# G81 Engineering Design Guidance Document

| OWNER | REVIEWERS | APPROVER |
|---|---|---|
| **Head of Technical (HoT) Services** | **Head of Special Projects** | **Designated Engineer** |
| **01-Jun-26** | **01-Jun-26** | **01-Jun-26** |

| | |
|---|---|
| **DOCUMENT NUMBER** | LENL/OPS/SPC/0081 |
| **CURRENT VERSION** | **6.0** |

**VERSION HISTORY**

| VERSION | DATE | REVISION DESCRIPTION |
|---|---|---|
| V1.0 | 19-SEP-2022 | First version of document. |
| V2.0 | 19-JUL-2023 | Material update and additional guidance on multi-occupancy installations. |
| V3.0 | 31-JAN-2024 | Clarification on BS7671, Use of fire dampers, Use of piles for earthing. |
| V4.0 | 19-May-2024 | Rebranding. |
| V5.0 | 29-Aug-2025 | Incorporation of G94 & Emergency Auxiliary Supplies |
| V6.0 | 01-Jun -2026 | Incorporation of Link Box Requirements |

This document forms part of the Leep Utilities Integrated Management System and compliance with its requirements is mandatory. Departure from these requirements may only be taken with the written approval of the above authoriser.

The electronic version of this document is the latest revision. It is the responsibility of the individual to ensure that any paper material is the current revision by referring to the document library on SharePoint. The printed version of this document is uncontrolled.

| Who needs to know? | |
|---|---|
| ☐ All Employees (AE) | ☐ HR |
| ☐ All Managers (MAN) | ☐ IT |
| ☒Asset Management (AM) | ☒Legal (LEG) |
| ☐ Billing (BIL) | ☒Operations (includes AM, PD, SW & WW) |
| ☒Business Development (BD) | ☒Project Delivery (PD) |
| ☒Commercial (CO) | ☒Regulation (REG) |
| ☐ Credit Control (CC) | ☒Senior Leadership Team (SLT) |
| ☐ Customer Service (Includes BIL & CC) | ☐ Shipping Water (SW) |
| ☒Finance (FI) | ☐ Water Wholesale (WW) |

## Contents

## 1. Introduction

This standard provides technical information for Customers, Independent Connection Providers (ICP) and Independent Distribution Network Operators (IDNO) involved in network construction, and extensions downstream of a declared point of connection under Competition-in- Connections.

Contestable work is governed by ENA Engineering Recommendation G81 which provides a technical framework for the design and installation of a network extension and consists of the following parts:

- Design and Planning (parts 1 and 4).
- Materials Specification (parts 2 and 5).
- Installation and Recording (parts 3 and 6).
- Contestable diversionary and reinforcement of underground and overhead works (part 7).

If an Independent Connection Provider (ICP) wishes to undertake the design and installation of a network extension the following requirements shall be complied with:

- Agree the principles of all designs with Leep Electricity Networks Limited during the design process and comply with the relevant industry standards.
- Submission of the proposed design to Leep Electricity Networks Limited for approval should contain the information detailed in Section 6.
- The procurement and provision of equipment and materials in accordance with the host DNO and where applicable, and specified in this document, Leep Electricity Networks Limited specifications.
- Trenching and other preparation of the site, including the circuit routes between the development and the POC.
- Construction of the contestable work.
- Recording work done and recording the location of cable routes and other equipment on site or elsewhere (where those assets are installed by the ICP), and the provision of this information to Leep Electricity Networks Limited.
- Reinstatement (both temporary, and if appropriate, and permanent)
- Making provision for the installation of metering equipment where necessary.
- Reinforcement and diversionary works associated with a connection (subject to limitations and exclusions).

Leep take a hierarchical approach to design, where designs shall, in the first case be compliant with the incumbent DNO. This is of special importance in ‘Close Boundary Conditions’, where the DNO’s equipment is bolted direct to Leeps equipment, for example an RMU close coupled to Leeps transformer. **Note** close coupled conditions can extend beyond a physical connection, and be by virtue of proximity, where the failure of an adjacent item could have a catastrophic effect on the DNO equipment. To ensure that designers do not breach close coupled requirements, the selection of plant and apparatus, used in this environment, must be specified within the incumbent DNO, G81, materials list.

Beyond close coupled conditions, there is some flexibility on design, however deviation from the incumbent DNO spec should be raised, for Leep derogation assessment, via the project PM.

Leeps technical forum review derogations, on a weekly basis. The request can be submitted

using the form shown at Annex A.

Where Leep Electricity Networks Limited requirements are not specified in this document, ICPs should plan to undertake any design work in accordance with the requirements of the HOST DNO. Complying with all appropriate legislation, including those referred to in this document.

ICPs are also required to enter into an adoption agreement with and obtain design approval from Leep Electricity Networks Limited prior to the commencement of construction for the adoption of all plant and equipment. Civil asset adoption requirements will be determined for each design.

If you need further information about the design process, please contact Leep Electricity Networks Limited competition in connections department technicalforum@leeputilities.co.uk.

## 2. Scope

This guidance document applies to ICPs and IDNOs involved contestable network extensions or network construction for adoption.

## 3. Glossary and Abbreviations

| Term | Definition |
|---|---|
| ADMD | After Diversity Maximum Demand |
| BNO | Building Network Operator (Licensed and Unlicensed) |
| DNO | Distribution Network Operator |
| EAC | Estimated Annual Consumption |
| ENA | Energy Networks Association |
| GSP | Grid Supply Point |
| ICP | Independent Connection Provider |
| IDNO | Independent Distribution Network Operator |
| INA | Independent Networks Association |
| LENL | Leep Electricity Networks Limited (IDNO) |
| MPID | Market Participant Identifier |
| | |

### 3.1 Substation Classification and Applicable Standards

| POC/Incoming Voltage | Outgoing Voltage | No Customers | Substation Standard |
|---|---|---|---|
| 132kV | 33kV | Any | Grid |
| 33kV | 11kV | Any | Primary |
| 11kV | 400V | >1 | Distribution |
| 6.6kV | 400V | >1 | Distribution |
| | | | |

## 4. Standards

This section provides an overview of the main standards covering planning, design, materials, installation, commissioning, and records in accordance with ENA ER G81. Specific LENL requirements are listed in section 4 under the appropriate headings.

