

Engineering Recommendation **G81 - Part 6**

Issue 1

Amendment 1 – January 2008



energy**networks**
association

Framework for Installation and Records of Commercial and Industrial Underground Connected Loads up to and including 11kV



© 2008 Energy Networks Association

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written consent of Energy Networks Association. Specific enquiries concerning this document should be addressed to:

**Engineering Directorate
Energy Networks Association
18 Stanhope Place
Marble Arch
London
W2 2HH**

This document has been prepared for use by members of the Energy Networks Association to take account of the conditions which apply to them. Advice should be taken from an appropriately qualified engineer on the suitability of this document for any other purpose.

© Energy Networks Association 2008

Engineering Recommendation G81 Part 6 Issue 1

Amendment 1: January 2008

Summary of Amendments:

Reference to Electricity and Pipe Line Works (assessment of environmental effects) Regulations removed

Reference to Electricity Works (Environmental Impact Assessment) (England and Wales) Regulations changed to refer to the document amended in 2007

Reference to Electricity Safety Quality and Continuity Regulations 2002 changed to refer to document amended in 2006.

CONTENTS

1	BACKGROUND	3
2	SCOPE	3
3	REFERENCES	4
3.1	Energy Networks Association / ESI publications.....	4
3.2	Energy Networks Association Technical Specifications (ENATS)	4
3.3	National Joint Utilities Group (NJUG) publications	4
3.4	Health & Safety Executive (HSE) publications	5
3.5	Pooling & Settlement Agreement	5
3.6	Ofgem approved publications.....	5
3.7	British Standards	5
4	LEGISLATION	5
5	DEFINITIONS and ABBREVIATIONS	7
6	INTRODUCTION	8
7	INSTALLATION	8
7.1	General	8
7.2	Underground cables	8
7.3	Plant.....	10
7.4	Service entries.....	11
7.5	Multi- occupancy dwellings	11
7.6	Work in contaminated land.....	13
8	RECORDS	14
9	TESTS.....	14
	APPENDIX A: TEST REQUIREMENTS	15
	APPENDIX B: HOST DLH REQUIREMENTS – <i>Typical Example Only</i>	16

1 BACKGROUND

- a. This document was agreed by the Ofgem Electricity Connections Steering Group on October 12th 2004. This revision extends the scope to include previously developed (“brownfield”) sites as well as the “Greenfield” sites previously covered.
- b. If there are queries about this document please discuss them with the Host DLH in whose area it is proposed that work is to be undertaken. In the event that it is not possible to resolve the question with the Host DLH, please seek advice from Connections Policy Team, Ofgem, 9 Millbank, London SW1P 3GE.

2 SCOPE

- a. This document sets the installation and record requirements for low voltage, 6.6kV and 11kV underground industrial and commercial connections, including their new associated HV and HV/LV distribution substations. It is one of the following suite of documents governing this work:
 - Adoption Agreement
 - Design and Planning framework (ER G81 Part 4)
 - Materials Specifications framework (ER G81 Part 5)
 - Installation and Records framework (ER G81 Part 6)
 - Underground unmetered connections framework
- b. This document must be read in conjunction with these documents as some issues, for example equipment ratings, are dependent both on specification and the manner in which their use is designed or installed.
- c. For requirements relating to underground connected housing developments, see Engineering Recommendation G81 parts 1, 2 and 3.

NB This suite of documents applies only to NEW installations and is not to be applied retrospectively

- d. It is intended to set out or make reference to design and planning requirements which have to be met for a Host DLH to adopt contested HV and LV networks and their associated new HV and HV/LV distribution substations supplying industrial and commercial loads connected up to and including 11kV.
- e. This document is intended to supplement but not amend, abridge or override any legislation referred to within this document.

3 REFERENCES

This document makes reference to the documents listed below, which must be complied with unless otherwise agreed in writing with the DLH. The latest editions of these documents including all addenda and revisions shall apply unless otherwise agreed with the DLH.

3.1 Energy Networks Association / ESI publications

ENA documents can be obtained via the ENA web site: www.energynetworks.org

Engineering Recommendations (ER)

G12/3	Requirements for the application of protective multiple earthing to low voltage networks
G17/3	Leakage of flammable gases recommendations
G39/1	Model code of practice covering electrical safety in the planning installation commissioning and maintenance of public lighting and other street furniture

3.2 Energy Networks Association Technical Specifications (ENATS)

ENATS 12-03	Outdoor meter cupboards
ENATS 12-23	Polythene protection tape for buried electricity supply cable
ENATS 12-24	Plastic ducts for buried electric cable
ENATS 37-2	LV distribution fuseboards
ENATS 41-24	Guidelines for the design, installation, testing and maintenance of main earthing systems in substations.

