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Engineering Recommendation P25

Issue 2 2016

The short-circuit characteristics of low voltage distribution networks for single-phase and three-phase supplies

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Amendments since publication

Issue	**Date**	**Amendment**
Issue 2	2016	Major revision of Issue 1 to address the following points. • Content from P25 Issue 1 and P26 Issue 1 amalgamated in a single document. • References to normative Standards updated. • Update terms in document, for example 'PES' now described as 'Distributor'. • Re-calculation of fault levels for range of service line lengths. The principal technical changes are described below. Title: Document title changed from '*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*' to '*The short-circuit characteristics of low voltage distribution networks for single-phase and three-phase supplies*' on account of the amalgamation of P25 Issue 1 and P26 Issue 1. Foreword: new clause added to provide publishing information and description of who the document is intended for. Some of the content has been taken from P25 Issue 1 Clause 1 and Clause 7 (Responsibility). Introduction: the content from P25 Issue 1 and P26 Issue 1 has been consolidated and references updated (ESQCR replaces Electricity Supply Regulations 1988). Reference to ER P23 has been included.

		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. 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. 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'. Clause 4, The incoming service arrangements: New sub-clause 4.1: added to highlight important references for LV network design and introduce the terms 'Distributor', 'consumer' and 'meter operator'. Sub-clause 4.2 (P25 Issue 1, Clause 2): description of 'looped' service has been deleted, references and terms updated and description of BS 7671 Regulation 473.1.4 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. Sub-clause 4.3 (P26 Issue 1, Clause 2): re-written to include a description of typical three-phase connection arrangements, a), b) and c). Clause 5, The PSCC on the Distributor's LV distribution network: Sub-clause 5.1 (P25 Issue 1 Clause 3 and P26 Issue 1 Clause 3): common aspects for both single-phase and three-phase are detailed, any duplicated content between the two previous documents has been deleted and editorial amendments completed. Sub-clause 5.2: new sub-clause inserted to describe the parameters used to determine the PSCC values on the Distributor's LV network. Reference to ER G74 and TS 35-1 have been inserted. 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. 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. Clause 6, Estimation of the PSCC at the supply terminals: Sub-clause 6.1: new sub-clause inserted to introduce the concept of attenuation. A paragraph describing the significance of power factor has been repeated, previously described in P26 Issue 1. Sub-clause 6.2: the content from P25 Issue 1 Clause 4 and Clause 5 has been repeated in this sub-clause. 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. Sub-clause 6.3: the content from P26 Issue 1 Clause 4 and Clause 5 has been repeated in this sub-clause.

		Table 2 & 3: all values previously published in P26 Issue 1 Table 1 and 2 have been deleted and replaced with newly calculated values. Clause 7, Selection of protective devices: Sub-clause 7.1: new sub-clause added to 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 important of power factor when verifying a device rating. Sub-clause 7.2 (P25 Issue 1 Clause 6): references have been updated as necessary. Bibliography: new clause added to capture information references. Details of all other technical, general and editorial amendments are included in the associated Document Amendment Summary for this Issue (available on request from the Operations Directorate of ENA).

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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 publishing. 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 P25”, which replaces the previously used abbreviation “ER P25”.

Guidance for 230 V single-phase supplies and 400 V three-phase supplies, previously provided in ER P25 Issue 1 and ER P26 Issue 1, is now superseded by this Engineering Recommendation (EREC). Subsequently, ER P26 has been withdrawn.

The guidance in this EREC will be of interest to designers of consumer low voltage (LV) installations and it is expected that such persons are conversant with the requirements of BS 7671 (IET Wiring Regulations).

This EREC provides guidance on the estimation of maximum prospective short-circuit current (PSCC) on the LV Distributor network and at the supply terminals.

This EREC also provides commentary on the selection of protective devices based on the estimated PSCC.

The advice contained in this EREC is given to the best knowledge, based on information available. No guarantee can be given however that the information will not change in the future. The Distributor cannot be held responsible for costs incurred due to inaccuracies or subsequent changes. Where the reader of this EREC is in doubt regarding the guidance provided, they should consult with the relevant Distributor.