### 4.1 General

The table below lists the host DNO's operating in license areas across Great Britain.

| DNO Name | Area | MPID | Area ID | GSP |
|---|---|---|---|---|
| UK Power Networks | East England | EELC | 10 | A |
| Wester Power Distribution (National Grid) | East Midlands | EMEB | 11 | B |
| UK Power Networks | London | LOND | 12 | C |
| SP Energy Networks | North Wales and Merseyside | MANW | 13 | D |
| Wester Power Distribution (National Grid) | West Midlands | MIDE | 14 | E |
| Northern Powergrid (Northeast) | Northeast England | NEEB | 15 | F |

| | | | | |
|---|---|---|---|---|
| Electricity Northwest | Northwest England | NORW | 16 | G |
| SSE (Scottish Hydro Electric) | North Scotland | HYDE | 17 | P |
| SP Energy Networks | South and Central Scotland | SPOW | 18 | N |
| UK Power Networks | Southeast England | SEEB | 19 | J |
| SSE (Southern Electric) | Southern England | SOUT | 20 | H |
| Wester Power Distribution (National Grid) | South Wales | SWAE | 21 | K |
| Wester Power Distribution (National Grid) | Southwest England | SWEB | 22 | L |
| Northern Powergrid | Yorkshire | YELG | 23 | M |

## 4.2 Substation Design

### 4.2.1 General

- Dimensions are based on standard switchgear constructed as a close coupled package. Additional space may be required for larger switchgear i.e., larger LV cabinets, and free-standing switchgear.
- All substations to have a securable generator "Cat Flap" either in the doors or wall adjacent to the LV cabinet.
- Small power and lighting is required on all Leep substations.
- A fire risk assessment (may form part of the design risk assessment) will be required where the design deviates from incumbent DNO fire mitigation and protection standards.
- **Installation of Unassigned LV Ways - LV Tails.** All spare LV pillar ways are to be terminated with a pot end the cable at least 3m outside the substation. All Pot ended tails must be a minimum of 300W/C. The selection of 3c or 4c will be as per their approved design. Pot ends are to be left de-energised. Note for High EPR site where sites are defined as high EPR, with HV - LV earth segregation, when installing cable tails with pot ends on spare fuse ways of LV boards, the tails should be of sufficient length to ensure that the Earth Electrode in the pot end is not at risk of transfer potential from the HV Earthing System.
- **Transform Load**. For design purposes, on unadopted sites, Leep's whole life costs are modelled for 95% of the transformer normal rated load. The Loading, size and selection of the transformer must also meet P2 - Security of Supply conditions.

### 4.2.2 GRP Substation

- Site access and land to be secured via lease agreement.
- To have a minimum external clearance of 1m unobstructed space around the base on all aspects.
- Any supply metering to be installed in a separate adjacent, secure, and lockable GRP enclosure dedicated to metering only.
- GRP substations are the preferred method for housing equipment in industrial / commercial and residential sites subject to a design and security risk assessment such as the ESQCR substation design risk assessment, where considered not suitable, other types of substations can be considered.
- The GRP enclosure is to be mounted on a suitable sealant strip in line with the manufacturers requirements to avoid water ingress and damage.
- A blast relief roof shall be installed.

### 4.2.2 Brick Built Substation

- Suitable provisions for blast relief need to be incorporated into the substation design.

- Floors to be painted with a suitable concrete floor sealer or appropriate floor paint.
- Walls and doors to be 4-hour fire rated construction.
- Double front access doors with a 4-hour fire rating will be required. A suitable rear emergency escape door is also required. Exceptions due to location or environment will only be accepted by design approval.
- Louvres to be mounted at low and high level to promote a cross flow of air over the transformer and switchgear. Low level on one side with high level on the opposite side small power and lighting is required on all Leep substations.
- Minimum clearance between the side and rear of any apparatus and wall/structure shall be 600mm.

### 4.2.3 Integral Substation

- Internal space to be a minimum of 4 X 4m with a ceiling height of 2.5m for bottom entry terminations and 3.5m for top entry terminations where approved.
- Transformers to be mounted on anti-vibration pads.
- To be 4-hour fire rated construction
- Fully Louvered doors with a high-level vent where required.
- Dwellings above substations only to be accepted by an agreed design.
- Floor and walls to be painted – floor anti-slip industrial floor paint, Walls white silk.
- Double doors will be required, in some circumstances triple doors may be more suitable.
- Small power and lighting is required on all Leep substations.
- Integral substations **MUST use Midel - 7131 filled transformers**. Alternatives shall be considered by agreement and subject to a design derogation request.
- Minimum clearance between the side and rear of any apparatus and wall/structure shall be 600mm.

### 4.2.4 Basement Substations

- Internal space to be a minimum of 5m X 5m with a ceiling height of 2.5m for bottom entry terminations and 3.5m when top entry terminations are approved. Deviations from this to be accepted by an agreed design.
- To be naturally ventilated where possible
- To be a 4 Hour fire rated construction
- Emergency light fittings near exits and above operational switch gear
- Use of fire dampers must be supported with a fire risk assessment.
- Light fittings where it is possible to be wall mounted at a height suitable for maintenance and repair.
- Floor and walls to be painted – floor anti-slip industrial floor paint, Walls white silk.
- Basement substations **MUST use Midel - 7131 filled transformers.** Alternatives shall be considered by agreement and subject to a design derogation request.
- Clear access and egress routes with adequate lighting
- Small power and lighting is required on all Leep substations.
- Minimum clearance between the side and rear of any apparatus and wall/structure shall be 600mm.

### 4.2.5 Doors

- Doors to be Sunray or similar DNO approved. A set of Leep specifications are available from Sunray by request.
- Wooden doors are NOT acceptable unless there is a specific architectural requirement, and this has been agreed with LENL during the design approval process.
- Panic bars are to be fitted to all operational doors.
- Locking Lugs / Mechanism to be qualified.

