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Engineering Recommendation P5

Issue 6 2017

Design methods for LV underground networks for new housing developments

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PUBLISHING AND COPYRIGHT INFORMATION

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Amendments since publication

Issue	Date	Amendment
Issue 6	March 2017	Complete redraft and rewrite of Issue 5. i) Capture learnings from LCNF projects relating to LV demand calculation. ii) Incorporate guidance on low carbon technology when designing a new LV network. iii) Include reference to principal LV planning Standards. iv) Improve and clarify the scope of the document, i.e. the document is focused on design methods for new LV networks. ENA EREC P5 title has been changed from ‘Design of Low Voltage Underground Networks for New Housing Estates’ to ‘Design methods for LV underground networks for new housing developments’. All previous content from Issue 5 covering topics such as voltage drop limits, protection, feeder and service loop impedance, and earthing has been deleted. ENA EREC G81 supersedes the majority of previous recommendations.

Contents

Figures

Tables

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Foreword

This Engineering Recommendation (EREC) is published by the Energy Networks Association (ENA) and comes into effect from the date of publication. It has been prepared under the authority of the ENA Engineering Policy and Standards Manager and has been approved for publication by the ENA Electricity Networks and Futures Group (ENFG). The approved abbreviated title of this engineering document is “EREC P5”, which replaces the previously used abbreviation “ER P5”.

This document supersedes ENA ER P5 Issue 5 1987 and represents a complete rewrite of previous recommendations. Low carbon technology connected to the LV network is considered for the first time in EREC P5. The document now references ENA EREC G81 Part 1 which is the national framework for LV design and planning. The guidance in EREC P5 includes design and planning principles and is intended to complement the network design policies of individual Network Operators.

This document introduces a means to modify the calculations in the established methodologies used by DEBUT software and the ADMD approach. The modifications are necessary to take account of modern electricity usage patterns and the connection of low carbon technology. The document also describes a supplementary tool – LV Network Template – for assessing transformer load, voltage levels and voltage headroom for a particular LV substation network design.

This document has been developed from the learnings and recommendations of the following Network Innovation projects.

- Northern Powergrid – Customer Led Network Revolution (CLNR).
- Electricity North West – Demand Scenarios: Analysis of domestic heat pumps.
- Western Power Distribution – LV Network Templates.

EREC P5 references a number of reports freely available to the reader through the ENA Smarter Networks portal (see Bibliography).

EREC P5 is intended for use by LV network designers involved in the design and planning of LV networks for new housing estates.

Where the term “shall” or “must” is used in this document it means the requirement is mandatory. The term “should” is used to express a recommendation. The term “may” is used to express permission.

NOTE: Commentary, explanation and general informative material is presented in smaller type, and does not constitute a normative element.

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Introduction

Good engineering practice is recognised in this EREC in respect of the design and planning for new LV networks intended to supply housing estates i.e. domestic properties. The design methods for determination of demand and voltage regulation are discussed.

ENA ACE Report 49 [1] introduced an alternative design method to the after diversity maximum demand (ADMD) approach adopted by ENA ACE Report 2 and ENA ACE Report 13. The methodology in ACE Report 49 was a means of calculating demand and voltage regulation and became the basis of the computer program DEBUT. Following ACE Report 49, ENA ACE Report 105 [2] brought together learnings and recommendations from all previous reports. Subsequently, ENA EREC P5 Issue 5 was published to summarise key points from ACE Report 105.

The DEBUT software program forms part of the WinDEBUT LV modelling tool, widely utilised by Network Operators for LV planning and design. DEBUT software calculations retain the statistical framework to calculate demand and voltage regulation introduced by ENA ACE 49 Report [1]. EREC P5 Issue 6 does not attempt to replicate DEBUT software calculations and has been revised on the basis that users are familiar with WinDEBUT.

The move towards sustainable and low carbon networks requires a change to design of LV networks to incorporate generation as well as demand technologies. In this context, the increasing application of LCT and the changing practices and activities of domestic customers is changing the nature of power flows on the LV network. The design and planning assumptions used to determine demand since ENA ER P5 was last published are becoming obsolete and hence the need for them to be revised.

This revised issue of EREC P5 allows for LV network designers to design and plan new LV networks for housing estates with the familiar tools and methodologies traditionally used, e.g. WinDEBUT and ADMD calculations, but with modification to the underlying calculations that more accurately represent the modern customer demand and the application of LCT.

1 Scope

This Engineering Recommendation applies to the design and planning of LV networks for new housing estates, by Network Operators. Both demand and generation are considered in this document. Recommendations for the design of LV networks supplying commercial customers or the reinforcement of existing LV networks is not within the scope of this Engineering Recommendation.

NOTE: Where an existing LV network is required to feed a new housing estate, an assessment of demand and voltage regulation of that LV network may be necessary. Any necessary reinforcement, would be designed using the available load profiling and the application of relevant established design principles, without the need to satisfy the recommendations in this EREC. The LV network for the new housing estate would be designed using the recommendations in this EREC.

2 Normative references

The following referenced documents, in whole or part, are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards

BS EN 62196-1, *Plugs, socket-outlets, vehicle connectors and vehicle inlets. Conductive charging of electric vehicles. General requirements*

BS EN 61000-3-2, *Electromagnetic compatibility (EMC). Limits. Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

BS EN 61000-3-3, *Electromagnetic compatibility (EMC). Limits. Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection*

BS EN 61000-3-11, *Electromagnetic compatibility (EMC). Limits. Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems. Equipment with rated voltage current ≤ 75 A and subject to conditional connection*

BS EN 61000-3-12, *Electromagnetic compatibility (EMC). Limits. Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase*

Other publications

[N1] ENA EREC G59, *Recommendations for the connection of generating plant to the distribution systems of licensed distribution network operators*

[N2] ENA EREC G81 Part 1, *Framework for design and planning, materials specification and installation and record for Greenfield low voltage housing estate installations and associated, new, HV/LV distribution substations. Part 1: Design and Planning*

[N3] ENA EREC G83, *Recommendations for the connection of type tested small-scale embedded generators (Up to 16A per Phase) in parallel with low-voltage distribution systems*

[N4] ENA ER P28, *Planning limits for voltage fluctuations caused by industrial, commercial and domestic equipment in the United Kingdom*

[N5] ENA ER P29, *Planning limits for voltage unbalance in the UK for 132 kV and below*

[N6] ENA ER G5, *Planning Levels for harmonic voltage distortion and the connection of non-linear equipment to transmission systems and distribution networks in the United Kingdom*

[N7] ENA EREC P25, *The short-circuit characteristics of single-phase and three-phase low voltage distribution networks*

[N8] ENA EREC P23, *Guidance on earth fault loop impedance at customers' intake supply terminals*

[N9] ENA ER G12, *Requirements for the Application of Protective Multiple Earthing to Low Voltage Networks*

[N10] IET Code of Practice, *Electric vehicles charging equipment installation,* 2nd edition, PSEV002P

[N11] The Carbon Plan, *Delivering our low carbon future, HM Government*, December 2010

[N12] Smart Grid Forum WS3 Project 82530, *Assessing the Impact of Low Carbon Technologies on Great Britain's Power Distribution Networks,* Version 3.1, 31/07/12.

[N13] RHI deployment data: November 2016, www.gov.uk, Official Statistics

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply