

Document Title: Engineering Recommendation P25, Issue 2  
2018

Issue: Final\_v6

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### **Document Amendment Summary**

#### **Summary**

Revision drafts of the document have been reviewed by the ENA P25 & P26 Revision Corresponding Group.

Member Company	Representative	Comments Recd
Scottish Power Energy Networks	Keith Evans Mikel Urizarbarrena Cristobal	Yes
Northern Powergrid	Rimnesh Shah Alan Creighton	Yes
National Grid	NA	NA
SSE	John Baker	Yes
UK Power Networks	Stephen Cuddihey Stephen Tucker	Yes
Western Power Distribution	Andrew Hood	Yes
NIE	Peter Johnston	Yes
ENWL	Peter Twomey	Yes
GTC	Steve Mockford	Yes

The document was subject to a public consultation (DCRP/17/03) in March 2017. Comments from this consultation are summarised in *DCode Consultation response ER P25 Consolidated TCL v3\_Approved*.

## **Document Amendment Summary**

### **Amendments in Final\_v6**

<b>Item</b>	<b>Amendment</b>	<b>Notes</b>
Editorial	Published year changed from '2017' to '2018' throughout document.	

### **Amendments in Final\_v5**

<b>Item</b>	<b>Amendment</b>	<b>Notes</b>
Editorial	Changed all symbol fonts to italics, throughout document.	
Editorial	Figure 3: Changed symbol in note from 'I <sub>DC</sub> ' to 'I <sub>DC</sub> '.	
Editorial	Clause 5.4, PSSC on the DNO's LV distribution main: Text in NOTE changed from 'at least greater than 2 metres' to 'greater than 2 metres'.	
Editorial	Clause 7.4.1, Synchronous machines: Test in NOTE changed from 'It may be likely.....' to 'It is likely.....'.	

### **Amendments in Final\_v4**

<b>Item</b>	<b>Amendment</b>	<b>Notes</b>
Technical	Clause 5.4, PSSC on the DNO's LV distribution main: Text in NOTE changed from 'at least 2 metres' to 'at least greater than 2 metres'.	
Technical	Clause 7.4.1, Synchronous machines: New NOTE added to provide guidance on contribution from machines and available headroom.	

### **Amendments in Final\_v3**

<b>Item</b>	<b>Amendment</b>	<b>Notes</b>
Technical	Introduction: Reference to 'Regulation 612.11 of BS 7671' changed to 'BS 7671'.	
Technical	Definition 3.3, LV: Definition for LV changed from 'voltage not exceeding 1 000 V a.c. r.m.s' to 'voltage above 50 V a.c. r.m.s. but not exceeding 1 000 V a.c. r.m.s.'	

## **Document Amendment Summary**

<b>Item</b>	<b>Amendment</b>	<b>Notes</b>
Technical	Clause 5.1: The following paragraph has been added 'The designer should request/obtain information from the appropriate DNO to enable an estimation of the LV generation/motor contribution. The estimation may not be necessary if the suggested criteria in Clause 7.4 for LV generation/motor contribution is not surpassed'.	
Editorial	PSCC formula for three-phase fault: The words 'quadratic sum of reactance and resistances changed to 'quadratic sum of phase reactances and resistances'.	
Technical	Clause 5.4, PSCC on the DNO's LV distribution main: New NOTE added to explain how the value of 16 kA is still applicable.	
Technical	Clause 8.1, Selection of protective devices: In the NOTE, reference to the ECA publication has been deleted and replaced with PD IEC/TR 619212-1.	
Technical	Clause 8.2, Single-phase supplies: The wording 'the conditional testing procedure' has been changed to 'the 16 kA conditional testing procedure'.	