3.3 National Joint Utilities Group (NJUG) publications

NJUG 4	The identification of small buried mains and services
NJUG 7	Recommended positioning of Utilities apparatus for new work on new developments and in existing streets
NJUG 10	Guidelines for the planning, installation and maintenance of utility services in proximity to trees.

3.4 Health & Safety Executive (HSE) publications

HS (G) 47 Avoiding danger from underground services

GS 6 Avoidance of danger from overhead electric power lines

3.5 Pooling & Settlement Agreement

Agreed Procedure – Unmetered Supplies Registered in PRS Vol 5 AP 520 Issue 3 -
now BSCP 520.

3.6 Ofgem approved publications

Distribution Code

Distribution Licence Conditions

3.7 British Standards

BS 7671 Requirements for Electrical Installations (IEE Wiring Regulations 16th
edition)

4 LEGISLATION

All requirements of all relevant legislation must be met. The following is a list of
some of the relevant legislation:

Ancient Monuments and Archaeological Areas Act 1979

Asbestos at Work Regulations 2002

Building Regulations (and its related current Approved Documents)

Confined spaces regulations 1997

Construction (Design Management) Regulations 1994

Construction Health, Safety & Welfare Regulations

Contaminated Land (England) Regulations 2000

Control of Substances Hazardous to Health Regulations 1999

EC Utilities Directive 93/38/EEC and UK SI 1996 No 2911

Electricity Act 1989 as amended by the Utilities Act 2000; and the Distribution Code which is given legal authority by the provisions of the Public Electricity Supply Licence issued under it.

Electricity Safety Quality and Continuity Regulations 2002 as amended 2006 (and associated Guidance issued by the DTI)

Electricity at Work Regulations 1989

Electricity Works (Environmental Impact Assessment) (England & Wales) Regulations 2000, as amended 2007

Environmental Protection Act 1990 & 1995

EU Habitats Directive 92/43/EEC – Special Areas of Conservation

Fire Precautions Act 1971

Fire Precautions (Workplace Regulations 1997 as amended 1999)

Health & Safety at Work etc Act 1974

Land Drainage Act 1991

Lifting Operations and Lifting Equipment Regulations 1998

Management of Health & Safety at Work Regulations 1999

Manual Handling Operations Regulations 1992

New Roads and Street Works Act and all related Codes of Practice and Specifications

Noise at Work Regulations 1989

Provision and Use of Work Equipment Regulations 1998

Town & Country Planning Act – General Development Order 1990

Water Resources Act 1991

Wildlife and Countryside Act 1981

Workplace Health, Safety and Welfare Regulations

5 DEFINITIONS AND ABBREVIATIONS

OFGEM	Office of Gas and Electricity Markets
ADMD	After Diversity Maximum Demand
Applicant	The Company wishing to undertake the contestable work
BSI	British Standards Institution
BS	British Standard
BS EN	A European Standard adopted as a British Standard
CDM	Construction (Design Management) Regulations 1994
CNE	Combined neutral and earth (of cable construction)
Applicant	The Company wishing to undertake the contestable work
DLH	Distribution Licence Holder – defined in Standard Licence Conditions for Electricity Distributors, issued under the Utilities Act and effective from 1 st Sept. 2001
DSA	Distribution Service Area – the service area of a DLH
EA	Electricity Association (replaced by ENA for Networks issues post Oct 2003)
ENATS	Energy Networks Association Technical Specification
ENA	Energy Networks Association
ER	National Engineering Recommendation issued by ENA or EA
ESQCRs	Electricity Safety Quality and Continuity Regulations 2002, as amended 2006 (and their associated Guidance documents issued by DTI)
HD	Harmonised Document (IEC standard adopted as a European reference document)
Host DLH	The DLH in whose licensed area (DSA) the works are to take place
Housing development	A development consisting of domestic dwellings
HSE	Health & Safety Executive
IEC	International Electrotechnical Commission
NRSWA	New Roads and Street Works Act
PSCC	Prospective Short Circuit Current

6 INTRODUCTION

- a. This framework describes installation test and records requirements for low voltage, 6.6kV and 11kV underground industrial and commercial connections, including their new associated HV and HV/LV distribution substations.
- b. This document is subject to some local variation between DLHs because, for example, of differences in:
 - substation specification
 - environment and impact on ratings, insulation, corrosion etc
 - compatibility with existing equipment
- c. Where a deviation from this framework is identified, it will be stated in the Appendices to this Technical Framework document.