### 4.2.6 Ventilation

Natural ventilation should be at the forefront of the design and used wherever possible. Where this cannot be achieved the designer should consult with LENL and discuss other methods with a view to issuing a design for consideration / approval. Any mechanical method of ventilation / cooling must be designed as such that there is a duty and standby arrangement monitored by the customers M&E contractor and maintained and operated by them.

The ventilation should allow enough air change and circulation to ensure the ambient temperature cannot exceed 40 degrees as a maximum.

### 4.2.7 Trenches and Coverings

Trenches are to be covered with either a 38mm or 50mm anti-slip GRP grating, easily removed without the use of tools.

### 4.2.8 Duct Sealing

Ducts are to be sealed using an industry approved duct sealing method to prevent the ingress of water and gases. Expanding foam is **NOT** to be used. Approved sealing methods should be referenced in the design submission for review / approval. A LENL duct sealing guide is available.

### 4.2.9 Plinths

Unless expressly confirmed otherwise all substation plinths shall be constructed out of concrete. Precast slabs are permissible subject to design approval. The plinth shall be levelled and screeded for a uniform plain. The plinth design shall comply with any local authority or building control requirements with respect to oil containment.

## 4.3 Earthing Design

In addition to the host DNO standard earthing design, LENL require a **dedicated LV earth** for each substation. The LV earth is to be directly connected to the earth bar and is to be clearly identified/labelled. The LV earth must be insulated and have sufficient segregation from the uncovered HV earth.

It is understood that this may not be possible in basement locations, to install a separate LV earth, the earthing design should be such that the site is proved to be “COLD” with a EPR value less than that specified in the incumbents DNO earthing documents. The G81 earthing requirements for the Incumbent DNO’s should always be referred to, since some DNO’s specify different values based on whether the LV earthing is SNE or PME. Failure to follow the DNO’s earthing guide and produce satisfactory test results will delay and may prevent the substation from being energised.

Piles are not to be solely relied upon for earthing purposes unless such a design is proved suitable. Earthing connected to sacrificial rods/non-structural parts of piles will be accepted assuming the desired earth values are achieved, and the design adequately demonstrates the connection is to non-structural member. Earthing should be achieved using traditional methods i.e., tape, cable, and earth rods wherever possible.

## 4.4 ENA P2/8 Compliance

All design and networks shall comply with ENA Engineering Recommendation P2/8. Transformers supplying more than one customer are limited to a maximum group demand of 1MW.

## 4.5 Low Voltage Network Design

All LV Networks should be designed and constructed in accordance with the appropriate

standard/sections of the publication(s) listed in Section 11 (National Standards). Please Note this is not an exhaustive list of publications and it is the designer's responsibility to exercise due technical diligence and draw reference to the appropriate standard.

### 4.6 Multi-Occupancy Networks

Design and construction of networks located within multi-occupancy buildings shall comply with ENA G87 which gives guidance on mains and services in multi-occupancy buildings. Networks located within the building that are to be adopted by LENL, are deemed to be an extension of the distribution network. These networks shall be constructed to G81 and G87 standards. **Distribution Network Equipment does not fall within the scope of BS7671**. Networks adopted by an **unlicensed BNO, where equipment is beyond the meter,** falls outside of Leep's scope and are to be designed in accordance with BS7671. Leep will consider adopting networks constructed to BS7671, however these networks will need to be designed to limit "customer minutes lost". To achieve this the system should be designed using J type fuses in place of MCCB's to limit customer minutes lost in the event of a single- phase fault. In a typical multi-occupancy configuration LENL's network ownership ends at the "Red Head" isolation point. All installations after this point and the meter are deemed privately owned.

The number of customers per "Feeder" should be limited to 80.

It is preferred that meters should be in communal meter rooms and/or riser cupboards, with meters located in apartments as a last resort solution. Access and egress arrangements will need to be agreed as part of the network adoption.

Risers and laterals shall be designed, installed and maintained in accordance with BS8313 (code of practice for the accommodation of building services in ducts) and BS9999 (code of practice for fire safety in the design, management and use of buildings) Note, in BS8313 the term "duct" refers to a "space formed for the passage of cables, pipes etc."

Cables shall be easily accessible for the lifetime of the building. Each cable shall only be installed in communal areas of the building and within the individual premises it supplies. Cables shall not be routed through other premises within the building.

Cable routes shall be as short as practical. Voltage drop considerations typically restrict service cables to 30m in length. Sufficient space shall be provided within the housing / trunking to allow cables to be replaced easily. At least 15% additional space shall be allowed for future additions.

It shall be possible to access / replace the cables without removing other cables or services. The minimum distance between the outer surface of any cable and any obstruction shall be 25mm. Cables / cable ducts shall not be run in wall / partition cavities or in lift wells.

Cables shall not be run in the same housing or trunking, which contains sources of heat and shall have sufficient protection from accidental or malicious damage. Each cable shall be marked with the relevant property number at each end and at all additional access points within the building.

Cables shall be secured using appropriate cleats / fixings. New (and replacement) cables to be located in multi-occupancy buildings shall be low smoke zero halogen separate neutral and earth (SNE) type.

### 4.7 Cut-Out & Meter Locations

External meter boxes are the preference for residential supplies allowing unrestricted access for the Network Operator, Meter operator and customer alike. Cut-outs in cupboards under the stairs are **not always** acceptable for safety reasons. If the design of the dwelling offers no other alternative, a suitable designed enclosure should be proposed for review / approval ensuring the cable and cut out are protected from damage. Such approval would be subject to safe working space and access and only considered on a case-by-case basis.
Cut outs **MUST** be mounted on a suitable fire rated meter board. For full specifications on meter locations, refers- Sect 5.15.1 of the INA Low Voltage Design Standards.

Industrial and commercial heavy duty CT metered cut outs should be installed on a solid constructed wall utilising the correct mounting board. The cable entry should be via a minimum of a 100mm (ID) smooth walled duct with a slow bend. Larger cables (185 / 300 mm) will require a 150mm (ID) duct.

### 4.8 Bulk LV Supplies

Supplies greater than 400 A (277 kVA) are to be connected via an ACB or MCCB with appropriated discrimination and protection in conjunction with the customers LV panel and chosen method of protection.