## Document Amendment Summary

### Amendments in Final\_v2

Item	Amendment	Notes
Editorial	Foreword: Paragraph 6 wording amended to remove reference to an 'author'.	
Technical	Clause 3.8, point of supply: reference to 'meter' removed from definition.	
Technical/ Editorial	Clause 4.2, Single-phase supplies: Wording in final paragraph amended to 'DNO may charge the customer'.	
Editorial	Standardised on the term 'cut-out unit' throughout the document.	
Editorial	Clause 5.2, Short-circuit terminology: 1 <sup>st</sup> paragraph, the wording 'fault current is interrupted' added to the end of the 1 <sup>st</sup> sentence.	
Technical	Figure 3: A second figure b) has been added to Figure 3, depicting the current characteristic near-to-generator. This second diagram, along with new NOTE, aids the distinction between and significance of, fault locations.	
Technical	Clause 5.3, Basis of calculation of the maximum PSCC: The definition of 'E' is the 2 <sup>nd</sup> equation has been corrected from 'phase-to-phase voltage' to 'phase-to-neutral voltage'.	
Editorial	Clause 7.1: Reference to 'Clause 7' corrected to 'Clause 8.1'.	
Editorial	Clause 7.3, Three-phase supplies: The first sentence of the 3 <sup>rd</sup> paragraph has been simplified.	

### Amendments in Final\_v1

Item	Amendment	Notes
General	Document year changed from '2016' to '2017' throughout.	
General/ Editorial	Wording and grammar corrected throughout to improve clarity and consistency.	
General	Title: Document title changed from ' <i>The short-circuit characteristics of low voltage distribution networks for single-phase and three-phase supplies</i> ' to ' <i>The short-circuit characteristics of single-phase and three-phase low voltage distribution networks</i> '	

## **Document Amendment Summary**

<b>Item</b>	<b>Amendment</b>	<b>Notes</b>
Technical	Clause 1, Scope: The wording 'single-phase service rated at 100 A' changed to 'single-phase services rated up to 100 A'	
Technical	Clause 2, Normative references: ENA TS 35-1 Part 1 added to normative references, following amendment to Clause 5.3.	
Technical	<p>Clause 3, Terms and definitions:</p> <p>The following definition has been added:</p> <ul style="list-style-type: none"> <li>point of supply (the term 'point of supply' has replaced 'point of connection' throughout the document)</li> </ul> <p>The following definitions have been amended:</p> <ul style="list-style-type: none"> <li>customer</li> <li>far-from-generator (NOTE 1 added)</li> <li>supply terminals</li> </ul>	
Technical	Figure 1: 'point of connection' replaced by 'point of supply'. The NOTE beneath Figure 1 has been amended to clarify that 80 A or 100 A are relevant for new domestic supplies.	
Technical	Figure 2: 'point of connection' replaced by 'point of supply'.	
Editorial/ Technical	Clause 5.2: Paragraph 3 wording amended to improve clarity. Footnote added to provide context for the statement 'short-circuits on LV networks are normally far-from-generator'.	
Technical	Clause 5.3: Reference to ENA TS 35-1 Part 1 added to item b). Formulae for short-circuit currents inserted into body of document.	
Technical	Table 3: Details for 300 mm <sup>2</sup> cable added to table.	
Editorial	Table 4 title amended.	
Technical	Clause 7.4.2: Paragraph 3 amended to explain that heat pumps may be driven via power electronics or directly coupled, and significance of this.	
Technical	Clause 8.1: Paragraph 3 amended to improve alignment with Regulation 434.3 of BS 7671. The sentence 'It should be noted that in practice, an agreement with the DNO does not normally exist' has been inserted at the end of the paragraph.	

### **Amendments in Draft\_v2**

<b>Item</b>	<b>Amendment</b>	<b>Notes</b>
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## **Document Amendment Summary**

<b>Item</b>	<b>Amendment</b>	<b>Notes</b>
General/ Technical	<p>The term 'consumer' has been changed to 'customer' throughout the document.</p> <p>The term 'Distributor' has been changed to 'DNO' throughout the document.</p> <p>The term 'service line' has been changed to 'service' throughout the document.</p> <p>The term 'power factor (p.f.)' has been changed to 'X/R ratio' throughout the document.</p>	
Technical	<p>Clause 1, Scope:</p> <p>The wording in the scope has been changed from 'three-phase line of capacity up to 300 kVA' to 'poly phase service rated up to 400 A per phase.</p> <p>The 3<sup>rd</sup> paragraph has been re-written clarify that the guidance in the document is not appropriate for 'interconnected-LV networks'. The Wirral has been added to the example regions for such networks.</p>	
Technical	<p>Clause 2, Normative references:</p> <p>IEC 60909-0 has been added to the normative references.</p> <p>The following references have been deleted from the normative list.</p> <ul style="list-style-type: none"> <li>• ENA EREC P5.</li> <li>• ENA EREC G74 (moved to the Bibliography).</li> <li>• ENA TS 35-1 Part 1.</li> </ul>	