7 INSTALLATION

7.1 General

- a. The installation of all plant and equipment to be adopted by the Host DLH shall meet the requirements of the listed references, all applicable legislation and the details in this section. It must be noted that ratings will be influenced by the installation arrangement and reference shall be made to the "Design and planning requirements framework" document (ER G81 Part 4 and Appendices) regarding equipment ratings.
- b. All plant and equipment installed shall comply with the requirements of the "Materials specification framework" document.
- c. The installation shall be such as to permit future live low voltage working on the asset by the Host DLH.

7.2 Underground cables

- a. There shall be no material change to routes (to the extent that it affects design criteria) detailed in previously submitted plans unless otherwise agreed in writing with the Host DLH and other interested parties.
- b. Cable laying depths shall be as NJUG 7, unless otherwise agreed, and shall be recorded.

- c. Trenches shall be prepared so that the bottom of the trench is free of rubble, sharp stones, flint etc., and an adequate layer of stone dust or other suitable bedding has been laid. Where a change of level is necessary, the bottom of the trench shall rise or fall gradually.
- d. Ducts shall be laid at least 300 mm below the carriageway construction and shall extend to the outer extremities of the kerb haunchings. Checks shall be made that all installed ducts are undamaged and are not obstructed (including any ducts laid as spare for future use). Duct mouths shall be sealed to prevent ingress of water, noxious or explosive liquids or gases. Ducts shall be suitably spaced to avoid congestion at either end to facilitate future jointing. Spare ducts shall be installed by the Applicant at positions agreed with the Host DLH.
- e. Wherever possible, cables should be laid by hand. If a winch is employed to pull the cable, rollers and skid plates shall be used in the trench to ensure that the cable does not touch the ground during pulling. A cable stocking, fitted with a swivel, must be used to connect the bond to the cable and a dynamometer used to check that the maximum pulling tension for the cable is not exceeded.
- f. Cable laying shall only take place when the ambient temperature is above 0° C and has been above this temperature for the previous 24 hours. Alternatively, special precautions shall be taken to maintain cables above this temperature to avoid risk of damage during handling.
- g. Cables shall not be bent further than their minimum bending radius.
- h. The cable shall be correctly spaced from other cables and other utility services, in accordance with NJUG specifications.
- i. Earth conductors and rods shall be laid in accordance with the previously submitted plans. Note should be taken of the requirements of ESQC Regulation 9 (2) (a) on the need for earths at the remote end of the main, during each stage of the energisation programme.
- j. Before backfilling a visual inspection shall be carried out to ensure the cable is free from damage. After laying the cable shall be backfilled with suitable graded fine fill material to tape level and the correct marker tape laid, in compliance with The Electricity Safety Quality and Continuity Regulations 2002 and Host DLH policy.
- k. Jointing materials comply with Host DLH specification or an agreed equivalent.
- l. Jointing practice shall be in accordance with a specification agreed with the Host DLH.

- m. Joints shall be made 'Colour True' or R - 1, Y - 2, B - 3, unless agreed otherwise with the Host DLH. DLHs are currently seeking to establish programmes with their cable suppliers for the managed introduction of the new European harmonised cable colours (Black, Brown, Grey phases with Blue Neutral). This should be discussed with the Host DLH.
- n. Cable terminations shall be made with correct phase connections.
- o. Service connections shall be made to the correct phase as shown on network drawings. The numbers of services taken from a single joint shall not exceed the number agreed with the Host DLH; that number being the maximum the Host DLH would accept for work undertaken directly on its own behalf.
- p. Where a DLH employs such a system, a unique permanent labelling system shall be applied to the joint giving the jointers name.
- q. The Applicant must provide a Completion Certificate, signed by the jointer, for each joint made. These shall be kept in the Construction File, together with copies of the inspection forms.

7.3 Plant

- a. Specifications of HV/LV distribution substations and HV switchboards and other equipment such as protection, SCADA, and battery systems shall follow Host DLH standards detailed in Appendix B. This may include such issues as layout, enclosure type, Electricity Safety Quality and Continuity Regulations and associated Guidance security requirements, internal arc relief etc.
- b. LV ac supply arrangements to substations shall be agreed with the Host DLH.
- c. Requirements on batteries such as location, ventilation, type, sizing, life and nominal voltages shall be discussed with the Host DLH unless these are fully set out in Appendix B.
- d. Requirements for accuracy testing of metering CTs and VTs , certification and hand over of documentation need to be agreed at an early stage, having regard to the requirements of BSCP 520. Care is required to ensure necessary testing and certification requirements are met before CTs and VTs are built into equipment as long delays may otherwise be caused.
- e. Plant delivered from manufacturers shall be unloaded and stored in a way that avoids damage or exposure.
- f. The Host DLH shall supply plant and substation numbering signage, property ownership and Danger of Death signs prior to energisation.

