Draft for Public Comment BS 7671:2008 Amendment 3

si.

Requirements for Electrical Installations

Draft for Public Comment Amendment 3

IET Wiring Regulations Seventeenth Edition



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Introduction to the Draft for Public Comment (DPC)

This draft for public comment on BS 7671:2008 Amendment 3 is based on IEC/CENELEC standards. The UK's ability to change the requirements is limited, however within that constraint comments are welcome.

Whilst the committees (JPEL/64 and its four panels) are particularly interested in comments on the draft changes contained within this document, they will also consider any other comments relating to BS 7671.

All comments must be received by the IET before 8th March 2014 and must be made on the official form which can be found on the IET website at www.theiet.org/updates. Copies of this DPC may also be obtained from that site.

The actual Amendment 3 has an expected publication date of January 2015. It will contain updated text for the following, which are not included in this DPC:

- (i) Foreword and Introduction to BS 7671:2008
- (ii) Editions
- (iii) Constitution
- (iv) Preface
- (v) Note by the Health and Safety Executive
- (vi) Appendix 1, British Standards to which reference is made in the Regulations
- (vii) Appendix 2, Statutory regulations and associated memoranda
- (viii) Index.

In an attempt to aid understanding:

- (i) **Text that has not been changed is generally not shown**, except where it has been left as an aid to the reader's understanding
- (ii) Text that has been deleted has been "struck through" and added text has been underlined; the change is also marked with a side bar.

Please note that:

- (i) Some trivial editorial changes and cross references have not been marked (so as not to waste commenter's time)
- (ii) In the case of some figures and equations it was clearer to show them crossed out, and then add the new version next to them (but the side bar is still present)
- (iii) In the case of some major additions it was clearer to add them without the underline, however their titles are underlined and have a side bar, so it should be obvious that the text has been added.

Introduction to the third amendment

The third amendment to BS 7671:2008 Requirements for Electrical Installations is expected to be published on 1st January 2015 and is intended to come into effect on 1st July 2015. Installations designed after 30th June 2015 are to comply with BS 7671:2008 incorporating Amendment 3, 2015.

A summary of the main changes is given below.

NOTE: This is not an exhaustive list.

New numbering system The 17th edition introduced a new IEC decimal point numbering system. For the third amendment 100 numbers represent CENELEC Harmonization Document reference numbers and 200 numbers represent UK-only regulations.

- **NOTE:** At DPC stage (which is a transition stage) there may be some UK-only regulations with 100 numbers that will be updated to the 200 numbering system prior to publication of Amendment 3.
- **Part 2** Definitions have been expanded and modified, including some new symbols. A list of Abbreviations used in the Regulations has been added.
- **Part 3** Assessment of general characteristics (Chapter 33 compatibility) Regulation 332.1 has been modified; it no longer refers to installations but only to equipment.

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Chapter 41 Protection against electric shock

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Reference to ordinary persons in Regulation 411.3.3 has been deleted. The regulation now requires RCD protection in accordance with Regulation 415.1 for socket-outlets up to 20 A (and for mobile equipment up to 32 A for use outdoors) for all installations. However, there is an exception for RCD protection (for socket-outlets up to 20 A) for a specific labelled socket-outlet, or where a documented risk assessment determines that RCD protection is not necessary.

Regulations 411.4.5, 411.5.4 and 411.6.4 now include a Cmin factor.

Maximum earth fault loop impedances given in Tables 41.2, 41.3, 41.4 and 41.6 have been revised to take account of the C_{min} factor given in CLC/TR 50480:2011. C_{min} is the minimum voltage factor to take account of voltage variations depending on time and place, changing of transformer taps and other considerations. Also, the notes to the Tables have been changed in connection with maximum permitted operating temperature.

Chapter 42 Protection against thermal effects The existing regulations have been modified slightly and a new Section 424 – Protection against overheating, has been added. A new Regulation 421.1.200 has also been included.

Regulation 421.1.200 now requires switchgear assemblies including consumer units to have their enclosure manufactured from non-combustible or not readily combustible material or be enclosed in a cabinet or enclosure constructed of non-combustible or not readily combustible material.

Chapter 43 Protection against overcurrent contains only minor corrections.

Chapter 44 Protection against voltage disturbances and electromagnetic disturbances Section 442 which deals with protection of low voltage installations against temporary overvoltages due to earth faults in the high voltage system and due to faults in the low voltage system, has been modified. Regulation 442.2.1 has been redrafted and Table 44.2 removed.

Chapter 51 Common rules includes a number of changes. Section 551 concerning compliance with standards requires all equipment to be suitable for the nominal voltage and also requires certain information to be noted on the Electrical Installation Certificate.

Section 512 now makes reference to the EMC Directive and includes requirements for the designer of the fixed installation.

Minor modifications have been made to Sections 513 and 514.

Chapter 52 Selection and erection of wiring systems

A new Regulation (521.200) is included, giving requirements for the methods of support of wiring systems in escape routes.

The regulations concerning selection and erection of wiring systems (impact) have been redrafted. Reference to "under the supervision of a skilled or instructed person" has been removed.

It is now required to protect cables concealed in a wall or partition (at a depth of less than 50 mm) by a 30 mA RCD for all installations if other methods of protection including use of cables with an earthed metallic covering or mechanical protection are not employed. This applies to a cable in a partition where the construction includes metallic parts other than fixings, irrespective of the depth of the cable. There is still an exception for cables forming part of a SELV or PELV circuit.

Chapter 53 Protection, isolation, switching, control and monitoring includes minor changes.

Chapter 55 Other equipment

Some changes have been made to Regulation 551.7.1 concerning low voltage generating sets.

A new Section 557 Auxiliary circuits is included. Auxiliary circuits (defined in Part 2) are circuits for transmission of signals intended for control, detection, supervision or measurement of the functional status of a main circuit such as circuits for control, signalling and measurement. Auxiliary circuits where specific standards exist, for example the construction of assemblies of electrical equipment etc. are excluded. The new section covers issues such as a.c. or d.c. power supplies for auxiliary circuits either dependent on the main circuit, or supplied by an independent source; protection against overcurrent; and wiring systems. Special requirements for auxiliary circuits used for measurement are also included.

Section 559 Luminaires and lighting installations Requirements for outdoor lighting installations and extra-low voltage lighting installations have been moved to new Sections 714 and 715 respectively. A number of changes have been made to the requirements in 559 (luminaires and lighting installations), 714 (outdoor lighting installations) and 715 (extra-low voltage lighting installations). For example, 715 includes additional requirements for isolation, switching and control.

Part 6 Inspection and testing Minor changes to Chapters 61, 62 and 63.

Part 7 Special installations or locations

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Section 701 Locations containing a bath or shower

Regulation 701.411.3.3 now requires all low voltage circuits serving or passing through the location to be RCD protected.

Section 704 Construction and demolition site installations The previous exclusion of mining applications in Regulation 704.1.1 has been deleted.

Section 711 Exhibitions, shows and stands Reference to a skilled/competent person has been removed in Regulation 711.55.6.

Section 712 Solar photovoltaic (PV) power supply systems Minor changes including changes to the general schematic.

Sections 714 and 715 Outdoor lighting and Extra-low voltage lighting installations A number of changes have been made to the requirements in 714 and 715. For example 715, includes additional requirements for isolation, switching and control.

Section 717 Mobile or transportable units contains a number of changes including a new Regulation 717.413 giving requirements for electrical separation. Also, a new Regulation 717.551.6 has been added, which prohibits units with different power supply systems and different earthing systems being interconnected. Also, changes have been made to the figures showing examples of connections associated with the mobile or transportable unit.

The following main changes have been made within the appendices:

Appendix 1 British Standards to which reference is made in the Regulations includes minor changes.

Appendix 3 Time/current characteristics of overcurrent protective devices and RCDs includes changes in connection with maximum earth fault loop impedance, to take account of the C_{min} factor given in CLC/TR 50480:2011. C_{min} is the minimum voltage factor to take account of voltage variations depending on time and place, changing of transformer taps and other considerations. Also, changes have been made to the Figures/Tables in connection with maximum operating time/current characteristics and a new table for fuses to BS 88-2 fuse system E has been added.

Appendix 4 Current-carrying capacity and voltage drop for cables contains a number of changes, including modifications to Tables 4A3, 4C3, and 4F4A. Reference is now made to PD CLC/TR 50480 for calculating circuit impedances, fault currents and other parameters. Reference is also made to the national annex to PD CLC/TR 50480 giving calculation methods for cable resistance and reactance, earth fault loop impedance for cables in conduit, etc and ring circuits.