## **Document Amendment Summary**

<b>Item</b>	<b>Amendment</b>	<b>Notes</b>
Technical	<p>Clause 3, Terms and definitions:</p> <p>Major changes to the definitions listed.</p> <p>The following definitions have been amended:</p> <ul style="list-style-type: none"> <li>• DNO (clarified that IDNO is also applicable)</li> <li>• HV</li> <li>• LV</li> <li>• PSSC</li> <li>• Power factor (Notes deleted)</li> <li>• Supply terminals Note added clarifying relationship to ‘point of connection’</li> </ul> <p>The following new definitions have been added:</p> <ul style="list-style-type: none"> <li>• Interconnected-LV network</li> <li>• RMS</li> <li>• Initial symmetrical short-circuit current (definition generally aligns with IEC 60909-0)</li> <li>• Peak short-circuit current (definition generally aligned with IEC 60909-0)</li> <li>• Symmetrical short-circuit breaking current (definition generally aligned with IEC 60909-0)</li> <li>• Far-from-generator (definition simplified from IEC 60909-0)</li> <li>• Near-to-generator (definition simplified from IEC 60909-0)</li> <li>• X/R ratio</li> </ul>	
Technical	<p>Clause 4.1, General:</p> <p>The 1<sup>st</sup> paragraph and items a)-c) from Draft_v1 have been deleted as the details are not relevant for P25.</p>	
Technical	<p>Clause 4.2, Single-phase supplies:</p> <p>The 3<sup>rd</sup> paragraph has been deleted and replaced with a new Figure 1, depicting a ‘Typical single-phase supply’.</p>	
Technical	<p>Clause 4.3, Three-phase supplies:</p> <p>Item c) referring to busbar connected customers has been deleted as it is not common practice. A new Figure 2 has been added, depicting a ‘Typical three-phase supply connected directly to the DNO substation’.</p>	

## Document Amendment Summary

Item	Amendment	Notes
Technical	<p>Clause 5.1, General:</p> <p>The 1<sup>st</sup> paragraph has been amended to clarify how PSCC is related to network capacity.</p> <p>With regards to the sentence 'changes on the DNO network, may cause the PSCC to increase', a 3<sup>rd</sup> bullet has been added to capture HV network reconfiguration.</p> <p>There has been a minor amendment to the wording in paragraph 4, relating to designer philosophy.</p>	
Technical	<p>New Clause 5.2, Short-circuit terminology:</p> <p>A new clause has been added to explain short-circuit theory and terminology. The content has been developed from IEC 60909-0.</p>	
Technical	<p>Clause 5.3, Basis of calculation of the maximum PSCC:</p> <p>Minor amendment to the wording in this clause.</p> <p>A footnote has been added to explain that 433 V is the no-load secondary voltage of a standard transformer and 400/230 V is the nominal voltage for DNO LV networks.</p>	
Technical	<p>Clause 5.4, PSCC on the DNO's LV distribution main:</p> <p>The PSCC value has been changed from 16 kA to 19.6 kA based on the latest spreadsheet calculations (<i>P25 Revision 2016 calculations v1</i>).</p> <p>The 2<sup>nd</sup> paragraph referring to 'London region' has been deleted and replaced with a new paragraph explaining the guidance for 'interconnected-LV networks'.</p>	
Technical	<p>Clause 5.5, PSCC for three-phase supplies:</p> <p>The PSCC value has been changed from 25 kA to 25.9 kA based on the latest spreadsheet calculations (<i>P25 Revision 2016 calculations v1</i>).</p> <p>A new 3<sup>rd</sup> paragraph has been added which provides guidance for 'interconnected-LV networks'.</p>	
Technical	<p>New Clause 6, Contribution to PSCC from LV generation or motors:</p> <p>New Clause added to provide guidance on assessing the contribution from LV generation and motors. The following sub-clauses detail the guidance:</p> <p>New Sub-Clause 6.1, General,</p> <p>New Sub-Clause 6.2, LV direct couple generation,</p> <p>New Sub-Clause 6.3, LV motors,</p> <p>New Sub-Clause 6.4. LV generation coupled via power electronics.</p>	