Protection settings for both devices are to be submitted with the design showing the two devices can operate safely and independently of one another within the required parameters. The protection settings are to be set by the ICP for Leep owned equipment prior to energisation.

## 4.9 G94 and the Implications of Multiple Supplies, Fed from Independent Sources, When Installed in the Same Building

**4.91 General Considerations**. G94, in most circumstances, prohibits the installation of x2 supplies, from separate sources, within the same building, because of circulating currents and secondary heating effects. There is also a safety concern, associated with either an attending engineer or the emergency services, being unaware of a second incoming supply. To ensure that the installation of x2 supplies, within the same building, having a common earth, by virtue of: bonding (main, extraneous or supplementary), extraneous conductive parts or the general mass of earth, complies with G94, the building installation must maintain the status of 'separately derived sources' and avoid the situation where the 2 supplies are connected in parallel.

**4.92 Terms and References**. For illustrative purposes, the following terms and references are used.

- Transformer (TX) 1 is the main supply under normal running arrangements.
- TX $2_1$ is the Auxiliary TX, which picks up the Secondary Landlord's Supply (Life Services$_2$).

**4.93 Remaining Compliant**. For designs to remain within G94 compliance, the developers electrical design shall ensure:

- The Auxiliary (TX 2) is restricted to emergency use only and is only connected to the Landlords Secondary Supply when the main TX1 supply fails.
- The supply to the Secondary Landlord circuits, must be fed via an Automatic Transfer Switch (ATS).
- The Secondary Landlords Supply shall only be used to energise circuits which the developer has deemed Life Services$_2$.
- The ATS must ensure that the supplies, from the independent sources (main or secondary), are never connected in parallel.
- The ATS must be 4 Pole. Breaking$_3$ all 3 Phases and the neutral conductor.
- The 4 Pole ATS, in breaking, then making the neutral conductor, should ensure that the reinstatement of the neutral, on any single make, carries the entire neutral current$_4$ for its corresponding phase conductors. **No lost or floating neutrals**.
- The ATS must only be activated if the primary power, to the building, fails. **Note**. the location of the remote monitoring, for the main supply, needs to be considered, thus avoiding a condition, in the building, where any two or more circuits are being energised from different sources. Ensuring that, at any one time, the entirety of the building circuits are, either fed from the main supply, during normal conditions or via the secondary supply, during a loss of the main supply.
- The ATS shall, within the limits of reasonably practicable, shall be located directly above the Secondary Landlords cut-out.
- To avoid any mutual inductance, the Landlords Secondary Supply, inclusive of: incoming LV cable, cut-out and ATS, should be no closer than 2.4m to any: plant, cable, or apparatus, which is normally energised by the buildings main supply.
- In the Substation, and any associated plantroom, where the main supply enters and is terminated into a cut out, there shall be signage posted to notify that there is an ATS installed, along with the appropriate SLD drawing, showing the running arrangements. This notification is to also include the location of the Secondary Landlord's cut-out.
- At the Secondary Landlords cut-out, there shall be signage posted to notify that there is an ATS installed, along with the appropriate SLD drawing, showing the running arrangements. This notification is to also include the location of the main supply.

- **NOTE**. The ICP, if building out the BS7671 circuits, or the developers ME Engineer, if not, will need to demonstrate, to Leep, that the ATS solution avoids back feeding the network. The designing party will be required to provide SLD's and include any control logic and truth table and will be expected to demonstrate its operation on site.

**Foot Notes**.

1. TX2 could be an alternative supply, fed from an LV point of connection or a backup generator.
2. Leep offer a Secondary Landlord Supply, which reliance upon, when used as a Life Service Supply, based on the redundancy, is at the liability of the developer. To be explicit, it is the developer's responsibility to ensure that the secondary supply, has sufficient redundancy as to not fail concurrent to the main supply. This is also a requirement under BS7671. BS7671 is beyond a Network Operators jurisdiction (DNO - IDNO), but a measure to be considered in the developer's electrical design. Please see an extract below.

BS 8519

> *NOTE 2 If the secondary supply is an alternative HV supply from a utility primary network, refer to BS 7671:2018, regulation 560.6.5: "Separate independent feeders from a distributors network shall not serve as electrical sources for safety services unless assurance can be obtained that the two supplies are unlikely to fail concurrently".*

3. Breaking all 3 phases and the neutral conductor, ensures that TX1 and TX2 remain separately derived sources.
4. Noting, for truly balanced loads, no current will flow in the neutral conductor. For purposes of this instruction, it is always assumed that there will be some current in the neutral conductor.

### 4.10 Points of Isolation (SSoW), Network Segregation & Link Boxes.

- **General Requirements - SSoW**. Where Leep do not own the substation, namely where the Point of Connection (PoC) is offered at a closing joint or breech, off the DNO main, then, for Leep Design Acceptance, there needs to be a point of isolation (link box), either at or as close as reasonably practicable, to the closing joint (DNO - IDNO boundary). This enables Leep to instruct ICP's, who are operating under a Transfer of Control (ToC), to work safely and importantly be able to work dead or isolate the main in an emergency. For example, if the works are required to be dead under ENA SHE 01 V3 or where a person is immobile and in contact with the LV network. With respect to maintainability, without a point of isolation, at the DNO-IDNO boundary, any Repairing Contractor, by default and in contrary to ENA SHE 01 v3, will be working live. However, due to the nature of some faults, work may need to be carried out dead.
- **Link Box Policy - Point of Isolation**. Link boxes are to be ideally located in the adoptable, verge section of the highway. Where verge is not available, then the footway shall be used to land the link box. Link boxes shall not be located in driveways, parking bays or carriageway. Link boxes are to be 2 Way and when commissioned, providing the downstream load is not > 200A, closed by the insertion of x3 200A JPU fuses. This will provide coordination with the upstream DNO feed and ensure that faults downstream, of the link box,

are contained on site and thus avoid rupturing the DNO fuse(s). Where the load for the outgoing main and service(s) or service (CT Metred > 138kVA), exceeds 200A, then a solid link shall be inserted. **Note**. In accordance with Leep ACOP 07 - 02, solid links shall never be inserted, if suspected of closing onto a fault.