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.

Introduction

The Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002 (as amended) [N1] enforces statutory requirements for Distributors. ESQCR Regulation 28 requires the Distributor to state the 'maximum prospective short-circuit current at the supply terminals'.

ESQCR [N1] also places a responsibility on the consumer of electricity to provide and maintain a safe electrical installation. Electrical installations which are designed to the requirements of BS 7671 are deemed to comply with the safety requirements in ESQCR [N1].

Regulation 612.11 of BS 7671 requires that the prospective fault current, under both short-circuit and earth fault conditions, be measured, calculated or determined by another method, at the supply terminals. This information may then be used in the selection of equipment in conjunction with appropriate Standards or manufacturer's information.

NOTE: ESQCR Regulation 28 also requires the Distributor to state 'the maximum earth loop impedance of the earth fault path outside the installation'. This is covered by ENA ER P23 [N3].

1 Scope

This Engineering Recommendation (EREC) provides guidance on the estimation of maximum prospective short-circuit current (PSCC) at the supply terminals of existing and planned electrical installations which are connected to Distributor LV networks via a single-phase service line of a capacity up to 100 A or a three-phase line of capacity up to 300 kVA.

Author Note: Previous P26 scope was not accurately defined. Reviewers asked to comment on a limit of 300 kVA for 3-phase supplies in the context of this document.

For three-phase supplies, where the service arrangement consists of more than one separately protected three-phase line, direct from the Distributor's LV bus-bars in the substation, individual guidance should be given on application to the Distributor.

Because of the particular conditions which apply in London, Merseyside and North Wales, the guidance in this EREC may not be fully appropriate for installations in these regions. Suitable guidance should be obtained direct from the Distributors operating in these regions.

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 publications

BS HD 60269-3, BS 88-3, *Low-voltage fuses. Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications). Examples of standardized systems of fuses A to F*

BS EN 61439-3, *Low-voltage switchgear and controlgear assemblies. Distribution boards intended to be operated by ordinary persons (DBO)*

BS 7671:2008+A1:2015, *Requirements for Electrical Installations. IET Wiring Regulations*

Other publications

[N1] Statutory Instrument 2002 No. 2665, *The Electricity Safety, Quality and Continuity Regulations 2002 (as amended)*[1]

[N2] Meter Operator Code of Practice Agreement, www.mocopa.org.uk

[N3] ENA ER P23, Customers' earth fault protection for compliance with IEE Wiring Regulations for electrical installations.

[N4] ENA EREC G81, *Framework for new low voltage housing development installations Parts 1*-6.

[N5] ENA EREC P5, *Methods to determine demand characteristics for LV underground networks which are designed for new housing developments*

[N6] ENA ER G74, *Procedure to meet the requirements on IEC 60909 for the calculation of short-circuit currents in three-phase AC power systems*

[N7] ENA TS 35-1 Part 1, *Distribution transformers. Part 1 Common clauses*

3 Terms and definitions

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

3.1
consumer
person who takes electricity at the supply terminals

NOTE: Consumers will include both domestic and commercial/industrial supplies.

3.2
Distributor
company licenced to operate an electricity network

NOTE: A distribution network operator (DNO) and independent distribution network operator (IDNO) are both Distributors.

3.3
LV
low voltage as defined in BS 7671

[1] In Northern Ireland, the Electricity Safety, Quality and Continuity Regulations (Northern Ireland) 2012 apply. Some aspects of overhead line clearances in this Specification may not apply retrospectively to existing overhead lines subject to the requirements of Regulation 2(9) with regard to "material alteration".

3.4
HV
6600 volts or 1100 volts

3.5
meter operator
registered authority under the MOCoPA, installing and maintaining electricity meters

3.6
MOCoPA
Meter Operator Code of Practice Agreement [N2]

3.7
prospective short circuit current (PSCC)
current that would flow in a circuit, in the event of a short-circuit of negligible impedance, if the overcurrent protective device were replaced by a conductor of negligible impedance

NOTE 1: PSCC is measured as the r.m.s (root mean square) value of the a.c. component.

