Threepwood Consulting

Report for Initial Review of ENA Engineering Recommendation P26

for

Energy Networks Association

Confidential to Client

Contract Reference: ENA_ENA112
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Contents

1. Executive Summary

Threepwood Consulting Limited has conducted an initial review of ENA Engineering Recommendation P26, *The estimation of the maximum prospective short-circuit current for three phase 415 V supplies,* to determine the requirements for subsequent revision.

Since the document was published in 1985, a number of Standards have been published relating to short-circuit calculation for three-phase systems; namely IEC 60909-0, *Short-circuit currents in three-phase a.c. systems - Part 0: Calculation of currents*, and ENA Engineering Recommendation G74, *Procedure to meet the requirements of IEC 909 for the calculation of short-circuit currents in three-phase AC power systems*.

Feedback from Member Companies has confirmed that ER P26 remains relevant and is required. The Member Companies have highlighted that the increase in LV distributed generation is an important consideration for fault level at the LV busbars. The impact of this generation should be investigated to determine whether the PSCC values declared in ER P26 need to be amended. Indeed, the revision of G74, which is currently in progress, should consider calculation of fault level of LV busbars with the objective of validating the PSCC values in ER P26.

The content in P26 is very similar ENA Engineering Recommendation P25, which provides guidance on the estimation of PSCC for 230 V single-phase supplies. It is recommended that a revisions of ER P26 and ER P25 are undertaken together with a view to amalgamating the documents.

The main recommendation of this initial review is that ER P26 be subjected to a “Major Revision”. This revision should be undertaken by a small revision team under the auspices of the Distribution Code Review Panel (DCRP) since ER P26 is a Distribution Code (DCode) Annex 1 Qualifying Standard.

2. Introduction

The Energy Networks Association (ENA) has commissioned Threepwood Consulting Limited (Threepwood Consulting) to conduct an initial review of a number of engineering documents due for revision as part of the 2016 Programme. The purpose of this initial review is to determine the requirements for subsequent revision of the documents.

This report relates to the initial review of ENA Engineering Recommendation P26 Issue 1 (subsequently referred to as ‘P26’).

The findings and recommendations from the initial review of this document are presented in this short form report.

3. Overview of Document

P26 was published in 1985 to provide guidance on the estimation of maximum prospective short circuit current (PSCC) at the supply terminals, connected via 415 V three-phase service line. P26 is most relevant to those involved in the design and installation of consumer supply arrangements. The document content is very similar to that of ENA Engineering Recommendation P25 (ER P25), which provides guidance on the estimation of PSCC for 230 V single-phase supplies. ER P25 has been recommended for revision as described in a separate report titled; *Threepwood Report_ENA_ENA112_ER P25_v1*.

Like ENA ER P25, P26 is referenced in the Distribution Code (DCode) as technical guidance under Clause DPC 4.3.2 'Design Principles' and Clause DPC 6.5.1 'Fault Level'. ER P26 is also a DCode Annex 1 Qualifying Standard, and its revision will fall under the governance of the DCRP.

4. Review of Technical References

4.1 General

The publication of P26 predates modern National and International Standards for short-circuit calculation in three-phase systems and hence, there is only one Standard referenced in the current version of P26. Clause 4.2 of this Report suggests new Standards for consideration.

4.2 Standards

4.2.1 International Standards

IEC Standards are not currently referenced in P26 but this review recommends that the following Standard is considered during a revision of P26.

- **IEC 60909-0:2016**, *Short-circuit currents in three-phase a.c. systems - Part 0: Calculation of currents*. This Standard was first published in 1988 (IEC 909:1988), after the publishing of P26. It is the recognised international Standard for the calculation of short-circuits and its application, for UK Network Operators, is described in ENA Engineering Recommendation G74, *Procedure to Meet the Requirements on IEC 909 for the Calculation of Short-Circuit Currents in Three-Phase AC Power Systems* (see Clause 4.4 of this report).

4.2.2 BSI Standards

P26 references only one national Standard, as described below.

- **IEE Wiring Regulations (15th Edition).** The IET (formerly the IEE) Wiring Regulations have been subject to a number of revisions (1992, 2001 and 2008) since P26 was published. The latest version of The Wiring Regulations is BS 7671:2008+A3:2015 (17th Edition). The updates to this Standard have included major amendments and it will be necessary to review the appropriate clauses closely when revising P26.

This review has not identified any other British Standards which may be relevant to the revision of P26.

4.3 CIGRÉ Documents

P26 does not currently reference any CIGRÉ publications and this review has not identified any CIGRÉ publications that are relevant to the revision of P26.

4.4 ENA Engineering Documents

The current version of P26 makes no reference to any other ENA Engineering Documents. It is proposed that any revision of P26 should include reference to the following Engineering Documents.