- **Link Box - Network Segregation**. A 2-Way link box shall be installed to segregate any LV main, fed from a single LV Feeder, which supplies > x80 MPANS or x80 Unmetered Services (UMS), in the case of streetlights and street furniture.
- **Link Boxes - When Not Permitted**. To avoid back feeding a substation, link boxes shall not be installed, for the purpose of paralleling x2 individual substations

## 5.0 Plant Requirements

### 5.1 Materials

Materials are to be Host DNO approved and listed in the design submission. Any deviation from the host DNO specification is to be agreed with LENL in advance of the design submission.

Should a change in plant or material be required during the construction / build programme, a design change request is to be submitted with details of the proposed equipment for LENL approval.

A full list of materials with DNO reference codes should be included in the design submission.

#### 5.1.1 Transformers

- All Unit transformers proposed for use on LENL Networks are to comply with ENATS 35-1
- All transformers for use on LENL networks are to have a fluid drain / sampling tap fitted.
- Transformers within a building or basement to be Midel filled, alternatives to be accepted by an agreed design with an accompanying fire risk assessment.
- If due to design and building constraints a suitable alternative to formal Midel Transformers will be considered, such as Cast Resin, but only by agreement and design approval process.
- Transformers in a coastal area (within two miles of the coastline) to have additional galvanised paint protection to coastal specification as advised by the manufacturer.

#### 5.1.2 LV Cabinet

- All LV cabinets to have “Litton Style” Generator connectors.
- Each LV cabinet shall have ENGRAVED labels and a Fuse way schedule.
- All spare outgoing ways to be tailed to a pot end using 300mm Waveform cable, alternatives to be accepted by an agreed design.
- LV cabinets to be ENATS approved and on a DNO G81 list.
- LV cabinets shall have a schedule dictating cable type, size, and fuse rating and what it is feeding.

#### 5.1.3 Ring Main Units

- Leep will **NOT** accept oil filled RMU’s.
- Where bottom entry equipment is not an option, Top entry “Inverted” HV Termination boxes may be used.

#### 5.1.4 Marker Tape/Tiles

- Tape-tile shall be used for all underground LV and standard HV cable installation.
- Stock boards shall be used for all EHV and stacked HV cable installations.
- Leep branded tape-tile and stock board can be purchased from Centriforce.

#### 5.1.5 Internal Mains & Lateral Services

- All mains cable, installed in buildings, where the room does not meet a 4-hour fire rating, which are greater than 3m and shorter than 10m, in length, shall be wrapped in Arc Tape.
- All mains cable, installed in buildings, where the room does not meet a 4-hour fire rating, that are greater than 10m, shall be of LSoH pattern.
- All lateral services, installed in multiple occupancy buildings, are to be of LSoH pattern.

- All mains cables installed within buildings/rooms with 4hr rating, can be non LSOH, providing the room vents out into a non-public/escape route area.

### 5.1.6 Internal HV Cables

- HV cables installed within the buildings, where the area does not meet a 4-hour fire rating are to be of LSoH pattern.
- HV cables installed within a substation, where the room meets a 4-hour fire rating, can be non LSoH, providing the room vents out into a non-public/escape route area.

### 5.1.7 Plant Replacement and Generation Strategy

As part of the overall design and design submission a plant replacement strategy will need to be submitted detailing the route the plant will take to be replaced, showing dimensions, Gatic hatches, lifting beams etc. where applicable. Consideration should be given to where a generator could be deployed and how generation would be achieved in the event of a major fault requiring generation to maintain customer supplies.

## 6.0 Testing and Records

### 6.1 Testing and Commissioning

Testing and commissioning results can be submitted using the ICP's or Host DNO's standard documentation. A complete testing and commissioning pack to include:

- Plant and Equipment Factory test sheets.
- Site Acceptance Testing/Commissioning.
- Protection grading and settings data.
- EFLI, Voltage, PSCC readings.
- IR and pressure tests.
- Sheath tests.
- Earthing test certificate.
- As laid drawings.
- Protection grading study and settings.

### 6.2 Records / As Laid Plans / SLD's

As laid drawings are to be submitted in dwg and pdf format as part of the technical handover / commissioning pack. The As laid plan must comply with the following:

- Leep templates.
- Table of cable type, length and current carrying capacity.
- Feeder fuse arrangements.
- Service, phase, and feeder allocation.

## 7.0 Design Appraisal and Supporting Information

A complete design submission checklist is available upon request; however, the following minimum information shall be provided by ICPs for Leep Electricity Networks Limited to assess and agree to any proposed network designs.

Designs containing rising and lateral mains shall ensure that the ownership boundaries and responsibilities comply with Leep Electricity Networks Limited Standards and details of the proposed BNO are made available. Design schematics to show the demarcation between IDNO and BNO.

## 7.1 Required Information for Design Appraisal

- Site name with full postal address and postcode.
- A site location map, with grid reference, outlining the site in relation to at least two streets or roads.
- A load schedule listing the property type and required maximum demand.
- Maximum power requirement in kVA for each transformer (where applicable).
- Completed network, civil and electrical designs:
- Design to show cable size, cable depths and cross section along the cable routes.
- Construction drawings where a substation is required, including plant layout, earthing and the small power and lighting.
- List of materials to be used including manufacturer's types and detailed specifications, with reference to UK/EU standards. Health and Safety Plan including the principal designers' details.
- Protection settings incorporating the design study and details of protection devices, relay's, ACB's etc.
- Programme of works.
- Plant replacement and Generation strategy.
- Engineering report.
- Earthing study / report.
- Design Risk Assessment.
- Phasing and build programme.
- Number of customers and connections per circuit.
- Earth fault loop, volt drop and PSCC values per circuit.
- HV and LV Single Line Diagram.
- Fuse type, rating.
- Substation ESQCR risk Assessment.
- DNO POC details and position.
- Designer details.
- Cable types and ratings.
- LV pillar types, rating, number of ways.
- Transformer type, rating, vector group, cooling method.
- S38 Drawing.
- Plot to postal addresses.