Appendix 6 Model forms for certification and reporting The Schedule of inspections (for new work only) has been replaced by examples of items requiring inspection during initial verifications (which must be appended to the Electrical Installation Certificate).

Also, some small changes have been made to the Electrical Installation Condition Report and associated notes, including a requirement to carry out an inspection within an accessible roof space where electrical equipment is present.

Appendix 14 Measurement of earth fault loop impedance

The equation for earth fault loop impedance has been changed to take account of the C_{min} voltage factor given in CLC/TR 50480:2011.

PART 1

SCOPE, OBJECT AND FUNDAMENTAL PRINCIPLES CHAPTER 11 SCOPE

110.1 GENERAL

110.1.3 The Regulations are intended to be applied to electrical installations generally but, in certain cases, they may need to be supplemented by the requirements or recommendations of other British or Harmonized Standards or by the requirements of the person ordering the work.

Such cases include the following:

- (i) Electric signs and high voltage luminous discharge tube installations BS 559 and BS EN 50107
- (ii) Emergency lighting BS 5266
- (iii) Electrical apparatus for explosive gas atmospheres BS EN 60079
- (iv) Electrical apparatus for use in the presence of combustible dust BS EN 50281 and BS EN 61241
- (v) Fire detection and fire alarm systems in buildings BS 5839
- (vi) Telecommunications systems BS 6701
- (vii) Electric surface heating systems BS EN 60335-2-96
- (viii) Electrical installations for open-cast mines and quarries BS 6907
- (ix) Code of practice for tT emporary electrical systems for entertainment and related purposes BS 7909
- (x) Life safety and firefighting applications BS 8519 and BS 9999.

110.2 EXCLUSIONS FROM SCOPE

The Regulations do not apply to the following installations:

- (i) Systems for the distribution of electricity to the public
- (ii) Railway traction equipment, rolling stock and signalling equipment
- (iii) Equipment of motor vehicles, except those to which the requirements of the Regulations concerning caravans or mobile units are applicable
- (iv) Equipment on board ships covered by BS 8450
- (v) Equipment of mobile and fixed offshore installations
- (vi) Equipment of aircraft
- (vii) Those aspects of mines and quarries specifically covered by Statutory Regulations
- (viii) Radio interference suppression equipment, except so far as it affects safety of the electrical installation
- (ix) Lightning protection systems for buildings and structures covered by BS EN 62305
- (x) Those aspects of lift installations covered by relevant parts of BS 5655 and BS EN 81-1
- (xi) Electrical equipment of machines covered by BS EN 60204
- (xii) Electric fences covered by BS EN 60335-2-76-
- (xiii) The d.c. side of cathodic protection systems complying with the relevant part(s) of BS EN 12696, BS EN 12954, BS EN 13174, BS EN 13636 and BS EN 14505.

CHAPTER 13

FUNDAMENTAL PRINCIPLES

132 DESIGN

132.15 Isolation and switching

132.15.1.200 Effective means, suitably placed for ready operation, shall be provided so that all voltage may be cut off from every installation, from every circuit thereof and from all equipment, as may be necessary to prevent or remove danger.

132.15.2.201 Every fixed electric motor shall be provided with an efficient means of switching off, readily accessible, easily operated and so placed as to prevent danger.

134 ERECTION AND INITIAL VERIFICATION OF ELECTRICAL INSTALLATIONS

134.1 Erection

134.1.1 Good workmanship by <u>competent persons or persons under their supervision skilled (electrically) or instructed (electrically) persons and proper materials shall be used in the erection of the electrical installation. Electrical equipment shall be installed in accordance with the instructions provided by the manufacturer of the equipment. The installation of electrical equipment shall take account of manufacturers' instructions.</u>

134.2 Initial verification

134.2.1 During erection and on completion of an installation or an addition or alteration to an installation, and before it is put into service, appropriate inspection and testing shall be carried out by competent persons electrically skilled persons competent to verify that the requirements of this Standard have been met.

Appropriate certification shall be issued in accordance with Sections 631 and 632.

PART 2

DEFINITIONS

Competent person. A person who possesses sufficient technical knowledge, relevant practical skills and experience for the nature of the electrical work undertaken and is able at all times to prevent danger and, where appropriate, injury to him/herself and others.

Instructed person <u>(electrically)</u>. A pPerson adequately advised or supervised by <u>electrically</u> skilled persons to enable him<u>/ or her to perceive risks and to avoid dangers hazards which electricity <u>may can</u> create.</u>

Ordinary person. A pPerson who is neither a skilled person nor an instructed person.

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Skilled person <u>(electrically)</u>. A <u>pP</u>erson with <u>technical knowledge or sufficient relevant education and experience</u> to enable him<u>/or</u> her to <u>perceive risks and to</u> avoid <u>dangers hazards</u> which electricity <u>may can</u> create.

Auxiliary circuit. Circuit for transmission of signals intended for control, detection, supervision or measurement of the functional status of a main circuit.

LV-Low voltage switchgear and controlgear assembly. A eCombination of one or more low voltage switching devices together with associated control, measuring, signalling, protective, regulating equipment, etc., completely assembled under the responsibility of the manufacturer with all the internal electrical and mechanical interconnections and structural parts. The components of the assembly may be electromechanical or electronic. The assembly may be eithertype tested or partially type tested (see BS EN 601439-1).

Non-flame propagating. Liable to ignite as a result of an applied flame but in which the flame does not propagate and which extinguishes itself within a limited time after the flame is removed.

Rated impulse withstand voltage level (U_w), {534}. The level of impulse withstand voltage assigned by the manufacturer to the equipment, or to part of it, characterizing the specified withstand capability of its insulation against overvoltages. **NOTE:** For the purposes of BS 7671, only withstand voltage between live conductors and \underline{eE} arth is considered.

SYMBOLS USED IN THE REGULATIONS including first reference

Cd	rating factor for depth of burial		Appx 4 sec 5. 3	$mV/A/m$ voltage drop per ampere per metre $mVA^{-1}m^{-1}$	Appx 4 sec 6
$C_{\mathbf{f}}$	rating factor for semi-enclosed fuse to BS 3036		Appx 4 sec 5. 3		
<u>Cmax</u>	maximum voltage factor		Not used		
<u>Cmin</u>	minimum voltage factor		<u>411.4.5</u>		
Cs	rating factor for thermal soil resistivity		Appx 4 sec 5. 3		
Ŧ	group rating factor		Appx 4 sec 2.3.3.1		
<u>f</u>	frequency in cycles per second	Hz	<u>Appx 6</u>		
I _{h5}	5 th -harmonic current	A	Appx 4 sec 5.6		

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ABBREVIATIONS USED IN THE REGULATIONS including first reference