- **ENA ER P25**, *The Short-Circuit Characteristics of Public Electricity Suppliers' Low Voltage Distribution Networks and the Co-ordination of Overcurrent Protective Devices on 230V Single Phase Supplies up to 100A*. This document has a close relationship and very similar scope to P26; and it is proposed that P26 is combined with ER P26 during the revision work (refer to *Threepwood Report_ENA_ENA112_ER P25_v1*) as described in Clause 6 of this report.
- **ENA ER G74**, *Procedure to meet the requirements of IEC 909 for the calculation of short-circuit currents in three-phase AC power systems*. ER G74 is very relevant for the calculation of PSCC in three-phase systems and hence should be referenced in P26. ER G74 is currently under revision and it is intended that the revised version will include guidance on distributed generation. Any work on P26 should be co-ordinated with the revision work on ER G74. Indeed, the revision team for G74 should be liaised with to ensure appropriate consideration is given to fault level calculation at the LV busbar, particularly where there is large numbers of connected LV distributed generation.
- **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*. It is proposed that the EREC G81 Part 1 is added as an appropriate reference in P26. Indeed, P26 is referred to in Clause 6.14 of EREC G81 Part 1.
- **ENA ER P23**, *Consumers earth fault protection for compliance with the IEE Wiring Regulations for Electrical Installations*. This document was last published in 1991 but has been subject to recent review by the ENA Earthing Co-ordination Group (ECG). It would be pertinent to review ER P23 and liaise with the ENA ECG whilst revising P26.

5. Legislation

There are currently no references to legislation on P26, but it is recommended that the Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002 (as amended) are referenced.

ESQCR Regulation 28 requires the electricity supplier to state the maximum PSCC at the supply terminals.

6. Review of Document Structure and Content

Although the document is well structured, alignment with the new ENA Standards template and associated ENA Engineering Recommendation governing the rules for structure, drafting and presentation of ENA engineering documents (ER G0) will be required.

It is proposed that out-of-date terms used in P26 are replaced as follows.

- Replace 'Electricity Board' and 'Board' with 'Network Operator (NO)'.
- Replace 'London Electricity Area' with 'UKPN London Power Network'.
- Replace 'Merseyside and North Wales Electricity Board' with 'SPEN'.

A number of new clauses are proposed for the revision including a 'Foreword', 'Normative references' and 'Bibliography'.

It in addition to editorial correction, reformatting and the inclusion of new clause headings, described above, it is proposed that the content of P26 is amalgamated with ENA ER P25. Many of the existing clause headings in P26 and ER P26 are the same, as described in the following table.

P26 Clause	P25 Clause	Comments
Clause 2 '*Service Line Arrangements*'	Clause 2 '*The Incoming Service Arrangements*'	P25 includes more details about the cut-out arrangement whereas, P26 includes very brief information about the service cable/overhead. Combining both clauses would not be difficult.
Clause 3 '*The Prospective Short-Circuit Level on the Board's Main Distributor*'	Clause 3 '*The Prospective Short-Circuit Level on the PES Main Distributor*'	There are some differences in the level of detail across Clause 3 of P25 and P26. Combining would involve a review of the content to ensure all details are still relevant to both documents.
Clause 4 '*Estimation of the Prospective Short-Circuit Current at the Board's Cut-out*'	Clause 4 '*Estimation of the Prospective Short-Circuit Current at the PES Cut-out*'	Both P25 and P26 have the same intent in Clause 4. Combining these could involve creating 2 sub-clauses to separate guidance for single-phase and guidance for three-phase.
Clause 5 '*Attenuation of the PSCC Beyond the Board's Cut-out*'	Clause 5 '*Estimation of Attenuation of the Prospective Short-Circuit Current Beyond the PES Cut-out*'	Both P25 and P26 have very similar content in Clause 5. Combining these would be straightforward.
Clause 6 '*Three-phase supplies to smaller installations consisting only of single-phase equipment*'	Clause 6 '*Selection of Protection Devices*'	Clause 6 in P26 is a short description referencing P25. Clause 6 in P25 advises the reader on the selection of an appropriately rated protection device. The protection device may also be appropriate for P26, hence, combining the Clauses is recommended.
Clause 7 - NONE	Clause 7 '*PES responsibility*'	Clause 7 in P25 is also applicable to P26. No issues combining the documents.
Table 1 - 3-phase estimated maximum PSCC values for different service line lengths when connected at the substation	Table 1 - Single -phase estimated maximum PSCC values for different service line lengths	There are no issues repeating these tables in their current arrangement, in a combined document.
Table 2 - 3-phase estimated maximum PSCC values for different service line lengths when connected at the LV main.	Table 2 - NONE	
Table 3 - Equivalent cable sizes for different cable types	Table 3 -NONE	When combining P25 and P26, Table 3 should be reviewed for relevance and currency and the sizes expanded to include those appropriate for single-phase services.