### 7.1.1 Legal Agreements

For all sites:

- Name and contact details of the landowner.
- Local authority area.
- Name and contact details of the Solicitor or agent acting for the landowner.
- Rights to be granted.
- Legal drawings and draft legal agreements – substation lease, cable easement drawings and draft legal agreements.
- Planning consents where applicable.
- All drawings to clearly show ownership boundaries.

### 7.2 Power Information (Electrical Design Loads)

Third parties may use comparable software packages available to them provided they can demonstrate they use equivalent data to produce comparable results. The calculated demand is dependent upon the number of connections, the diversity applied and the designer's estimate of annual unit consumption. The INA publish an agreed schedule of After Diversity Maximum Demand (ADMD) loads for dwellings, EV charging and ASHP. These figures, where used, should be referenced as INA Diversified loads in any load schedule. Commercial and industrial load calculations should show the area of each unit and the watts per square metre used along with the diversity factor used if any to show the maximum demand figure.

- Number and type of connections with design loads or ADMD loads.
- Detail of type and load requirement of equipment to be connected, e.g., number and size of motors, cookers, showers, space, and water heating arrangements including details of equipment which is subject to switching by the appointed supplier.
- Maximum voltage regulation % from LV busbars of HV/LV substation to end of main.
- A load schedule showing the number of connections and estimated demand should be issued covering all connections.
- Diversified loads MUST be shown as diversified, and the diversity factor used.

A table as shown below (Table 7-1) should be completed for each distribution transformer.

| Transformer Location / Name | Transformer Rating | Number of Customers Connected | Est Max Demand |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

**Table 7-1 -Typical Customer Distribution Transformer Data**

A table shown below (Table 7-2) should be completed for each LV distribution cable – Number of Customer and connections on each phase.

| Cable Ref No | Number of Customers Connected | R | Y | B |
|---|---|---|---|---|
| 1 | No. Customers | | | |
| 2 | No. | | | |
| 3 | No. | | | |
| 4 | No. | | | |

**Table 7-2 - Typical LV Feeder Usage Chart for Domestic Development**

### 7.2.1 Information for Industrial/Commercial Sites

- Start current of the largest lift or other motors including starter type and frequency of start and frequencies and magnitudes of the harmonic rejection currents (thyristor soft start only).
- All connections shall adhere to ENA-EREC G5/5 Guidance Standards on Harmonic voltage distortion and the connection of harmonic sources and/or resonant plant to transmission systems and distribution networks in the United Kingdom. The impact of any harmonics or generation on Leep Electricity Networks Limited' local network. Dependent upon the type and magnitude of the load a detailed harmonic assessment may be required, the cost of which will be chargeable to the ICP. Voltage fluctuations and fault level increase caused by embedded generation may also be issues which could prevent the connection of embedded generation to some existing networks.
- Details of any proposed generation, PV, Backup generators etc. Please note the customer will be required to submit a G99 / G100 application for planned generation irrespective of export. Back Feed prevention relays are to be used, and tests witnessed by Leep engineers.
- It is the ICP's responsibility to ensure any generation connections are included in the POC application. This will ensure any upstream considerations are applied and mitigate against further delays and costs.

### 7.2.2 LV Distribution Cable

For each distribution cable, the following shall be provided:

- Maximum feeder load per phase in amps.
- Voltage drop for each feeder.
- Earth loop impedance values.
- Service voltage drop for the furthest service.
- Generation (where applicable).
- Number of generators connected.
- Number of customers on each feeder and phase.
- Export capacity per generator.
- Prime mover for each generator.
- Contribution to LV fault level per generator.

### 7.2.3 Motors

Information to be provided where motors are intended to be connected onto LENL distribution network.

- No of Motors
- Motor Size (kW)
- Motor Connection Voltage
- No of Phases
- Duty Cycle as number of starts per hour.
- Method of Starting
- Starting Current (Amps)
- Full Load Current (Amps)

### 7.2.4 Typical Domestic Customer Loads

ICP's and their respective designers are to submit their demand calculations as per their design load with ADMD applied.

### 7.2.5 Typical Commercial Customer Loads

Commercial loads tend to be speculative and based on W/m$^2$, this approach is acceptable providing the developer includes the building load in kW.

## 7.3 Network Characteristics

### 7.3.1 Earth Loop Impedance - Cut Out

Maximum Earth Fault Loop Impedance for services (for sites to be adopted by Leep Electricity Networks Limited) are tabled below.

| Serial | Service Head | Pass Criteria 1 & 3 Phase Services |
|---|---|---|
| 1. | ELI - 100A Service Cut Out | SNE: 0.8 Ohm |
| | | CNE: 0.35 Ohm |
| 2. | ELI - 200A Heavy Duty Cut Out | 0.35 Ohm |
| 3. | ELI - 400A Heavy Duty Cut Out | 0.2 Ohm |
| 4. | ELI 600A Heavy Duty Cut Out and over (Solidal' s) | 0.15 Ohm |

**Table 7-3 - Maximum Permissible ELI**

### 7.3.2 Earth Fault Loop Impedance - Network Design

To the end of the domestic services, this shall not exceed 250 milli-ohms. Where this is unachievable the maximum Earth Loop Impedance permissible at the service cut out position is 300 milli- ohms, with individual service calculations undertaken as needed. This shall only be considered where the upstream LV POC offered exceeds 200 milli-ohms and other steps to reduce the Earth Loop Impedance, such as shorter routes and increased cable sizes, have already been exhausted. For other services, refer to the requirements of ENA ER P23.

### 7.3.3 Maximum Service Volt Drop

Maximum Service volt drop between LV main and service cut-out shall not exceed 2%.

Maximum Voltage rise at Point of Common Coupling (POCC) where embedded generation is to be installed shall be no greater than 2%.

**Looped services for domestic customers shall not be installed on new LV networks.**

### 7.3.4 Maximum Voltage Unbalance

To ensure compliance with ENA ER P29, the maximum voltage unbalance, at any point, shall not exceed 1%.