7.4 Service entries

- a. Service entry policy may vary between DLH's – see information in Appendix B of "Design and planning framework" document for details.
- b. Cavity service entry shall not normally be permitted as this de-rates the service cable.
- c. If alternative arrangements are considered the following shall be taken into account:
 - The air temperature surrounding the cut out must not exceed 30°C.
 - All meter cabinets must be installed in a way that maintains the manufactured fire resistance values.
- d. Service ducting shall be installed from the service position to the point where the service cable will be jointed onto the main. The service cable shall be drawn by hand into this duct. Black duct shall be used for electrical service cables, to prevent confusion with other utility services.
- e. The Applicant shall provide phase marking on cut out terminals.

7.5 Multi- occupancy dwellings

- a. The following additional clauses apply to installations for multi-occupancy premises such as offices, and shops. There are a number of different approaches which are employed in various DLH service areas on the design of connections to multi-occupancy premises. The following paragraphs describe the most common practices, not all will necessarily be accepted by Host DLH; refer to Appendix A for any Host DLH variations.
- b. LV cable entry to building – approved rigid black duct or fireclay duct with slow radius bend, minimum bending radius 900mm, 150mm inside diameter, with drawcord for each incoming mains cable to area clear of building and any concreted area, buried with minimum 450mm cover overlaid with marker tape and into drawpit in termination enclosure 700mmD, 1000mmL 450mmW. Some DLHs do not employ drawpits and use duct as described above to area clear of building and any concreted area.
- c. LV intake position accommodation - Developer to provide suitable secure and fire proof enclosure for cut out and distribution board (when required) in suitable common access location on ground floor minimising route length to exterior and which provides suitable cable routes, meter position and exit points for each dwelling.

- d. Communal LV meter / service enclosures shall not be used for other purposes posing increased risk to equipment, risk of fire or risks to operatives. The size of the LV enclosure is dictated by the equipment installed and the need for adequate working space. There shall be a minimum of 300mm separation to any gas meter or gas pipe joints. The average temperature shall not exceed 30C.
- e. Where the building entrance is closed for security reasons or there is no alternative means of escape, the LV enclosure should be sited adjacent to an external wall and be accessible from outdoors. HV substations shall be arranged to be in a separate building or on an outside wall unless otherwise agreed with the Host DLH. Outside doors shall be lockable, weatherproof and vandal resistant. See Appendix B for Host DLH requirements on locks.

f. Lateral connections:

The developer is responsible for the design, construction and installation of the service cable routes within the building. The design route / cable length used to calculate voltage drop shall not be exceeded.

- g. Service cables must not be routed through individual (non common space) premises other than the one being served. Mains shall not be routed through premises. The routes selected within the building must ensure that after installation cables are accessible for withdrawal / replacement without damage to the building.
- h. Mains and service cables must not be in the same duct as non electrical services. Where not ducted it must be clipped to cable tray. Where a multi-service shaft is provided, the electrical installation must be compartmented to provide a fire barrier from the other services. Every vertical duct, shaft or trunk must have internal barriers to prevent excessive heat rise at the top. The maximum separation between barriers is 1 floor or 5 metres, whichever is less. After installation of cabling the developer shall carry out fire stopping using materials such as cement mortar, gypsum based plaster, cement or gypsum based vermiculite / perlite mixes, intumescent mastics, proprietary sealing systems, rockwool or as specified differently by the Host DLH in Appendix B. The method of ducting should be agreed with the Host DLH taking account of the derating factor of the current carrying capacity of the cables.
- i. If service or mains cables pass through a part of the building required to have a minimum fire resistance period, the installation must maintain the integrity of the fire resistance. Minimum fire resistance periods are listed in the Building Regulations, to which reference must be made.

j. LV Meter positions:

- 1) Meter cabinets shall be fire resistant, and of a type approved by the Host DLH. Meter positions shall be accessible from communal areas. Meters should be positioned so that they are installed not less than 450mm and not more than 1800mm from the floor.
- 2) Meter positions shall either be separated by 2 metres, effectively screened or effectively bonded against the risk of electric shock by simultaneous touch under earth fault conditions.
- 3) LV group meters and switchgear must be clearly identified to the appropriate dwelling by a secure label supplied and installed by the Developer.

k. Bonding:

- a. Bonding of electrical installations must be in accordance with BS 7671. The Developer shall ensure that PME bonding shall include bonding to metal services as close as possible to their point of entry into the building and to accessible steelwork.
- b. Each premises shall be regarded as separate and treated in the same way as individual houses, irrespective of any bonding carried out elsewhere, e.g. where communal services enter the building.