## Document Amendment Summary

Item	Amendment	Notes
Technical	<p>Clause 7.2, Single-phase supplies:</p> <p>'16 kA (p.f. 0.44)' has been changed to '19.6 kA (<math>X/R = 2.5</math>)'.</p> <p>New sentence added to 1<sup>st</sup> paragraph 'The tee-off point is assumed to be at 15 m along a 300 mm<sup>2</sup> cable which connected to the substation transformer'. A footnote has been added providing details of the cable resistance and reactance values.</p> <p>Table 1 values have been updated using the calculation spreadsheet (<i>P25 Revision 2016 calculations v1</i>) to take account of the 15 m of 300 mm<sup>2</sup>. The p.f. values have been changed to X/R values.</p> <p>The previous note relating to 'London region' not being applicable has been deleted - this requirement has been captured adequately elsewhere in the document.</p>	
Technical	<p>Clause 7.3, Three-phase supplies:</p> <p>The 3<sup>rd</sup> paragraph relating to the previous Table 3 has been deleted.</p> <p>The previous Table 3, titled 'Estimated maximum PSCC at the Distributor's cut-out based on declared level of 18 kA (0.5 p.f.) at the point of connection of the service line to the LV distribution main' has been deleted.</p> <p>Table 2 values have been updated with the 25.9 kA value and all p.f. values have been changed to X/R ratio values.</p>	
Technical	<p>New Clause 7.4, Estimation of LV generation/motor contribution:</p> <p>New clause added to provide guidance on determining contribution to short-circuit current from generation and motors.</p>	
Technical	<p>Clause 8.1, General:</p> <p>New note added referring to the ECA publication on the Wiring Regulations and explaining that the designer should take responsibility for selection of protection device rating.</p>	
Technical	<p>Bibliography:</p> <p>The following references have been added to the bibliography:</p> <ul style="list-style-type: none"> <li>• ENA ER G74</li> <li>• IET publication 'Short-circuit currents'</li> </ul>	

## Document Amendment Summary

### Amendments in Draft\_v1

Item	Amendment	Notes
General/ Editorial	NOTE: Prior to carrying out any amendments, the previous revision was imported into the latest ENA engineering document template. As the structure of the new template differs from the previous revision the contents have been assigned to the appropriate section in the revised document and any associated numbering and cross-referencing of Clauses has been updated. Similarly, any editorial changes necessary to comply with the conventions and formatting in the ENA engineering document template and Engineering Recommendation ER G0 Rules, for structure, drafting and presentation of ENA engineering documents have been carried out. These changes may not be 'marked'; however, any subsequent technical, general or editorial changes are 'marked' in the tracked version of the document.	
General/ Technical	Major revision of Issue 1 to address the following points. <ul style="list-style-type: none"> <li>Content from P25 Issue 1 and P26 Issue 1 amalgamated in a single document.</li> <li>References to normative Standards updated.</li> <li>Update terms in document, for example 'PES' now described as 'Distributor'.</li> <li>Re-calculation of fault levels for range of service line lengths.</li> </ul>	
General/ Editorial	Title: Document title changed from ' <i>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</i> ' to ' <i>The short-circuit characteristics of low voltage distribution networks for single-phase and three-phase supplies</i> ' on account of the amalgamation of P25 Issue 1 and P26 Issue 1.	
General/ Technical	Foreword: New clause added to provide publishing information and a description of who the document is intended for. Some of the content has been taken from P25 Issue 1 Clause 1. Clause 7 (Responsibility) from P25 Issue 1 has been moved to this new Foreword.	