### 7.3.5 General Design Information for Circuits

For each service/feeder:

- Maximum earth loop resistance (ohms) at cut-out position/feeder end.
- Fuse sizes selected (amps).
- Maximum clearance time (seconds):
- For phase-to-earth fault at the remote end.
- For phase-to-phase fault at the remote end (3Ø supplies). For each service:

- Cut-out fuse size selected (amps).
- Service earthing (PME, TT, etc.).
- Design prospective short circuit current at LV busbars of HV/LV transformer (kA).
- Maximum design prospective short circuit current at connection of service to main (kA), where applicable for:
    - 1ph 230V 16kA
    - 3ph 230/400V 25kA

## 7.4 Substations

**7.4.1** To ensure**:**

**Leep Policy for Design and Security Specifications for Operational Sites** All designs, shall include an ESQCR risk assessment on the location of the substation and its appropriate enclosure type e.g., brick built, to comply with the perceived risk in area, flood risk etc. ICP's and Developers, when considering design and security requirements for operational sites, are to firstly refer to the incumbent DNO's authoritative documents. These are available, free from their G81 libraries. All measures which are deemed as: 'expected as normal security provision' or are 'mandatory', are to be incorporated into the design. In addition, for areas where crime and vandalism are prevalent, those DNO specified measures, based on the higher risk, must also be incorporated into the substation installation. Leep may not be fully aware of these increased security measures during the initial design approval and may only become evident during the build. If during the build and prior to asset adoption, additional security measures are required, then the building ICP or developer will be responsible for the provision and installation of such items. Leep substations must meet the **mandatory/expected standards** as a minimum and subject to the neighbourhood may require additional security measures. This security assessment would also extend to cable bridges and cable tunnels.

**7.4.2** A substation construction drawing showing detail of transformer plinth, foundation, duct entry, ventilation, earthing, power and lighting and access arrangements.

**7.4.3** Plant with manufacturer type, specification, and proposed layout within the substation with dimensions.

## 7.5 Cable Layout and Information

A site layout to an appropriate standard scale to show sufficient detail overlaid with the proposed main and service cable design. The drawing should indicate the:

- Cross sectional size type of each main and service cable.
- Cross sectional make up of bedding and blinding material.
- Location and size/type of ducts to be used, location.
- Rating of substations and location of link boxes.
- Cross sectional drawing showing circuit grouping and identification.
- In addition, highway/footway to be adopted by local authority should also be clearly indicated.

- A single line operational diagram indicating ownership boundaries shall also be provided.

## 8.0 Primary Substation

All primary substations are to be designed to the host DNO specification incorporating host DNO G81 approved equipment. SCADA shall be included at all primary substations; a full signal list shall be agreed as part of the design appraisal process. All SCADA systems shall have a dual connection (Broadband and 4G failover), where this is not permissible alternatives shall be agreed with LENL.

Specifications for SCADA (I/O's, Analogues and Control signals) are available from your PM. Leep will insist on an RTU, being built by Nortech, incorporating an iHost software platform. Amongst Leeps generic monitoring signals, the SCADA must be capable of remotely actuating, from Leeps Control, via iHost, all NGET Grid Code OC6 (5.3) Demand Control signals. Namely, Disconnections and Voltage Reductions. Where these measures shall be initiated within 2 minutes and completed within 5 minutes for Disconnection and 10 minutes for voltage reduction. **Note** in order to effect Voltage Reductions (VR), your design solution will need to consider the interoperability of the transformer(s) auto tap changers and the RTU. Having the ability to initiate the VR, then retrospectively return the circuit to normal running conditions (automatic).

**General Considerations**. All sites shall have the following but are not limited to:

a. Security Alarm fitted with auto dialer for intruder notification.
b. Heating with thermostatic control.
c. Dehumidifier with permanent drain.

## 9.0 Unmetered Supplies

Leep will provide unmetered supplies in the following circumstances, in line with 'The Electricity Unmetered Supplies Regulation':

d. The load is of a predictable nature.
e. The load is below 500 watts per inventory item.

The type of installation which can be unmetered includes street lighting under solar cell control, street signs, bollards, surveillance cameras and traffic monitoring systems etc. Leeps Technical design standards for unmetered supplies and street furniture are detailed in a separate 3rd Pty guidance document.
Reference should be made to the Elexon list to determine whether an item of street furniture can be given an unmetered supply.

Normally this type of supply will be provided to an installation which will be adopted and maintained by the Local Street lighting Authority.

The ICP shall include the streetlighting design, inclusive of the UMS inventory (charging codes and switch regimes), and any section 38 drawings, and details of the adopting local authority.

Following assessment by Leep, and in its capacity as a USMO, Leep will issue a Connection Agreement and MPAN(s) accordingly. The ICP must not energise until the UMS are registered with a supplier for billing.

## 9.1 UMS Submission Requirements

- Classes of equipment.

- Maximum demand per item(s).
- Drawing showing locations and equipment.
- Switching Regime where applicable i.e. Street lighting and street furniture operational duration.
- Design details, cable type, run, volt drop, PSCC, EFLI Calculations.
- Charge Codes.
- UPRN.
- S38 Drawing.
- Feeding arrangements.

## 10. Embedded Generation

Any generation unit connected or intended to be connected, with the capability of exporting (inclusive of nil export schemes) must be declared to LENL prior to energisation (G99 and G100).

LENL recommend the ICP includes any intended generation in the POC application process to the host DNO. Retrospective export applications can increase costs and delay energisation significantly. It is also recommended due to the increase in network constraints and lower voltage levels.

The ICP shall submit a copy of the ENA generation application form and supporting documentation.

Leep cannot issue an export MPAN or sign off any G99 applications, until the import MPAN is live and the supply is energised.

Generation connections and applications will be subject to upstream notification and may invoke upstream reinforcement works up to transmission level. Dependent on the size of embedded generation, the export may be subject to Gate 1 and Gate 2 approval.