7. Review of Technical Relevance

7.1 General

Nominated ENA Standard Representatives from a number of Member Companies were invited to provide feedback on the technical relevance of P26, in particular, what changes, if any, are required to meet their business processes and applications currently and in the medium term (i.e. 1 - 5 years). The responses are captured in Appendix A. In addition to their feedback, a number of comments were raised as discussed in the following paragraphs.

1. Establishing baseline fault level
   A Member Company has pointed out that P26, although useful to those involved in the design of LV supply installations, it is also used to establish a baseline fault level at the LV busbars. This baseline fault level is used in the planning of future connections and switchgear specification. Hence, the accuracy and relevance of P26 PSCC values has high significance for Network Operators.
2. LV busbar fault levels
   Following on from item 1 above, the value of PSCC declared in P26 should be investigated and validated for networks with LV connected distributed generation. This consideration becomes more pertinent given the penetration levels of distributed generation on some LV networks. At the very least, P26 should include additional guidance for the calculation of PSCC when there is distributed generation.
3. Consideration of make and break ratings
   Following on from item 2 above, where there is LV distributed generation - P26 should differentiate between LV switchgear make and break ratings, at the LV busbar.
4. Modern waveform cables
   The tables in P26 should be updated to take account of modern LV waveform cable.
5. Typical service length
   Consideration should be given to specifying a typical service line length of 20 m as opposed to 50 m, currently inferred by P26. Given that the earth loop impedance should less than 250 ohms for networks, the maximum service length should conform to this. In any case, if the PSCC value at 20 m service length is suitable, longer service lines will be satisfactory by default i.e. PSCC value decreases as service line length increases.

7.2 Low Carbon Networks Projects

The following Low Carbon Network Funded (LCNF) projects may be relevant for the revision of P26, in particular, for researching short-circuit and fault level calculation findings and considerations.

- WPD - Fault level Monitor Project (2008/09). A project trialling a product to calculate fault levels.
- SPEN - Fault level Monitor (2012). A project trialling the use of a product to calculate fault levels on a 6.6 kV network.
- SPEN - Fault infeed calculations (2008/09). A project comparing a number of software products for the calculation of fault currents.
- ENWL - Investigation of switchgear ratings (2015). A project to determine the short circuit ‘envelope’ for switchgear by determining its fault level performance.

8. Conclusions

The content of P26 is still very relevant and the document is a required reference when Network Operators are declaring the maximum PSCC, in accordance with Regulation 28 of ESQCR. Network Operators may also refer to the PSCC values in P26 when designing LV networks and the specification of associated switchgear.

A number of Member Companies were requested to provide feedback on the document during this review and the following points were raised, warranting consideration during a revision of P26.

- The impact of LV distributed generation on the fault level at the LV busbars and hence the value of PSCC declared in P26.
- Adding details for modern LV waveform cable and amending the details on the inferred service line length.

The content of P26 is very similar to ER P25, which considers the PSCC value for single-phase supplies. A revision of P26 should be co-ordinated with a revision of ER P25 and the two documents should be amalgamated.

9. Recommendations

The main recommendation is that P26 is subject to a "Major Revision", on account that the document requires investigation of the PSCC values to ensure the fault level contribution from LV distributed generation is taken into account.

It is recommended that P26 is amalgamated with ER P25, which is also recommended for revision (refer to *Threepwood Report_ENA_ENA112_EP P25_v1*).

The revision of P26 should be co-ordinated with the ENA team who are currently undertaking a revision of ER G74.

It is recommended that revision of P26 is undertaken alongside the revision of ER P25 and overseen by a small Revision Team consisting of the following members.

- One representative from Threepwood Consulting Ltd, who will act as the ENA Co-ordinator and Chief Author for changes to the document.
- A minimum of three representatives from Member Companies who are nominated as the primary reviewers, and will have primary responsibility for overseeing the document as it is revised.

The first stage of any revision should involve drafting the Terms of Reference (ToR) of the Revision Team for approval by the DCRP.

Appendix A: Technical Relevance

Summary of Feedback from ENA Member Company Standard Representatives

		SPN	NIE	NPGRID	NGRID	SSE	UKPN	WPD	ENW	COMMENTS
Q1	Do you use this engineering document to support your current business processes / practices?	NO RESPONSE	NONE	IN PART	NA	NONE	IN PART	NONE	NONE	See Clause 7.1
Q2	Does this engineering document meet your engineering requirements in its current format?	NO RESPONSE	NONE	IN PART	NA	NONE	IN PART	NONE	NONE	See Clause 7.1
Q3	Are there any significant errors or omissions in this engineering document that you believe should be addressed in the next revision?	NO RESPONSE	NONE	NO	NA	NONE	NO	NONE	NONE	See Clause 7.1
Q4	What is the extent of review you believe is required for the revision of this engineering document?	NO RESPONSE	NONE	Major	NA	NONE	Revise	NONE	NONE	See Clause 7.1