable trenches may be used.

Where a high voltage switchboard is included and incoming HV cables enter and/or exit at the top of the switchboard, the ceiling height inside the transformer room over the high voltage switchboard shall not be less than 4000mm.

In Transformer Rooms the maximum individual weights of plant employed shall not normally exceed 6.5 tonnes. In all cases checks by a qualified Structural Engineer shall be carried out before adding plant.

Where fluid filled plant is used, continuous bund walls constructed of engineering brick, and sealed with appropriate material, shall be incorporated. These bunds shall be capable of containing the whole fluid of the largest liquid filled item of plant, plus 10%. Separator systems shall be required for external units.

Plant door openings for Transformer Rooms need to accommodate access for Transformers, typically 2100mm high, 2000mm long and 1950mm wide. Switchgear typically shall be 2500mm high with individual cubicles of 800mm width. Over panels shall be incorporated over plant doors where necessary.

7.4.1 Transformer-rooms with HV Switchgear

The requirements specified for a typical traction substation under sub-section 7.1 shall generally apply, except that the transformer-room shall should ideally have an unobstructed floor area of not less than 150 sq.metres, with typical plan dimensions of 15 metres x 10 metres for electrical plant only. Any deviation from these minimum dimensions must be by agreement with Powerlink prior to construction.

7.4.2 Transformer-rooms without HV Switchgear

The requirements specified for a typical traction substation under sub-section 7.1 shall generally apply, except that the transformer-room should ideally have an unobstructed floor area of not less than 100 sq.metres, with typical plan dimensions of 10 metres x 10 metres, for electrical plant only. Any deviation from these minimum dimensions must be by agreement with Powerlink prior to construction.