NOTE 2: The actual fault current will be less if the protective device has a current limiting feature or an appreciable impedance.

NOTE 3 Referred to as 'prospective fault current' in BS 7671.

3.8
power factor (p.f.)
ratio of the real power, flowing to the load, to the apparent power in the circuit

NOTE 1: Power factor = $\cos(\tan^{-1} X/R)$.

NOTE 2: Power factor and the X/R ratio are both expressions of the same characteristic.

3.9
rated breaking capacity
maximum value of prospective current at which the device is capable of complying with a prescribed test duty cycle at the prescribed voltage and power factor

3.10
supply terminals
ends of the electric lines situated upon any consumer's premises at which the supply is delivered and, unless otherwise agreed in writing, where a meter is employed to register the value of the supply and is directly connected to those lines, the terminals of that meter furthest from the installation of the owner of that meter

NOTE: Referred to as 'origin of an installation' in BS 7671.

4 The incoming service arrangements

4.1 General

The following sub-clauses provide a brief description of the service arrangements for typical single-phase and three-phase supplies. The design and installation of LV supplies should generally be completed in accordance with the following documents, as appropriate.

a) Distributor specific Standards

b) ENA EREC G81 [N4] relevant Parts

c) ENA EREC P5 [N5]

The user of this EREC should ensure they are familiar with the responsibilities of the consumer, Distributor and the meter operator. For the meter operator, the MOCoPA [N2] defines responsibilities.

4.2 Single-phase supplies

The Distributor LV distribution main is typically overhead or underground and installed along the public pathway or road either at the front of the property or on the far side of the road. In new open plan housing estate developments the LV distribution main would normally be located in the public footpath at the front of the house.

The Distributor incoming service line is either overhead or underground. It is most likely to be directly connected to the nearest point of the LV distribution main.

The service termination is typically accommodated within the premises or in an external meter cabinet. The service termination normally consists of a termination for the service line as an integral part of a cut-out unit. The cut-out consists of a solidly connected neutral and is fitted with a single pole fuse-link to BS HD 60269-3, BS 88-3 Type II which should be rated, up to 100 A, and in accordance with the Distributor's requirements.

NOTE: New domestic supplies typically have a 100 A cut-out fuse-link fitted. Older domestic supplies may have an 80 A or 60 A cut-out fuse-link fitted.

The Distributor cut-out fuse-link is installed to meet the requirements of ESQCR Regulation 24.The cut-out fuse-link protects the Distributor's service line from overcurrent but also provides protection against overcurrent in the zone between the output terminals of the cut-out and the supply terminals. This zone includes the electricity meter(s) and any control devices installed for tariff purposes. Under the terms of the MOCoPA [N2], the responsibility for the connection between the cut-out and the meter rests with the meter operator.

The connections and equipment on the load side of the supply terminals (e.g. in the consumer unit) are the property and responsibility of the consumer. Refer to Clause 7 for guidance on selection of protection device.

If the Distributor cut-out fuse-link may not clear faults on the consumer's installation and the Distributor cannot accept responsibility for consequent damage to the consumer's installation. The Distributor has the right to charge the consumer the cost of supplying and fitting a replacement cut-out fuse-link in this event.

Author Note: Is the 'right to charge' current and relevant?

4.3 Three-phase supplies

Three-phase LV supplies are typically provided by an underground or overhead circuit and designed depending on the size and type of connection, and in accordance with the Distributor's requirements. A number of possible arrangements are described in items a), b) and c).

a) Three-phase cut-out and service line, connected to the Distributor LV distribution main.

b) Three-phase cut-out and service line, connected to the LV bus-bar at the Distributor's substation.

c) Consumer's cables connected to the LV bus-bar at the Distributor's substation.

The requirements for the three-phase supply are generally the same as for single-phase supplies governed by ESQCR [N1] and defined in BS 7671 and the Distributor's documentation.

5 The PSCC on the Distributor's LV distribution network

5.1 General

The PSCC available at any point of the Distributor's LV network, including the consumer's supply terminals, is directly related to the overall network capacity and the distance from the supply source.