7.6 Work in contaminated land

Where work is to take place in contaminated land, special precautions will need to be established, to cover in particular, the following:

- Prevention of the creation of pathways, for example by trenching, allowing the movement of contamination
- Prevention of damage or reduction in normal life of assets as a result of contamination, e.g. by the removal of contamination, creation of barriers or use of specific resistant materials
- The CDM file shall include: details of the contamination survey, worker risk mitigation both during installation and during subsequent service life to asset removal.

8 RECORDS

- a. It shall be the responsibility of the Applicant to provide the Host DLH with accurate records of the installation. These records shall include:
 - For all installed cables and joints: plans showing route, depth, cable types and sizes, ducts lengths and sizes, joint locations, joint and service phasing and earth rod location. (Note that there are also draft requirements set out in NRSWA Records Code of Practice)
 - For all installed plant and protection: location, maker, type, rating and serial numbers.
- b. The accuracy requirements and means by which plans are provided to the Host DLH shall be the same as would apply if the work was undertaken directly for the Host DLH. The Host DLH shall provide the Applicant with information in Appendix B to facilitate this.

9 TESTS

- a. The Applicant shall perform tests on the complete installation to verify that it has been correctly installed, it is safe to energise and customers may be safely connected. Appendix A provides a list of typical test requirements.
- b. A programme of tests shall be agreed between Host DLH and Applicant in respect of HV equipment including HV protection and any remote control / automation / SCADA facilities. The extent of tests required and the format for recording test results will be specified by the Host DLH in Appendix B.

APPENDIX A: TEST REQUIREMENTS

Each service	<ul style="list-style-type: none">- polarity / phase rotation (3ph)- insulation resistance 500/1000V- earth loop impedance
Each new section of main	<ul style="list-style-type: none">- insulation resistance ph-ph and ph-n/earth 500/1000V- continuity
Each p.m.e. electrode	<ul style="list-style-type: none">- earth resistance
Earthing resistance	<ul style="list-style-type: none">- overall value measured at substation- at HV/LV substation – combined HV/LV / not combined and overlap (depends on achieving < 1 Ohm)
LV fuse cabinet	<ul style="list-style-type: none">- insulation resistance 500/1000V
HV/LV transformer	<ul style="list-style-type: none">- insulation resistances HV- LV winding/earth- pressure test- voltage and phasing checks- tap setting check- oil moisture content- oil electric breakdown strength- statement on pcb content < 2ppm new oil
HV Switchgear	<ul style="list-style-type: none">- insulation resistance 5kV- pressure test- protection test, secondary injection or dummy HV fuse tester (e.g. B&S device)- functional test of interlocks and operation- insulation test any loose test devices- busbar resistance if work includes connection of busbars, new to new or new to existing- gas pressure if gas filled
HV Cables	<ul style="list-style-type: none">- insulation resistance 5kV- pressure test RYB-E, RY-B, BR-Y- continuity
HV Protection	<ul style="list-style-type: none">- functional testing including injection testing- insulation resistance

APPENDIX B: HOST DLH REQUIREMENTS – Typical Example Only

The following is only provided as an indication of the type of information which would be included by the Host DLH in this Appendix.

Service entries

Cavity service entry shall not normally be permitted as this de-rates the service cable.

LV meter cabinet and installation arrangements shall be one of the type agreed with the Host DLH [ongoing need to hold spare doors etc]. These arrangements shall be agreed in advance and documented, with appropriate drawings.

If alternative arrangements are considered the following shall be taken into account:

The air temperature surrounding the cut out must not exceed 30°C.

All meter cabinets must be installed in a way that maintains the manufactured fire resistance values.

HOST DLH REQUIREMENT - ASSET RECORDING – Typical only

Principles of recording cables
Taking measurements using triangulation
Extended sight lines and right angles
Chain Lines
Same feature recording
Other data to be recorded on site
Recording of cable sections
Process of cable recording
Example of cable sketch