Types of Power Generating Module are defined in Engineering Recommendation G99 and repeated below:

f. **Type A:** A Power Generating Module with a Connection Point below 110 kV and a Registered Capacity (i.e., rating) of 0.8 kW or greater but less than 1 MW.
g. **Type B:** A Power Generating Module with a Connection Point below 110 kV and Registered Capacity of 1 MW or greater but less than 10 MW.
h. **Type C:** A Power Generating Module with a Connection Point below 110 kV and a Registered Capacity of 10 MW or greater but less than 50 MW.
i. **Type D:** A Power Generating Module with a Connection Point at, or greater than, 110 kV; or with a Connection Point below 110 kV and with Registered Capacity of 50 MW or greater.

For all G99 network assessments > 50kW these will require modelling both by Leep and the upstream DNO, to assess the aggregated effects of the new and existing generation connections, on the local network, at the DNO/IDNO boundary. Due to the effects of thermal overload and contributory fault current, upstream DNOs may specify a flexible export connection under the control of the DNO's Network Management Centre (NMC). The NMC will then have the ability to curtail or even isolate the generation during periods of thermal stress, during faults or when a circuit is running in abnormal conditions.

**10.1 Flexible Generation Connections**. Where generation exports are >200kW or where an Export Limitation Scheme (ELS) is restricting the export to less, but the generation is greater than 500kW, then most DNO's will insist on (non-contestable item), providing and installing an RTU, typically in the boundary substation. The RTU will not affect import, but will be under the control of the local DNO's Network Management

Centre, who under flexibility, will be able to back off or even stop generation, where there are abnormal running arrangements, and fault currents could exceed design loads (thermal stress), or where there is a fault on the DNO network and embedded

generation is contributing to the fault current. Designing ICP's or developers are to refer to the incumbent DNO's **Flexible Connections for Demand and Generation** policy to ensure their embedded generation is compatible and the correct control cabling, from the generation, to the RTU is installed.

**10.2 Gate 1 and Gate 2 Approval**. Small and medium G99 connections, >1MVA, in UK, less Scotland, these will require DNO or TNO Gate 1 and Gate 2 approval. Lower limits are applied in areas of Scotland and NI. Refer standards to NESO for details.

For G98 connections, where the OP is less than 16A per phase, these can be assessed on the ENA Connect Direct site and providing they meet compliance are connected under a 'Connect & Notify' regime.

## 11. National Standards (Including but not limited to)

| | |
|---|---|
| ESQCR | Electricity, Safety, Quality & Continuity Regulations 2002. |
| ENA EREC P2 | Security of Supply. |
| ENA P5 | Design Methods for LV Underground Networks for New Housing Developments. |
| ENA ER P23 | Guidance on Earth Fault Loop Impedance at Customers' Intake Supply Terminals. |
| ENA EREC P25 | The short-circuit characteristics of single-phase and three-phase low voltage distribution networks. |
| ENA EREC P28 | Planning limits for voltage fluctuation caused by industrial, commercial and domestic equipment in the UK. |
| ENA ER P29 | Planning Limits for Voltage Unbalance in the United Kingdom. |
| ENA EREC G12 | Requirements for the application of Protective Multiple Earthing to LV networks. |
| ENA ER G81 | Part 1: Design and Planning. Framework for Design and Planning, Materials Specification, Installation and Records for Low Voltage Housing Development Installations and associated new HV/LV Distribution Substations |
| ENA ER G81 | Part 2: Materials Specification. Framework for Design and Planning, Materials Specification, Installation and Records for Low Voltage Housing Development Installations and associated new HV/LV Distribution Substations |
| ENA ER G81 | Part 3: Installation Records. Framework for Design and Planning, Materials Specification, Installation and Records for Low Voltage Housing Development Installations and associated new HV/LV Distribution Substations |
| ENA ER G81 | Part 4: Framework for Design and Planning of Industrial and Commercial Underground Connected Loads up to and including 11kV. |
| ENA ER G81 | Part 5: Framework for Materials Specifications for Industrial and Commercial Underground Connected Loads up to and including 11kV. |
| ENA ER G81 | Part 6: Framework for Installation and Records of Commercial and Industrial Underground Connected Loads up to and including 11kV. |
| ENA ER G81 | Part 7: Framework for Contestable Diversionary and Reinforcement Underground and Overhead Works not exceeding 33kV and HV/LV Distribution Substations. |
| ENA ER G87 | Guidelines for the Provision of Low Voltage Connections to Multiple Occupancy Buildings. |
| ENA ER G88 | Principles for the Planning, Connection and Operation of Electricity Distribution Networks at the Interface between DNOs and IDNOs. |
| ENA ER G94 | Managing the Risks Associated with the Provision of Multiple Connections in Close Proximity |
| ENA EREC G98 | Requirements for the connection of Fully Type Tested Micro- generators (up to and including 16 A per phase) in parallel with public Low Voltage Distribution Networks on or after 27 April 2019. |

| | |
|---|---|
| ENA G99 | Requirements for Connection of Generation Equipment in Parallel with Public Distribution Networks on or After 27 Apr 2019. |
| ENA G100 | Technical Requirements for Customers' Export and Import Limitation Schemes. |
| ENA EREC G103 | Generic industry risk assessment and asset management approach for Low Voltage termination equipment. |
| ENA ER G5-5 | Harmonic voltage distortion and the connection of harmonic sources and/or resonant plant to transmission systems and distribution networks in the United Kingdom. |
| INA | (ETSC DES-001) Low Voltage Design Standards. |
| BS 7671 | IET Wiring Regulations. |

## 12. Annex A to G81 Engineering Design Guidance Document

Title: Leep Operations Derogation Form V3.0

| Date of submission | Requester Name | Target Return Date |
|---|---|---|
| | | |

| Document/Process Number | Version | Document Owner |
|---|---|---|
| | | |
| **Details of changes to be made** | | |

| **Impact of Change** | |
|---|---|
| **Impact of existing document remaining unchanged** | **Impact/Benefit of change request** |
| | |
| **To support your request for change. Please provide a cross reference or link to an authoritative or policy document.** | |
| | |

**Leep Internal**

**TO BE COMPLETED BY DOCUMENT/PROCESS/SYSTEM OWNER**

| Accepted/Rejected | Decision by: | Signature | Date |
|---|---|---|---|
| | Document Owner | | |
| | Process/System Owner | | |
| | Action Owner | | |
| | Director | | |
| **Comments** | | | |
| | | | |