Changes to the LV network in the course of time: increasing demand leading to additional capacity to be installed, or connection of distributed generation, may cause the PSCC to increase. To avoid the need for repeated changes in the protective equipment and the consequent costs, Distributors normally design their LV network to a maximum PSCC and select the equipment for their network accordingly. This equipment includes the Distributor's switchgear, for example, the cut-out and fuse-link.

It is strongly recommended that designers of consumer installations should adopt the same approach in selecting equipment, particularly where it will be required to operate close up to the supply terminals.

5.2 Basis of calculation of the maximum PSCC

Short-circuit calculations on the Distributor's HV network are carried out in accordance with ENA ER G74 [N6]. For the Distributor's LV network, the maximum PSCC is generally determined by fault calculation based on the Distributor's: HV network fault level; the distribution transformer impedance; and the voltage at the secondary side of the distribution transformer. The following values are applied in the calculation of maximum PSCC.

a) Distributor HV network fault level: 250 MVA (X/R ratio = 10).

b) Distribution transformer: three-phase transformer with maximum rating of 1000 kVA and impedance of 4.75% in accordance with ENA TS 35-1 Part 1 [N7].

c) Phase-to-phase voltage on secondary side of distribution transformer: 433 V.

Using the above values and also taking account of the size and length (impedance) of the LV distribution main and service cables connected to the transformer secondary, a maximum PSCC value is calculated.

Author Note: The reviewers should consider how distributed generation is accounted for. At the very least there should be a rule of thumb as to when generation should be added to the calculation (capacity greater than X% of transformer rating) and how the value could be calculated (current source of a certain value based on the aggregated export capacity?) Reviewers to comment.

5.3 PSCC on the Distributor's LV distribution main

Given the range of LV distribution mains cables used in Distributor's LV networks, the maximum design value of the PSCC for single-phase 230 V supplies should be taken as 16 kA at the point of connection of the service line to the LV distribution main.

Within the London region special conditions apply and it is recommended that the maximum PSCC for such supplies is taken as 16 kA at the supply termination (cut-out). High load density areas of other major city centres may warrant the same special consideration.

5.4 PSCC for three-phase LV supplies

The maximum design value of PSCC for three-phase 400 V supplies in situations where the service line is connected direct to the LV bus-bar of the Distributor's substation should be taken as 25 kA at the point of connection.

In cases where the service line is connected to Distributor's LV main, the maximum design value for the PSCC of 18 kA at the point of connection of the service line is recommended.

6 Estimation of the PSCC at the supply terminals

6.1 General

The maximum PSCC values described in Clauses 5.3 and 5.4 will be subject to attenuation by the service line which should be accounted for in estimating the maximum PSCC at the consumer's supply terminal.

An indication of the power factor (p.f.) is provided in the following sub-clauses, which is of interest when selecting protective equipment (see Clause 7). The p.f. indicated is calculated for fault conditions and does not relate to the power factor of the installation under normal load conditions.

6.2 Single-phase supplies

Table 1 shows the maximum PSCC and power factor for service line lengths up to 20 m, based on 16 kA (p.f. 0.44) at the tee-off point, for a single 100 A service. Two sets of values are given to account for the range and sizes of cables and overhead lines in use by the Distributors.

The service line length may be measured or estimated from site plans as the shortest distance from the edge of the footpath nearest the installation to the service cut-out. Even if the position of the LV main is known to be on the far side of the road, this additional length should not be included since it is not uncommon to increase the capacity of the LV distribution network by installing additional LV distribution mains.

For the majority of installations covered by this Engineering Recommendation, the consumer's switchgear will be positioned approximately within a metre of the Distributor cut-out. Where this is not the case, for example in some forms of multiple-occupancy building, the designer may wish to allow for the additional attenuation in PSCC due to the length of distributor cable between the cut-out and the consumer's switchgear. The designer may find it convenient to add the service line length estimated to the length of the distributor cable within the installation and read the PSCC from Table 1. Alternatively the PSCC estimated at the cut-out may be used as a basis for calculating additional attenuation.

NOTE: This Clause is not applicable to installations within the London region.

Table 1 — Estimated maximum PSCC at the Distributor cut-out based on declared level of 16 kA (0.44 p.f.) at the point of connection of the service line to the LV distribution main

Length of service line (m)	Up to 25 mm² Al or 16 mm² Cu Service Cable or Overhead line		Up to 35 mm² Al or 25 mm² Cu Service Cable or Overhead line	
	PSCC (kA)	p.f.	PSCC (kA)	p.f.
0	16	0.44	16	0.44
1	14.5	0.50	15	0.50
2	12.8	0.55	13.8	0.56
3	11.5	0.60	12.7	0.60
4	10.4	0.63	11.7	0.65
5	9.5	0.67	10.8	0.69
6	8.7	0.69	10.1	0.71
7	8.0	0.71	9.4	0.74
8	7.5	0.73	8.8	0.77
9	7.0	0.75	8.3	0.79
10	6.5	0.77	7.8	0.81
11	6.1	0.78	7.4	0.82
12	5.8	0.79	7.0	0.84
13	5.5	0.80	6.6	0.85
14	5.2	0.81	6.3	0.86
15	5.0	0.82	6.0	0.87
16	4.7	0.82	5.8	0.88
17	4.5	0.83	5.5	0.89
18	4.3	0.84	5.3	0.89
19	4.1	0.85	5.1	0.90
20	4.0	0.85	4.9	0.91

Author Note:

PSCC for 25/16 service line calculated using spreadsheet with following selections:

- 25 m of '300 Al U/G' cable = 16.4 kA, 0.44 p.f.
- Increments from 1-20 m of '16 Cu O/H' service.

PSCC for 25/35 service line calculated using spreadsheet with following selections::

- 25 m of '300 Al U/G' cable = 16.4 kA, 0.44 p.f.
- Increments from 1-20 m of '35 Hybrid Service 1PH' service.

Comparing to Issue 1 values, the above values are lower. This may be due to lower cable/overhead impedance values. Alternatively, Issue 1 values may have been subject to a correction factor to increase headroom?

6.3 Three-phase supplies

Table 2 shows the maximum PSCC and power factor at the service entry position for service lines connected direct to the LV bus-bar in the Distributor’s substation. Table 3 shows the maximum PSCC and power factor at the cut-out for service lines connected to an LV distribution main. Both Table 2 and 3 provide the information for lengths of service line up to 50 m.

To use the tables it is necessary to ascertain the length and cross-sectional area of the service line phase conductors. For Table 2, information on the length of the service line will normally be available. For Table 3, the service line length may be measured or estimated from site plans as the shortest distance from the public right of way nearest the installation to the cut-out. This procedure is recommended since, even if the precise position of the LV distribution main or of the service line is known at the design stage, it may be necessary to move them in the future.

In the case where the supply terminals are a cut-out arrangement and the consumer’s switchgear is positioned more than one metre electrically from the cut-out, the designer may wish to allow for additional attenuation in the PSCC due to the length of distributor cable between the cut-out and the consumer's switchgear. The designer may find it convenient to add the service line length estimated to the length of distributor cable within the installation and read the PSCC from Tables 2 or 3. Alternatively, the PSCC estimated at the cut-out may be used as a basis for calculating the additional attenuation.

Tables 2 and 3 are based on standard aluminium cables in metric sizes. Table 4 gives approximate equivalent sizes of copper conductor in metric and imperial units and of aluminium conductor in imperial units.

Table 2 — Estimated maximum PSCC at the Distributor's cut-out based on declared level of 25 kA (0.23 p.f.) at the point of connection of the service line to the LV bus-bar in the Distributor's substation.