## **Document Amendment Summary**

<b>Item</b>	<b>Amendment</b>	<b>Notes</b>
General/ Technical	Introduction: The content from P25 Issue 1 and P26 Issue 1 has been consolidated and references updated (ESQCR replaces Electricity Supply Regulations 1988). The Introduction now provides context for the Statutory requirements and the application of BS 7671. Reference to ER P23 has been included.	
General/ Technical	Scope: New clause added to define the supply types which are covered in the document. Some of the wording has been taken from the 'Introduction' in P25 Issue 1 and P26 Issue 1. Wording has been amended to clarify that both 'existing' and 'planned' supplies are covered. A new capacity limit for three-phase LV supplies covered is set at 300 kVA. This is based on the fact that above 300 kVA, LV 3-phases are likely to consist of a dedicated transformer arrangement and specific design aspects.	
General/ Technical	Clause 2, Normative references: New clause added to capture all normative references. Previous references described in P25 Issue 1 Annex A have been updated and/or removed as appropriate.	
General/ Technical	Clause 3, Terms and definitions: New clause added to capture all terms and definitions used in the document. Previous terms in P25 Issue 1 Annex A have been repeated. New definitions have been inserted for 'consumer', 'Distributor', 'LV', 'HV', 'meter operator', 'MOCOPA' and 'power factor'.	
General/ Technical	<p>Clause 4, The incoming service arrangements:</p> <p>New sub-clause 4.1: General requirements added to provide explanation of LV network design Standards and introduce the terms 'Distributor', 'consumer' and 'meter operator'. Reference to the MOCOPA has been added.</p> <p>Sub-clause 4.2 (P25 Issue 1, Clause 2), description of 'looped' service has been deleted as these are no longer permitted by Distributors. References and terms have been updated and the description of BS 7671 Regulation 473.1.4 (does not exist) has been deleted and replaced with reference to Clause 7 of the document. A note has been inserted highlighting the differing sizes of cut-out fuse-link which may be in use. The purpose of the cut-out fuse-link has also been clarified in paragraph 4.</p> <p>Sub-clause 4.3 (P26 Issue 1, Clause 2): This has largely been re-written from P26 and now includes a description of the typical three-phase connection arrangements, a), b) and c).</p>	

## **Document Amendment Summary**

Item	Amendment	Notes
General/ Technical	<p>Clause 5, The PSCC on the Distributor's LV distribution network</p> <p>Sub-clause 5.1 (P25 Issue 1 Clause 3 and P26 Issue 1 Clause 3): The clause includes the common aspects for both single-phase and three-phase taken from P25 Issue 1 and P26 Issue 1. Duplicated content between the two previous documents has been deleted and editorial amendments completed.</p> <p>Sub-clause 5.2: This new sub-clause has been added to describe the parameters used in the determination of PSCC values on the Distributor's LV network. Reference to ER G74 and TS 35-1 have been inserted.</p> <p>Sub-clause 5.3: the single-phase PSCC value of 16 kA as described in P25 Issue 1 Clause 3 has been repeated in this sub-clause as well as the exceptions for London region.</p> <p>Sub-clause 5.4: the three-phase PSCC values of 25 kA and 18 kA described in P26 Issue 1 Clause 3 have been repeated in this sub-clause. '415 V' has been changed to '400 V' to align with 230 V phase-to-earth.</p>	
General/ Technical	<p>Clause 6: Estimation of the PSCC at the supply terminals.</p> <p>Sub-clause 6.1: This new sub-clause has been added to introduce the concept of attenuation. A paragraph describing the significance of power factor has been repeated, previously described in P26 Issue 1 Clause 4.</p> <p>Sub-clause 6.2: the content from P25 Issue 1 Clause 4 and Clause 5 has been repeated in this sub-clause. There are minor amendments to the wording. The 'Note' from P25 Issue 1 Clause 5 which intimates that the application of the estimation procedure for the London region is acceptable has been deleted as it may confuse the reader after reading the 'Note' which stipulating that the estimation procedure is not applicable in the London region.</p> <p>Table 1: all values previously published in P25 Issue 1 Table 1 have been deleted and replaced with newly calculated values. PSCC values for service line lengths greater than 20 m have been removed.</p> <p>Sub-clause 6.3: the content from P26 Issue 1 Clause 4 and Clause 5 has been repeated in this sub-clause. There has been minor amendments to the wording.</p> <p>Table 2 &amp; 3: all values previously published in P26 Issue 1 Table 1 and 2 have been deleted and replaced with newly calculated values.</p>	

## **Document Amendment Summary**

<b>Item</b>	<b>Amendment</b>	<b>Notes</b>
General/ Technical	Clause 7, Selection of protective devices: Sub-clause 7.1: new sub-clause added clarify general requirements for protection device selection. Previous content in P25 Issue 1 Clause 6 has been updated with new references to BS 7671 and an explanation of the importance of power factor when verifying a device rating. Sub-clause 7.2 (P25 Issue 1 Clause 6): references have been updated as necessary.	
General/ Editorial	Bibliography: new clause added to capture information references.	