Length of service line (m)	Service line cross-sectional area									
	95 mm² Al		120 mm² Al		185 mm² Al		240 mm² Al		300 mm² Al	
	PSCC (kA)	p.f.	PSCC (kA)	p.f.	PSCC (kA)	p.f.	PSCC (kA)	p.f.	PSCC (kA)	p.f.
0	25	0.23	25	0.23	25	0.23	25	0.23	25	0.23
5	23.6	0.40	23.9	0.38	24.4	0.32	24.6	0.30	24.7	0.28
10	21.1	0.53	21.9	0.47	22.9	0.39	23.2	0.35	23.5	0.33
15	18.8	0.62	20.0	0.56	21.4	0.46	22.0	0.40	22.4	0.37
20	16.8	0.69	18.2	0.62	20.1	0.51	20.8	0.48	21.3	0.40
25	15.1	0.74	16.7	0.67	18.8	0.55	19.7	0.49	20.3	0.44
30	13.7	0.78	15.3	0.72	17.7	0.59	18.7	0.51	19.4	0.47
35	12.5	0.81	14.1	0.75	16.6	0.62	17.8	0.55	18.6	0.49
40	11.4	0.83	13.1	0.78	15.7	0.65	16.9	0.57	17.8	0.51
45	10.5	0.85	12.1	0.80	14.8	0.68	16.1	0.60	17.0	0.54
50	9.8	0.86	11.3	0.82	14.0	0.70	15.4	0.62	16.4	0.55

Author Note:

PSCC values calculated using spreadsheet as follows:

1. For 95 - used the '95 Al U/G'. Values align with previous issue until 15 m where figures diverge.
2. For 120 - used the '120 Al U/G'. Values align with previous issue until 20 m where figures diverge.
3. For 185 - used the '185 Al U/G'. Values align with previous issue until 30 m where figures diverge.
4. For 240 - used the '240 Consac'. Values align with previous issue until 35m where figures diverge.
5. For 300 - used the '300 Al U/G'. Values align with previous issue.

Table 3 — 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.

Length of service line (m)	Service line cross-sectional area													
	Up to 35 mm^2 Al		70 mm^2 Al		95 mm^2 Al		120 mm^2 Al		185 mm^2 Al		240 mm^2 Al		300 mm^2 Al	
	PSCC (kA)	p.f.	PSCC (kA)	p.f.	PSCC (kA)	p.f.	PSCC (kA)	p.f.	PSCC (kA)	p.f.	PSCC (kA)	p.f.	PSCC (kA)	p.f.
0	18	0.50	18	0.50	18	0.50	18	0.50						
5	14.7	0.70	16.4	0.61	16.7	0.58	17.2	0.56	17.5	0.53	17.7	0.52	17.8	0.51
10	11.7	0.81	14.4	0.70	15.3	0.65	15.8	0.61	16.5	0.57	16.8	0.55	17.0	0.54
15	9.6	0.87	12.8	0.76	13.9	0.70	14.7	0.66	15.6	0.60	16.1	0.57	16.4	0.55
20	8.0	0.91	11.4	0.80	12.8	0.74	13.6	0.70	14.8	0.63	15.3	0.60	15.7	0.57
25	6.9	0.93	10.2	0.83	11.7	0.78	12.7	0.73	14.0	0.66	14.7	0.62	15.1	0.59
30	6.0	0.94	9.3	0.86	10.8	0.80	11.8	0.76	13.3	0.68	14.1	0.64	14.5	0.60
35	5.4	0.95	8.5	0.88	10.0	0.82	11.1	0.78	12.7	0.70	13.5	0.65	14.0	0.61
40	4.8	0.96	7.8	0.89	9.3	0.84	10.4	0.80	12.1	0.71	12.9	0.66	13.5	0.63
45	4.4	0.96	7.2	0.90	8.7	0.85	9.8	0.81	11.6	0.73	12.4	0.68	13.1	0.64
50	4.0	0.97	6.7	0.92	8.2	0.87	9.3	0.83	11.1	0.74	12.0	0.69	12.6	0.65

Author Note:

PSCC values calculated using spreadsheet as follows:

35 m of '300 Al U/G' added to reduce 3-phase fault level to 18 kA. Then increments of the following used.

1. For up to 35 - used the '35 Al U/G'. Values align with previous issue until 10 m where there is then divergence.
2. For 70 - used the '70 Al U/G'. Values align with previous issue until 15 m where there is then divergence.
3. For 95 - used the '95 Al U/G'. Values align with previous issue until 20 m where there is then divergence.
4. For 120 - used the '120 Al U/G'. Values align with previous issue until 25 m where there is then divergence.

5. For 185 - used the ‘185 Al U/G’. Values align with previous issue until 35 m where there is then divergence.

6. For 240 - used the ‘240 Consac’. Values are slightly greater than previous issue.

7. For 300 - used the ‘300 Al U/G’. Values are slightly greater than previous issue.

Table 4 — Approximate equivalent cable sizes for use with Tables 2 and 3.

Aluminium metric cable (mm^2)	Copper metric cable (mm^2)	Copper imperial cable (in^2)	Aluminium imperial cable (in^2)
70	35	0.06	0.1
95	-	-	-
120	70	0.1	0.15
150	95	-	0.2
185	-	0.15	0.25
240	120	0.20	0.3

7 Selection of protective devices

7.1 General

It is the designer's responsibility to select protective devices for protection of the consumer installation against fault current in accordance with Regulation 434 of BS 7671.

If the rated breaking capacity of the proposed device is equal to or greater than the maximum PSCC as stipulated in Clause 5 or as estimated in Clause 6, no further consideration may be necessary.

In accordance with Regulation 434.3 of BS 7671, a protective device may not be needed if, at the supply terminals, the "Distributor installs one or more devices providing protection against fault current and agrees that such a device affords protection to the part of the installation between the origin and the main distribution point of the installation where further protection against fault current is provided".

When performing short-circuit calculations, it is important to consider the power factor (similarly the X/R ratio). The lower the power factor (higher the X/R ratio), the greater the degree of magnetic energy stored in the system and so the greater is the energy of the arc (higher the fault current) which the protection has to control. Therefore, when verifying the ratings of electrical equipment, both rated breaking capacity and the power factor must be taken into consideration.

AUTHOR NOTE: The reviewer's attention is drawn to the following information in a publication by Electrical Contractors' Association *Guide to the Wiring Regulations 17th Edition IEE Wiring Regulations (BS 7671: 2008*)

Under Section C4.4 of the publication, the following is written:

"*The DNO will supply this information and usually quote a maximum fault current of 16 kA. This is a theoretical maximum that is rarely found in practice. This level of fault will mean that MCBs will need to be rated at 16 kA. Whilst it is possible to purchase 16 kA devices, they are usually double width and often more expensive than the 3, 6, 9 or 10 kA devices. …..For most domestic installations the prospective fault current is unlikely to exceed 6 kA*"

The above reference has been added to the bibliography as it is deemed appropriate and relevant.

7.2 Single-phase supplies

For single-phase supplies, when the rated breaking capacity of the protection equipment is less than this maximum PSCC it is possible to allow at the design stage for the limitation in fault energy let through by the Distributor cut-out fuse (see BS 7671 Clause 435.5.1). If this option is used, the designer should assume that the cut-out will contain a 100 A fuse-link to BS HD 60269-3, BS 88-3. The designer should also take into account the requirements in BS 7671 to avoid danger and minimise inconvenience in the event of faults (Regulation 314.1).

In order to assist designers in selecting protective devices in conjunction with the limitation in energy let-through of the Distributor cut-out fuse-link, the conditional testing procedure has been established in Annex ZB of BS EN 61439-3. Whenever devices are selected on the basis of the conditional test the designer should ensure that the conditions that pertain within the installation are not more onerous than those required by BS EN 61439-3.

7.3 Three-phase supplies

Installations supplied by a three-phase service line which consist only of separated single-phase equipment, so that there is no possibility of a phase-to-phase fault within the installation, could be regarded so far as the selection of protective equipment is concerned, as single-phase installations. In such cases for service line sizes up to 35 mm^2 the guidance given for single-phase supplies in this EREC may be applied.

Bibliography

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[1] Electrical Contractors' Association (ECA) Guide to the Wiring Regulations 17th Edition IEE Wiring Regulations (BS 7671: 2008)