<u>breviation</u>	wording in full	<u>First use</u>	Abbreviation	<u>1 Wording in full</u>	<u>First</u>
<u>28</u>	Assembly for Construction Sites	704.537.2.2	HSE	Health and Safety Executive	
N	Bonding network	<u>Part 2</u>	HTM	Health Technical Memorandum	<u>710.1 note</u>
<u>RC</u>	Bonding ring conductor	<u>A444.1.4</u>	HV	High voltage	
<u>s</u>	British Standard	<u>110.1.3</u>	<u>IEC</u>	International Electrotechnical	<u>133.1.1</u>
<u>s au</u>	British Standard Automotive Series	<u>A721.55.2.6</u>		Commission	
<u>s en</u>	British Standard Euro Norm (BSI published version of European	<u>110.1.3</u>	<u>IEC/TS</u>	International Electrotechnical Commission Technical Specification	<u>706.1</u>
S EN ISO	harmonized standard) A BS EN which has the core text of an	A721.55.2.6	<u>IET</u>	Institution of Engineering and Technology	
	ISO standard		IMD	Insulation monitoring device	<u>411.6.3</u>
<u>SI</u>	British Standards Institution		<u>IP</u>	International Protection Code	<u>412.2.2.3</u>
<u>SI IEC</u>	British Standards Institution	<u>523.3</u>	<u>ISO</u>	International Standards Organisation	<u>A721.533</u>
	International Electrotechnical Commission, A BSI IEC means the		IT	Information technology	<u>443.2.4</u>
	UK has adopted an IEC standard that		<u>LPG</u>	Liquefied petroleum gas	717.528.3
	has not been put through from adoption in Europe		<u>LPZ</u>	Lightning protection zone	<u>534.1</u>
N	Common bonding network	444 5 2	<u>LSC</u>	Luminaire supporting coupler	<u>411.7.5</u>
ENFLEC	European Committee for	Preface	LV	Low voltage	
<u>AILLLC</u>	Electrotechnical Standardization	<u>I Teldee</u>	<u>OCPD</u>	Overcurrent protective device	<u>534.2.3.5</u>
	compact fluorescent lamp	<u>444.6.2</u>	<u>PD</u>	Published Document (IEC)	<u>414.2</u>
LC/TS	European Committee for	<u>534.1</u>	<u>PE</u>	Protective conductor	<u>Fig 3.8</u>
	Electrotechnical Standardization, Technical Specification		PELV	Protective extra-low voltage	<u>410.3.3</u>
<u>c</u>	circuit protective conductor	Part 2	<u>PEN</u>	<u>Protective and neutral conductor</u> (combined)	<u>Fig 3.9</u>
<u>CL</u>	Device for connecting a luminaire	<u>411.7.5</u>	РМЕ	Protective multiple earthing	Fig 3.9
<u>10</u>	Distribution network operator	<u>560.6.9 note 1</u>	PV	Photovoltaic	712.1
<u>.V</u>	Extra-low voltage	<u>Part 2</u>	<u>PVC</u>	Polyvinyl chloride	709.521.1
<u>AC</u>	Electromagnetic compatibility	<u>332.1</u>	RCBO	Residual current circuit-breaker with	Table 41.3
<u>41</u>	Electromagnetic interference	<u>332.2</u>		integral overcurrent protection	
<u>1</u>	European norm		<u>RCCB</u>	Residual current circuit-breaker	<u>Appx 1</u>
<u>VA</u>	Energy Networks Association	560.6.9 note 1	PCD	Paridual aurrent device (DCCD)	
<u>PR</u>	Earth potential rise - stress voltage	<u>442.2</u>	KUD	RCBO)	
<u>SQCR</u>	Electricity Safety, Quality and Continuity Regulations	<u>114.1</u>	<u>RCM</u>	Residual current monitor	<u>411.6.3</u>
<u>/</u>	Electric vehicle	<u>722.511.1</u>	<u>rms</u>	root mean square	<u>133.2.1</u>
ELV	Functional extra-low voltage	<u>411.7</u>	<u>SELV</u>	Separated extra-low voltage	<u>410.3.3</u>
<u>)</u>	Harmonization Document	Preface	<u>SPD</u>	Surge protective device	<u>443.1.1</u>
<u>-</u>	High frequency	Appx 5 concise list			

PART 3 ASSESSMENT OF GENERAL CHARACTERISTICS CHAPTER 33 COMPATIBILITY

332 ELECTROMAGNETIC COMPATIBILITY

332.1 All electrical installations and equipment shall be in accordance with the meet the appropriate electromagnetic compatibility (EMC) regulations requirements and shall be in accordance with the relevant EMC standard.

PART 4 PROTECTION FOR SAFETY

CHAPTER 41

PROTECTION AGAINST ELECTRIC SHOCK

411 PROTECTIVE MEASURE: AUTOMATIC DISCONNECTION OF SUPPLY

411.3 Requirements for fault protection

411.3.3 Additional protection

In a.c. systems, additional protection by means of an RCD in accordance with Regulation 415.1 shall be provided for:

- (i) socket-outlets with a rated current not exceeding 20 A-that are for use by ordinary persons and are intended for general use, and
- (ii) mobile equipment with a current rating not exceeding 32 A for use outdoors.

An exception to (i) is permitted for:

- (a) socket outlets for use under the supervision of skilled or instructed persons, or
- (b) <u>for</u> a specific labelled or otherwise suitably identified socket-outlet provided for connection of a particular item of equipment., or
 - (b) where a documented risk assessment determines that the RCD protection is not necessary.

NOTE 1: See also Regulations 314.1(iv) and 531.2.4 concerning the avoidance of unwanted tripping.

NOTE 2: The requirements of Regulation 411.3.3 do not apply to FELV systems according to Regulation 411.7 or reduced low voltage systems according to Regulation 411.8.

411.4 TN system

411.4.5 The characteristics of the protective devices (see Regulation 411.4.4) and the circuit impedances shall fulfil the following requirement:

 $Z_s \times I_a \leq U_0 \times \underline{C}_{\min}$

where:

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- Z_s is the impedance in ohms (Ω) of the fault loop comprising:
 - the source
 - the line conductor up to the point of the fault, and
 - the protective conductor between the point of the fault and the source.
- I_a is the current in amperes (A) causing the automatic operation of the disconnecting device within the time specified in Table 41.1 of Regulation 411.3.2.2 or, as appropriate, Regulation 411.3.2.3.Where an RCD is used this current is the rated residual operating current providing disconnection in the time specified in Table 41.1 or Regulation 411.3.2.3.
- U_0 is the nominal a.c. rms or d.c. line voltage to Earth in volts (V).
- <u>Cmin</u> is the minimum voltage factor to take account of voltage variations depending on time and place, changing of transformer taps and other considerations.
 - **NOTE 1:** For a low voltage supply given in accordance with the Electricity Safety, Quality and Continuity Regulations 2002 as amended, C_{min} is given the value 0.95.
- **NOTE**<u>2</u>: Where compliance with this regulation is provided by an RCD, the disconnection times in accordance with Table 41.1 relate to prospective residual fault currents significantly higher than the rated residual operating current of the RCD.

T/	٩B	LE	41	.2	-
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Maximum earth fault loop impedance (Z_s) for fuses, for 0.4 s disconnection time with U₀ of 230 V (see Regulation 411.4.6)

(a) Genera and G (clip	l purpose (go in)	G) and moto	r circuit app	lication (gM)	fuses to BS	88-2 – fuse	systems E (I	bolted)
Rating (amperes)	<u>2</u>	<u>4</u>	6	10	16	20	25	32
Z _s (ohms)	<u>33.1</u>	<u>15.6</u>	<u>8.21</u> <u>7.80</u>	4 <u>.89 4.65</u>	2.56-<u>2.43</u>	<u>1.77-1.68</u>	<u>1.35-1.29</u>	<u>1.04-0.99</u>
(b) Fuses t	o BS 88-3 fu	se system C						
Rating (amperes)	5	16	20	32				
Z _s (ohms)	<u>10.45-9.93</u>	<u>2.42-2.30</u>	<u>2.04-1.93</u>	0.96-<u>0.91</u>				
(c) Fuses t	o BS 3036				(d) Fuses	to BS 1362		
Rating (amperes)	5	15	20	30	Rating (amperes)	3	13	
Zs (ohms)	9.58-<u>9.10</u>	2.55-<u>2.43</u>	1.77-<u>1.68</u>	1.09 <u>1.04</u>	Zs (ohms)	16.4-<u>15.6</u>	2.42-<u>2.30</u>	

NOTE 1: The circuit loop impedances given in the table should not be exceeded when:

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(i) the line conductors are at their normal-the appropriate maximum permitted operating temperature, as given in Table 52.1, and

(ii) the circuit protective conductors are at the appropriate assumed initial temperature, as given in Tables 54.2 to 54.5. If the conductors are at a different temperature when tested, the reading should be adjusted accordingly. See Appendix 14.

NOTE 2: The circuit loop impedances have been determined using a value for factor C_{min} of 0.95.

TABLE 41.3 -

Maximum earth fault loop impedance (Z_s) for circuit-breakers with U₀ of 230 V, for instantaneous operation giving compliance with the 0.4 s disconnection time of Regulation 411.3.2.2 and 5 s disconnection time of Regulation 411.3.2.3 (for RCBOs see also Regulation 411.4.9)

Rating (amperes)	3	6	10	16	20	25	32	40	50	63	80	100	125	In
Z _s (ohms)		7.67		<u>2.87</u>		1.84		1.15		0.73		0.46		46
	15.33	<u>7.28</u>	4 .60	<u>2.73</u>	2.30	<u>1.75</u>	1.44	<u>1.09</u>	<u>0.92</u>	<u>0.69</u>	0.57	<u>0.44</u>	0.37	<u>437/10</u> In
	<u>14.57</u>		<u>4.37</u>		<u>2.19</u>		<u>1.37</u>		<u>0.87</u>		<u>0.55</u>		<u>0.35</u>	
(b) Type C	circuit-	breake	rs to BS	60 EN 60	898 and	d the ov	ercurre	ent char	acterist	tics of F	RCBOs	to BS E	N 6100)9-1
Rating (amperes)		6	10	16	20	25	32	40	50	63	80	100	125	In
Z _s (ohms)		3.83		1.44		0.92		0.57		0.36		0.23		23
		<u>3.64</u>	2.30	<u>1.37</u>	1.15	<u>0.87</u>	0.72	<u>0.55</u>	0.46	<u>0.35</u>	0.29	<u>0.22</u>	0.18	<u>437/20</u> In
			<u>2.19</u>		<u>1.09</u>		<u>0.68</u>		<u>0.44</u>		<u>0.27</u>		<u>0.17</u>	
(c) Type D	circuit-	breake	rs to BS	60 EN 60	898 and	I the ov	ercurre	nt char	acterist	tics of F	RCBOs	to BS E	N 6100)9-1
Rating (amperes)		6	10	16	20	25	32	40	50	63	80	100	125	In
Z _s (ohms)		<u>1.92</u>		0.72		0.46		0.29		0.18		0.11		11.5
0.1 to 3 secs		<u>1.82</u>	1.15	<u>0.68</u>	0.57	<u>0.44</u>	0.36	<u>0.27</u>	0.23	<u>0.17</u>	0.14		0.09	<u>437/40</u> In
			<u>1.09</u>		<u>0.55</u>		<u>0.34</u>		<u>0.22</u>					
<u>Zs (ohms)</u>		3.64		1.37		0.87		0.55		0.35		0.22		<u>437/20In</u>
5 secs			<u>2.19</u>		1.09		0.68		0.44		0.27		0.17	

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NOTE_1: The circuit loop impedances given in the table should not be exceeded when:

(i) the <u>line</u> conductors are at their normal the appropriate maximum permitted operating temperature, as given in Table 52.1, and

(ii) the circuit protective conductors are at the appropriate assumed initial temperature, as given in Tables 54.2 to 54.5. If the conductors are at a different temperature when tested, the reading should be adjusted accordingly. See Appendix 14.

NOTE 2: The circuit loop impedances have been determined using a value for factor C_{min} of 0.95.

TABLE 41.4 –

Maximum earth fault loop impedance (Z_s) for fuses, for 5 s disconnection time with U₀ of 230 V (see Regulation 411.4.8)

(a) General purpose (gG) and motor circuit application (gM) fuses to BS 88-2 – fuse systems E (bolted) and G (clip-in)

	_ ,							
Rating (amperes)	<u>2</u>	<u>4</u>	6	10	16	20	25	32
Z _s (ohms)	<u>44</u>	<u>21</u>	<u>12.8-12</u>	<u>7.19 6.8</u>	4 <u>.18 4.0</u>	<u>2.95-2.8</u>	2.30-<u>2.2</u>	<u>1.84-1.7</u>
	40	50	63	80	100	125	160	200
	1.35-<u>1.3</u>	1.04-<u>0.99</u>	0.82-<u>0.78</u>	0.57-<u>0.55</u>	0.46 <u>0.42</u>	0.34-<u>0.32</u>	0.28 <u>0.27</u>	0.19-<u>0.18</u>
(b) Fuses t	o BS 88-3 fu	se system C						
Rating (amperes)	5	16	20	32	45	63	80	100
Z _s (ohms)	<u> 15.33-14.6</u>	4 <u>.11-3.9</u>	3.38-<u>3.2</u>	1.64 - <u>1.6</u>	<u>1.04-1.0</u>	<u>0.72-0.68</u>	<u>0.53-0.51</u>	<u>0.40-0.38</u>
(c) Fuses te	o BS 3036							
Rating (amperes)	5	15	20	30	45	60	100	
Zs (ohms)	17.7-<u>16.8</u>	5.35 <u>5.08</u>	3.83 <u>3.64</u>	2.64-<u>2.51</u>	<u>1.59-1.51</u>	1.12-<u>1.07</u>	0.53 <u>0.51</u>	
(d) Fuses t	o BS 1362							

Rating	3	13
(amperes)		

Zs (ohms) 23.2-22.0 3.83-3.64

NOTE<u>1</u>: The circuit loop impedances given in the table should not be exceeded when:

(i) the <u>line</u> conductors are at their normal-the appropriate maximum permitted operating temperature, as given in Table 52.1, and

(ii) the circuit protective conductors are at the appropriate assumed initial temperature, as given in Tables 54.2 to 54.5.

If the conductors are at a different temperature when tested, the reading should be adjusted accordingly. See Appendix 14.

NOTE 2: The circuit loop impedances have been determined using a value for factor C_{min} of 0.95.

NOTE 3: Data for fuses of rating exceeding 200 A should be obtained from the manufacturer.

411.5 TT system

411.5.4 Where an overcurrent protective device is used the following condition shall be fulfilled:

 $Z_s \times I_a \leq U_0 \times \underline{C_{min}}$

where:

- Z_s is the impedance in ohms (Ω) of the earth fault loop comprising:
 - the source
 - the line conductor up to the point of the fault
 - the protective conductor from the exposed-conductive-parts
 - the earthing conductor
 - the earth electrode of the installation, and
 - the earth electrode of the source.
- I_a is the current in amperes (A) causing the automatic operation of the disconnecting device within the time specified in Table 41.1 of Regulation 411.3.2.2 or, as appropriate, Regulation 411.3.2.4.
- U_0 is the nominal a.c. rms or d.c. line voltage to Earth in volts (V).

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- <u>Cmin</u> is the minimum voltage factor to take account of voltage variations depending on time and place, changing of transformer taps and other considerations.
 - **NOTE:** For a low voltage supply given in accordance with the Electricity Safety, Quality and Continuity Regulations 2002 as amended, Cmin is given the value 0.95.

411.6 IT system

411.6.4 After the occurrence of a first fault, conditions for automatic disconnection of supply in the event of a second fault occurring on a different live conductor shall be as follows:

(i) Where the exposed-conductive-parts are interconnected by a protective conductor and collectively earthed to the same earthing system, the conditions similar to a TN system apply and the following conditions shall be fulfilled where the neutral conductor is not distributed in a.c. systems and in d.c. systems where the midpoint conductor is not distributed:

$$Z_{s} \leq \frac{U \times C_{min}}{2I_{a}}$$

or, where the neutral conductor or midpoint conductor respectively is distributed:

$$Z_s \stackrel{top}{=} \frac{U_0 \times C_{\min}}{2I_a} \qquad Z_s^1 \le \frac{U_0 \times C_{\min}}{2I_a}$$

where:

- U is the nominal a.c. rms or d.c. voltage, in volts, between line conductors.
- U₀ is the nominal a.c. rms or d.c. voltage, in volts, between a line conductor and the neutral conductor or midpoint conductor, as appropriate.
- Z_s is the impedance in ohms of the fault loop comprising the line conductor and the protective conductor of the circuit.
- Z_{s}^{1} is the impedance in ohms of the fault loop comprising the neutral conductor and the protective conductor of the circuit.
 - I_a is the current in amperes causing automatic operation of the protective device within the time specified in Table 41.1 of Regulation 411.3.2.2, or as appropriate, Regulation 411.3.2.3, for a TN system.
- <u>Cmin</u> is the minimum voltage factor to take account of voltage variations depending on time and place, changing of transformer taps and other considerations.

NOTE: For a low voltage supply given in accordance with the Electricity Safety, Quality and Continuity Regulations 2002 as amended, C_{min} is given the value 0.95.

The time stated in Table 41.1 for a TN system is applicable to an IT system with a distributed or non-distributed neutral conductor or midpoint conductor.

(ii) Where the exposed-conductive-parts are ...

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TABLE 41.6 – Maximum earth fault loop impedance (Zs) for 5 s disconnection time and U₀ of 55 V (single-phase) and 63.5 V (three-phase)

(see Regulations 411.8.1.2 and 411.8.3)

	overci	Circuit-b urrent char	General purpose (gG) fuses to BS 88-2 – fuse						
	I	3	C <u>ar</u>	<u>1d D</u>	ł	•	systems E and G		
U0 (Volts)	55	63.5	55	63.5	55	63.5	55	63.5	
Rating amperes		1		Z _s oh	ms				
<u>3</u>	<u>3.48</u>	<u>4.02</u>	<u>1.74</u>	<u>2.01</u>					
6	1.83 <u>1.74</u>	<u>2.12-2.01</u>	0.92 <u>0.87</u>	<u>1.07-1.01</u>	0.47	0.53	3.06-<u>2.90</u>	3.53-<u>3.35</u>	
10	1.10 <u>1.05</u>	<u>1.27-1.21</u>	0.55-<u>0.52</u>	0.64 <u>0.60</u>	0.28	0.32	<u>1.72-1.63</u>	1.98-<u>1.89</u>	
16	0.69-<u>0.65</u>	0.79 <u>0.75</u>	0.34-<u>0.33</u>	0.40-<u>0.38</u>	0.18	0.20	<u>1.00-0.95</u>	1.15-<u>1.10</u>	
20	0.55-<u>0.52</u>	<u>0.64-0.60</u>	0.28 <u>0.26</u>	0.32 <u>0.30</u>	0.14	0.16	0.71-<u>0.67</u>	0.81 <u>0.77</u>	
25	0.44-<u>0.42</u>	<u>0.51-0.48</u>	0.22 <u>0.21</u>	0.26 <u>0.24</u>	0.11	0.13	0.55 <u>0.52</u>	0.64-<u>0.60</u>	
							-	-	
32	0.34-<u>0.33</u>	0.40-<u>0.38</u>	0.17-<u>0.16</u>	<u>0.20-0.19</u>	0.09	0.10	0.44 <u>0.42</u>	0.51-<u>0.48</u>	
40	0.28 <u>0.26</u>	<u>0.32-0.30</u>	<u>0.14-0.13</u>	0.16-<u>0.15</u>	0.07	0.08	<u>0.32-0.31</u>	0.37-<u>0.35</u>	
50	<u>0.22 0.21</u>	<u>0.25 0.24</u>	<u>0.11-0.10</u>	<u>0.13-0.12</u>	0.06	0.06	<u>0.25-0.24</u>	<u>0.29-0.27</u>	
63	<u>0.17-0.17</u>	<u>0.20-0.19</u>	<u>0.09-0.08</u>	0.10	0.04	0.05	<u>0.20-0.19</u>	<u>0.23-0.22</u>	
80	0.14 <u>0.13</u>	0.16 <u>0.15</u>	0.07	0.08	0.04	0.04	<u>0.14-0.13</u>	0.16-<u>0.15</u>	
100	<u>0.11-0.10</u>	<u>0.13-0.12</u>	0.05	0.06	0.03	0.03	<u>0.11-0.12</u>	0.12-<u>0.14</u>	
125	<u>0.09-0.08</u>	0.10	0.04	0.05	0.02	0.03	0.08	0.09	
In	<u>++-10.4</u> In	<u>12.7-12.1</u> In	<u>5.5-5.2</u> In	<u>6.4-6.1</u> In	2.8 In	<u>3.2</u> In			

NOTE<u>1</u>: The circuit loop impedances given in the table should not be exceeded when:

the line conductors are at their normal-the appropriate maximum permitted operating temperature, as given in Table <u>(i)</u> 52.1, and

the circuit protective conductors are at the appropriate 'assumed initial temperature', as given in Table 54.2 to 54.5. <u>(ii)</u> If the conductors are at a different temperature when tested, the reading should be adjusted accordingly. See Appendix 14.

NOTE 2: The circuit loop impedances have been determined using a value for factor C_{min} of 0.95.

412 PROTECTIVE MEASURE: DOUBLE OR REINFORCED INSULATION

412.2 Requirements for basic protection and fault protection

412.2.1.1 Electrical equipment shall be of the following types, type-tested and marked to the relevant standards:

- Electrical equipment having double or reinforced insulation (Class II equipment) (i)
- Electrical equipment declared in the relevant product standard as equivalent to Class II, such as assemblies (ii) of electrical equipment having total insulation (see BS EN 601439-1).

NOTE: This equipment is identified by the symbol **D** Refer to BS EN 60417: Class II equipment.

414 PROTECTIVE MEASURE: EXTRA-LOW VOLTAGE PROVIDED BY SELV OR PELV

414.2 Requirements for basic protection and fault protection

Both basic protection and fault protection is are deemed to be provided where:

- (i) the nominal voltage cannot exceed the upper limit of voltage Band I, and
- (ii) the supply is from one of the sources listed in Regulation 414.3, and
- (iii) the conditions of Regulation 414.4 are fulfilled.

NOTE 1: If the system is ...

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CHAPTER 42

PROTECTION AGAINST THERMAL EFFECTS

420.1 Scope

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This chapter applies to electrical installations and equipment with regard to measures for the protection of persons, livestock and property <u>against</u>:

- (i) against the harmful effects of heat or thermal radiation developed by electrical equipment
- (ii) against the ignition, combustion or degradation of materials
- (iii) against-flames and smoke where a fire hazard could be propagated from an electrical installation to other nearby fire compartments, and
- (iv) against safety services being cut off by the failure of electrical equipment.
- **NOTE 1:** For protection against thermal effects and fire, statutory requirements may be applicable. Refer to Appendix 2.

NOTE 2: Protection against overcurrent is dealt with in Chapter 43 of these Regulations.

421 PROTECTION AGAINST FIRE CAUSED BY ELECTRICAL EQUIPMENT

421.1 General requirements

421.1.1 Persons, livestock and property shall be protected against harmful effects of heat or fire which may be generated or propagated in electrical installations.

Manufacturers' instructions shall be taken into account in addition to the requirements of BS 7671.

NOTE 1: Harmful effects of heat or fire may be caused by:

- heat accumulation, heat radiation, hot components or equipment
- failure of electrical equipment such as protective devices, switchgear, thermostats, temperature limiters, seals of cable penetrations and wiring systems
- overcurrent
- insulation faults or arcs, sparks and high temperature particles
- harmonic currents
- external influences such as lightning surge-
- inappropriate selection or erection of equipment.

NOTE 2: Lightning strikes and overvoltages are covered in BS EN 62305 and Section 443 of these Regulations.

421.1.5 Where electrical equipment in a single location contains flammable liquid in significant quantity, adequate precautions shall be taken to ...

421.1.200 Switchgear assemblies including consumer units shall:

- (i) have their enclosure manufactured from non-combustible or not readily combustible material, or
- (ii) be enclosed in a cabinet or enclosure constructed of non-combustible or not readily combustible material.
- **NOTE 1:** Ferrous metal e.g. steel is deemed to be an example of a non-combustible material
- **NOTE 2:** For the purposes of this regulation insulating material e.g. plastic meeting a 960 °C glow-wire flammability test as defined in BS EN 60695-2-11 is considered to be an example of a not readily combustible material.

421.1.6 Materials used for the construction of enclosures of electrical equipment shall comply with the resistance to heat and fire requirements in an appropriate product standard.

Where no product standard exists, the materials of an enclosure shall withstand the highest temperature likely to be produced by the electrical equipment in normal use.

422 PRECAUTIONS WHERE PARTICULAR RISKS OF FIRE EXIST

422.2 Conditions for evacuation in an emergency

422.2.1 In conditions BD2, BD3 or BD4, wiring systems shall not encroach ...

(ii) Non-flame propagating conduit systems shall meet the requirements of BS EN-61386 61836-1

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422.3 Locations with risks of fire due to the nature of processed or stored materials

422.3.3 Switchgear or controlgear shall be installed outside the location unless:

- (i) it is suitable for the location, or
- (ii) it is installed in an enclosure providing a degree of protection of at least IP4X or, in the presence of dust, IP5X or, in the presence of electrically conductive dust, <u>IPX6 IP6X</u>, except where Regulation 422.3.11 applies.

422.3.4 A cable shall, as a minimum, satisfy the test under fire conditions ...

A powertrack system shall satisfy the test under fire conditions specified in the for resistance to flame propagation specified in BS EN 61534 series.

422.3.7 A motor which is automatically or remotely controlled or which is not continuously supervised shall be protected against excessive temperature by a protective device with manual reset. A motor with star delta starting shall be protected against excessive <u>over-</u>temperature in <u>both the star and delta configurations all</u> <u>operational modes</u>.

422.3.8 Every luminaire shall:

- (i) be appropriate for the location, and
- (ii) be provided with an enclosure providing a degree of protection of at least IP4X or, in the presence of dust, IP5X or, in the presence of electrically conductive dust, <u>IPX6 IP6X</u>, and
- (iii) have a limited surface temperature in accordance with BS EN 60598-2-24, and
- (iv) be of a type that prevents lamp components from falling from the luminaire.

In locations where there may be fire hazards due to dust or fibres, luminaires shall be installed so that dust or fibres cannot accumulate in dangerous amounts.

422.3.100.200 Flexible cables shall be of the following construction:

- (i) Heavy duty type having a voltage rating of not less than 450/750 V, or
- (ii) suitably protected against mechanical damage.

422.3.101.201 A heating appliance shall be fixed.

422.3.102.202 A heat storage appliance shall be of a type which prevents the ignition of combustible dusts or fibres by the heat storing core.

422.5 Fire propagating structures

The requirements of this regulation shall be applied in addition to those of Section 421 in locations where CB2 conditions exist.

CB2 conditions relate to the propagation of fire and exist where a building has a shape and dimensions which facilitate the spread of fire (e.g. chimney effect), such as high-rise buildings or where a building has a forced ventilation system.

NOTE: Fire detectors may be provided which ensure the implementation of measures for preventing propagation of fire, for example, the closing of fireproof shutters in ducts, troughs or trunking.

Boxes and enclosures according to BS EN 60670-1 for hollow walls and cables in accordance with BS EN 60332-3 series can be used. BS EN 60670-1 includes marking with the symbol H for boxes and enclosures for hollow walls.

424 PROTECTION AGAINST OVERHEATING

424.1 Forced air heating systems

Forced air heating systems shall be such that their heating elements, other than those of central storage heaters, cannot be activated until the prescribed air flow has been established and are deactivated when the air flow is less than the prescribed value. In addition, they shall have two temperature limiting devices independent of each other which prevent permissible temperatures from being exceeded in air ducts.

Supporting parts, frames and enclosures of heating elements shall be of non-combustible material.

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424.2 Appliances producing hot water or steam

All appliances producing hot water or steam shall be protected by design or erection against overheating in all service conditions. Unless the appliances comply as a whole with the appropriate British Standards, the protection shall be by means of an appropriate non-self-resetting device, functioning independently of the thermostat.

If an appliance has no free outlet, it shall also be provided with a device which limits the internal water pressure.

424.3 Space heating appliances

The frame and enclosure of space heating appliances shall be of non-combustible material.

NOTE: In operating areas with a fire risk, space heating appliances may not be operated if the air from these areas is guided through the appliance.

The side walls of radiant heaters which are not touched by the heat radiation should have a sufficient distance from flammable parts. In case of a reduction of the distance by an inflammable partition, this partition should have a distance of at least 1 cm to the enclosure of the radiant heater and to flammable parts.

Radiant heaters shall be mounted so that in the direction of radiation a safety distance of at least 2 m from flammable parts is ensured unless otherwise declared by the manufacturer,

CHAPTER 43

PROTECTION AGAINST OVERCURRENT

431 PROTECTION ACCORDING TO THE NATURE OF THE CIRCUITS AND THE DISTRIBUTION SYSTEM

431.2 Protection of the neutral conductor

431.2.3 Harmonic currents

Overcurrent detection shall be provided for the neutral conductor in a <u>multipoly</u>phase circuit where the harmonic content of the line currents is such that the current in the neutral conductor may exceed the current-carrying capacity of that conductor. The overcurrent detection shall cause disconnection of the line conductors but not necessarily the neutral conductor. Where the neutral is disconnected the requirements of Regulation 431.3 are applicable.

434 PROTECTION AGAINST FAULT CURRENT

434.5 Characteristics of a fault current protective device

434.5.3 For a busbar trunking system complying with BS EN-<u>60439-2</u> <u>61439-6</u> or a powertrack system complying with BS EN 61534, one of the following requirements shall apply:

(i) The rated short-time withstand ...

CHAPTER 44 PROTECTION AGAINST VOLTAGE DISTURBANCES AND ELECTROMAGNETIC DISTURBANCES

440 INTRODUCTION

440.1 Scope

These requirements are intended to provide requirements for the safety of electrical installations in the event of voltage disturbances and electromagnetic disturbances generated for due to different specified reasons causes.

The requirements are not intended to apply to systems for distribution of energy to the public, or <u>to</u> power generation and transmission for such systems, although such disturbances may be conducted into or between electrical installations via these supply systems. The requirements of this chapter are in addition to those of Chapter 43.

440.2 General

This chapter covers the protection of electrical installations and measures against voltage disturbances and electromagnetic disturbances. The requirements are arranged into four sections as follows:

- (i) Section 442 Protection of low voltage installations against temporary overvoltages due to earth faults in the high voltage system and due to faults in the low voltage system
- (ii) Section 443 Protection against overvoltages of atmospheric origin or due to switching
- (iii) Section 444 Measures against electromagnetic disturbances
- (iv) Section 445 Protection against undervoltage.

441 NOT USED

442 PROTECTION FOR SAFETY – PROTECTION OF LOW VOLTAGE INSTALLATIONS AGAINST TEMPORARY OVERVOLTAGES DUE TO EARTH FAULTS IN THE HIGH VOLTAGE SYSTEM AND DUE TO FAULTS IN THE LOW VOLTAGE SYSTEM

442.1 Scope and object

This regulation provides requirements for the safety of the low voltage installation in the event of:

- (i) a fault between the high voltage system and Earth in the transformer substation that supplies the low voltage installation
- (ii) loss of the supply neutral in the low voltage system
- (iii) short-circuit between a line conductor and neutral in the low voltage installation
- (iv) accidental earthing of a line conductor of a low voltage IT system.
- **NOTE:** In Great Britain, the requirements for the earthing of transformers that provide a supply from a system for distribution of electricity in accordance with the Electricity Safety, Quality and Continuity Regulations 2002 are addressed in the Distribution Code.

442.1.1 General

Section 442 gives rules for the designer and installer of the substation. It is necessary to have the following information on the high voltage system:

- (i) Quality of the system earthing
- (ii) Maximum level of earth fault current
- (iii) Resistance of the earthing arrangement.

The following regulations consider four situations which generally cause the most severe temporary overvoltages:

- (iv) Fault between the high voltage system(s) and Earth (see Regulation 442.2)
- (v) Loss of the neutral in a low voltage system (see Regulation 442.3)
- (vi) Accidental earthing of a low voltage IT system (see Regulation 442.4)
- (vii) Short-circuit in the low voltage installation (see Regulation 442.5).

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442.1.2 Symbols

In Section 442 the following symbols are used (see Figure 44.1):

- I_E part of the earth fault current in the high voltage system that flows through the earthing arrangement of the transformer substation
- R_E resistance of the earthing arrangement of the transformer substation
- R_A resistance of the earthing arrangement of the exposed-conductive-parts of the equipment of the low voltage installation
- R_B resistance of the earthing arrangement of the low voltage system neutral, for low voltage systems in which the earthing arrangements of the transformer substation and of the low voltage system neutral are electrically independent
- U₀ <u>in TN and TT systems:</u> nominal a.c. rms line voltage to Earth in IT systems: nominal a.c. rms voltage between line conductor and neutral conductor or midpoint conductor, as appropriate
- Uf power frequency fault voltage that appears in the low voltage system between exposed-conductive-parts and Earth for the duration of the fault
- U₁ power frequency stress voltage between the line conductor and the exposed-conductive-parts of the low voltage equipment of the transformer substation during the fault
- U₂ power frequency stress voltage between the line conductor and the exposed-conductive-parts of the low voltage equipment of the low voltage installation during the fault.
- **NOTE 1:** The power frequency stress voltages (U₁ and U₂) are the voltages that appear across the insulation of low voltage equipment and across surge protective devices connected to the low voltage system.

The following additional symbols are used in respect of IT systems in which the exposed-conductive-parts of the equipment of the low voltage installation are connected to an earthing arrangement that is electrically independent of the earthing arrangement of the transformer substation.

- I_h the fault current that flows through the earthing arrangement of the exposed-conductive-parts of the equipment of the low voltage installation during a period when there is a high voltage fault and a first fault in the low voltage installation (see Table 44.1)
- I_d the fault current, in accordance with Regulation 411.6.2, that flows through the earthing arrangement of the exposed-conductive-parts of the low voltage installation during the first fault in a low voltage system (see Table 44.1)
- Z is the impedance (for example, the IMD internal impedance or the artificial neutral impedance) between the low voltage system and an earthing arrangement.
- **NOTE 2:** An earthing arrangement may be considered electrically independent of another earthing arrangement if a rise of potential with respect to Earth in one earthing arrangement does not cause an unacceptable rise of potential with respect to Earth in the other earthing arrangement.

442.2 Overvoltages in low voltage (LV) systems during a high voltage (HV) earth fault

In case of a fault to Earth in the HV side of the substation the following types of overvoltage may affect the LV installation:

- (i) Power frequency fault voltage (Uf)
- (ii) Power frequency stress voltages (U_1 and U_2).

Table 44.1 provides the relevant methods of calculation for the different types of overvoltage.





Where high and low voltage earthing systems exist in proximity to each other, two practices are presently used:

- interconnection of all high voltage (R_E) and low voltage (R_B) earthing systems
- separation of high voltage (R_E) from low voltage (R_B) earthing systems. _

The general method used is interconnection. The high and low voltage earthing systems shall be interconnected if the low voltage system is totally confined within the area covered by the high voltage earthing system (see BS 7430).

NOTE 1: Details of the different types of system earthing are shown in Part 3 (TN, TT) and Appendix 9 (IT).

- NOTE 2: In Great Britain, the requirements for the earthing of transformers that provide a supply from a system for distribution of electricity in accordance with the Electricity Safety, Quality and Continuity Regulations 2002 are addressed in the Distribution Code.
- NOTE 3: BS EN 50522, Table 2, gives minimum requirements for determining whether it is feasible to interconnect high voltage and low voltage earthing arrangements. Feasibility is dependent on the earthing design for the substation achieving minimum safe touch and step voltages and a tolerable 'earth potential rise' (EPR - stress voltage).

	connections	U1	U ₂	Uf		
TT	$R_{\rm E}$ and $R_{\rm B}$ connected	U ₀	R_{E} · I_E + U_0	0 *		
11	R _E and R _B separated	$R_{E}I_{E} + U_{0}$	U0 *	0 *		
TN	R _E and R _B connected	U ₀	U0 *	R _E .I _E **		
IN	R _E and R _B separated	$R_{E} I_{E} + U_{0}$	U0 *	0 *		
	R _E and Z connected	U ₀	$R_{E}I_{E} + U_{0}$	0 *		
	$R_{\rm E}$ and $R_{\rm A}$ separated	U0•√3	$R_{E}I_{E} + U_{0}\sqrt{3}$	R _A .I _h		
	R_E and Z connected	U ₀	U ₀	R _E .I _E		
IT	$R_{\rm E}$ and $R_{\rm A}$ interconnected	U₀ . √3	U₀ . √3	R _E .I _E		
	R_E and Z separated	$R_{E}I_{E} + U_{0}$	U0 *	0 *		
R_E and R_A separated $R_E I_E + U_{0.}\sqrt{3}$ $U_{0.}\sqrt{3}$ $R_A I_d$						
With existing earth fault in the installation.						

TABLE 44.1 – Power frequency stress voltages	
and power frequency fault voltage in the low voltage system	n

NOTE 1: The requirements for U1 and U2 are derived from design criteria for insulation of low voltage equipment with regard to temporary power frequency overvoltage (see also Table 44.2).

NOTE 2: In a system whose neutral is connected to the earthing arrangement of the transformer substation, such temporary power frequency overvoltage is also to be expected across insulation which is not in an earthed enclosure where the equipment is outside a building.

NOTE 3: In TT and TN systems the terms 'connected' and 'separated' refer to the electrical connection between R_E and R_B . For IT systems the terms refer to the electrical connection between R_E and Z and the connection between R_E and R_A .

442.2.1 Magnitude and duration of Power frequency fault voltage

The magnitude and duration of the fault voltage U_{f} , where specified in Table 44.1, which appears in the LV installation between exposed conductive parts and Earth shall not exceed the values given for U_{f} by the curve of Figure 44.2 for the duration of the fault. If the PEN conductor of the low voltage system is connected to Earth at more than one point it is permitted to double the value of U_{f} given in Figure 44.2.

Normally, the PEN conductor of the low voltage system is connected to Earth at more than one point. In this case, the total resistance is reduced. For these multiple earthed PEN conductors, $U_{\rm f}$ can be calculated as:

 $U_{f} = 0.5 R_{f} I_{f}$



NOTE: The curve shown in Figure 44.2 is taken from IEC 61936-1. On the basis of probabilistic and statistical evidence this curve represents a low level of risk for the simple worst case where the low voltage system neutral conductor is earthed only at the transformer substation earthing arrangements. Guidance is provided in IEC 61936-1 concerning other situations.

The fault voltage U_f as calculated in Table 44.1, which appears in the low voltage installation between exposedconductive-parts and Earth, shall not exceed a dangerous level.

- **NOTE 1:** In a TN system where R_E and R_B are connected together (see Table 44.1), their connection to a low voltage global earthing system as described in BS EN 50522:2010, clause 3.4.19, can be considered to be a safety measure against dangerous fault voltages.
- **NOTE 2:** A global earthing system is an earthing system created by the interconnection of local earthing systems that ensures, by the proximity of these earthing systems, that there are no dangerous touch voltages.

In installations outside a global earthing system, additional connection shall be made between the PEN conductor and Earth.

442.2.2 Magnitude and duration of power frequency stress voltages

The magnitude and duration of the ...

444 MEASURES AGAINST ELECTROMAGNETIC DISTURBANCES

444.1 Scope

This section provides basic requirements and recommendations to enable the avoidance and reduction of electromagnetic disturbances.

The designer of the electrical installation shall consider the measures described in this section for reducing electromagnetic disturbances on electrical equipment. Those involved in the design, installation and maintenance of, and alterations to, electrical installations shall give due consideration to the measures described in this section.

Electromagnetic disturbances can disturb ...

PART 5

SELECTION AND ERECTION OF EQUIPMENT

CHAPTER 51

COMMON RULES

511 COMPLIANCE WITH STANDARDS

511.1 Every item of equipment shall comply with the relevant requirements of the applicable British or Harmonized Standard, appropriate to the intended use of the equipment. The edition of the standard shall be the current edition, with those amendments pertaining at a date to be agreed by the parties to the contract concerned (see Appendix 1).

Alternatively, if equipment complying with a foreign national standard based on an IEC Standard is to be used, the designer or other person responsible for specifying the installation shall verify that any differences between that standard and the corresponding British or Harmonized Standard will not result in a lesser degree of safety than that afforded by compliance with the British or Harmonized Standard. <u>Such use shall be noted on the Electrical Installation Certificate specified in Part 6.</u>

511.2 Where equipment to be used is not covered by a British or Harmonized Standard or is used outside the scope of its standard, the designer or other person responsible for specifying the installation shall confirm that the equipment provides at least the same degree of safety as that afforded by compliance with the Regulations. Every item of equipment shall be suitable for the nominal voltage (U_0) of the installation or the part of the installation concerned, where necessary taking account of the highest and/or lowest voltage likely to occur in normal service. In an IT system, equipment shall be insulated for the nominal voltage between lines. Such use shall be noted on the Electrical Installation Certificate specified in Part 6.

512 OPERATIONAL CONDITIONS AND EXTERNAL INFLUENCES

512.1 Operational conditions

512.1.1 Voltage

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Every item of equipment shall be suitable for the nominal voltage (U_0) of the installation or the part of the installation concerned, where necessary taking account of the highest and/or lowest voltage likely to occur in normal service. In an IT system, equipment shall be insulated for the nominal voltage between lines.

512.1.2 Current ...

512.1.5 Compatibility

Every item of equipment shall be selected and erected so that it will neither cause harmful effects to other equipment nor impair the supply during normal service including switching operations.

Switchgear, protective devices, accessories and other types of equipment shall not be connected to conductors intended to operate at a temperature exceeding 70 $^{\circ}$ C at the equipment in normal service unless the equipment manufacturer has confirmed that the equipment is suitable for such conditions, or the conductor size shall be chosen based on the current ratings for 70 $^{\circ}$ C cables of a similar construction. See also Regulation 523.1 and Table 4A3.

The designer of the fixed installation shall ensure that the installed fixed equipment, where relevant, is designed and manufactured in accordance with the EMC Directive and, upon request, the relevant documentation shall be made available.

NOTE 1: Information on the parameters to be considered is given in Section 444.

The responsible person for the fixed installation shall provide, upon request, documentation which is established as specified by EMC Directive 2004/108.

NOTE 2: The level of detail of the documentation may vary from very simple information to much more detailed documentation for complex installations involving important potential EMC aspects. Where installations are composed solely of apparatus placed on the market in conformity with the EMC Directive and carrying the CE marking, the responsible person satisfies the documentation requirements by being able to provide, on request, the instructions for installation, use and maintenance provided by the supplier of each item of apparatus.

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512.2.4 The selection of equipment according to external influences is necessary not only for proper functioning, but also to ensure the reliability of the measures of protection for safety complying with these Regulations generally. Measures of protection afforded by the construction of equipment are valid only for the given conditions of external influence if the corresponding equipment specification tests are made in these conditions of external influence.

NOTE-4: For the purpose of these Regulations, the following classes of external influence are conventionally regarded as

normat.	
AA Ambient temperature	AA4
AB Atmospheric humidity	AB4
Other environmental conditions	XX1 of each parameter
(AC to AS)	
Utilisation and construction	∫ XX1 of each parameter, except
of buildings (B and C)	$\chi X2$ for the parameter BC

NOTE 2: The word "normal" appearing in the third column of the table in Appendix 5 signifies that the requirement must generally satisfy applicable standards.

514 IDENTIFICATION AND NOTICES

514.4 Identification of conductors by colour

514.4.1 Neutral or midpoint conductor Where a circuit includes a neutral or midpoint conductor identified by colour, the colour used shall be blue.

514.9 Diagrams and documentation

514.9.1 A legible diagram, chart or table or equivalent form of information shall be provided indicating in particular:

- (i) the type and composition of each circuit (points of utilisation served, number and size of conductors, type of wiring), and
- (ii) the method used for compliance with Regulation 410.3.2, and
- (iii) the information necessary for the identification of each device performing the functions of protection, isolation and switching, and its location, and
- (iv) any circuit or equipment vulnerable to a typical test.

For simple installations the foregoing information may be given in a schedule. A durable copy of the schedule relating to a distribution board shall be provided within or adjacent to each distribution board.

Any symbol used shall comply with IEC 60617.

514.9.2 Any symbol used shall comply with IEC 60617. <u>Moved by BS 7671:2008 Amendment 3 to 514.9.1.</u>

514.10 Warning notice: voltage

514.10.1 Every item of equipment or enclosure within which a nominal voltage exceeding 230 volts to earth exists and where the presence of such a voltage would not normally be expected, shall be so arranged that before access is gained to a live part, a warning of the maximum voltage to earth present is clearly visible.

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CHAPTER 52

SELECTION AND ERECTION OF WIRING SYSTEMS

521 TYPES OF WIRING SYSTEM

521.4 Busbar trunking systems and powertrack systems

A busbar trunking system shall comply with BS EN-60439 2 61439-6 and a powertrack system shall comply with the appropriate part of the BS EN 61534 series. A busbar trunking system or a powertrack system shall be installed in accordance with the manufacturer's instructions taking account of external influences. See also Appendix 8.

521.10 Installation of cables

521.10.1 Non-sheathed cables for fixed wiring shall be enclosed in conduit, ducting or trunking. This requirement does not apply to a protective conductor complying with Section 543.

Non-sheathed cables are permitted if the cable trunking system provides at least the degree of protection IPXXD or IP4X, and if the cover can only be removed by means of a tool or a deliberate action.

NOTE: For a trunking system to meet IP4X requirements, IP4X trunking and related accessories would need to be installed. If a system includes site-fabricated joints the installer must confirm the completed item meets at least the degree of protection IPXXD.

521.10.100 A bare live conductor shall be installed on insulators.

521.200 Wiring systems in escape routes

521.200.1 Wiring systems in escape routes shall be supported such that they will not be liable to premature collapse in the event of fire. The requirements of Regulation 422.2.1 shall also apply, irrespective of the classification of the conditions for evacuation in an emergency.

- **NOTE 1:** Non-metallic trunking or other non-metallic means of support can fail when subject to either direct flame or hot products of combustion. This may lead to wiring systems hanging across access or egress routes such that they hinder evacuation and firefighting activities.
- **NOTE 2:** This precludes the use of non-metallic cable clips, cable ties or trunking as the sole means of support. For example, where non-metallic trunking is used, a suitable fire-resistant means of support/retention must be provided to prevent cables falling out in the event of fire.

522 SELECTION AND ERECTION OF WIRING SYSTEMS IN RELATION TO EXTERNAL INFLUENCES

522.6 Impact (AG)

522.6.100 A cable installed under a floor or above a ceiling shall be run in such a position that it is not liable to be damaged by contact with the floor or the ceiling or their fixings.

A cable passing through a joist within a floor or ceiling construction or through a ceiling support (e.g. under floorboards), shall:

- (i) be <u>placed</u> at least 50 mm measured vertically from the top, or bottom as appropriate, of the joist or batten, or
- (ii) incorporate an earthed metallic covering which complies with the requirements of these Regulations for a protective conductor of the circuit concerned, the cable complying with BS 5467, BS 6724, BS 7846, BS EN 60702-1 or BS 8436, or comply with Regulation 522.6.203.
- (iii) be enclosed in earthed conduit complying with BS EN 61386-21 and satisfying the requirements of these Regulations for a protective conductor, or
- (iv) be enclosed in earthed trunking or ducting complying with BS EN 50085-2-1 and satisfying the requirements of these Regulations for a protective conductor, or
- (v) be mechanically protected against damage sufficient to prevent penetration of the cable by nails, screws and the like, or
- (vi) form part of a SELV or PELV circuit meeting the requirements of Regulation 414.4.

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522.6.101.201 A cable <u>concealed installed</u> in a wall or partition at a depth of less than 50 mm from a surface of the wall or partition shall:

- (i) incorporate an earthed metallic covering which complies with the requirements of these Regulations for a protective conductor of the circuit concerned, the cable complying with BS 5467, BS 6724, BS 7846, BS EN 60702-1 or BS 8436, or
- (ii) be enclosed in earthed conduit complying with BS EN 61386-21 and satisfying the requirements of these Regulations for a protective conductor, or
- (iii) be enclosed in earthed trunking or ducting complying with BS EN 50085-2-1 and satisfying the requirements of these Regulations for a protective conductor, or
- (iv) be mechanically protected against damage sufficient to prevent penetration of the cable by nails, screws and the like, or
- (v) be installed in a zone within 150 mm from the top of the wall or partition or within 150 mm of an angle formed by two adjoining walls or partitions. Where the cable is connected to a point, accessory or switchgear on any surface of the wall or partition, the cable may be installed in a zone either horizontally or vertically, to the point, accessory or switchgear. Where the location of the accessory, point or switchgear can be determined from the reverse side, a zone formed on one side of a wall of 100 mm thickness or less or partition of 100 mm thickness or less extends to the reverse side, or
- (vii) form part of a SELV or PELV circuit meeting the requirements of Regulation 414.4 comply with Regulation 522.6.203.

Where indent (i) but not indent (ii) applies, the cable shall be provided with additional protection by means of an RCD having the characteristics specified in Regulation 415.1.1.

522.6.102 Where Regulation 522.6.101 applies and the installation is not intended to be under the supervision of a skilled or instructed person, a cable installed in accordance with Regulation 522.6.101(v), and not also complying with Regulation 522.6.101(i), (ii), (iii) or (iv), shall be provided with additional protection by means of an RCD having the characteristics specified in Regulation 415.1.1.

522.6.103.202 Irrespective of the depth of the cable from a surface of the wall or partition, in an installation not intended to be under the supervision of a skilled or instructed person, a cable concealed in a wall or partition the internal construction of which includes metallic parts, other than metallic fixings such as nails, screws and the like, shall:

- (vi) be provided with additional protection by means of an RCD having the characteristics specified in Regulation 415.1.1-, or
- (i) incorporate an earthed metallic covering which complies with the requirements of these Regulations for a protective conductor of the circuit concerned, the cable complying with BS 5467, BS 6346, BS 6724, BS 7846, BS EN 60702-1 or BS 8436, or
- (ii) be enclosed in earthed conduit complying with BS EN 61386-21 and satisfying the requirements of these Regulations for a protective conductor, or
- (iii) be enclosed in earthed trunking or ducting complying with BS EN 50085-2-1 and satisfying the requirements of these Regulations for a protective conductor, or
- (ivi) be mechanically protected sufficiently to avoid damage to the cable during construction of the wall or partition and during installation of the cable, or
- (v) form part of a SELV or PELV circuit meeting the requirements of Regulation 414.4, or
- (iii) comply with Regulation 522.6.203.

For a cable installed at a depth of 50 mm or less from the surface of a wall or partition the requirements of Regulation 522.6.101.201 shall also apply.

522.6.203 For the purposes of Regulations 522.6.200(ii), 522.6.201(ii) and 522.6.202(iii), a cable shall:

- (i) incorporate an earthed metallic covering which complies with the requirements of these Regulations for a protective conductor of the circuit concerned, the cable complying with BS 5467, BS 6724, BS 7846, BS 8436 or BS EN 60702-1, or
- (ii) be installed in earthed conduit complying with BS EN 61386-21 and satisfying the requirements of these Regulations for a protective conductor, or
- (iii) be enclosed in earthed trunking or ducting complying with BS EN 50085-2-1 and satisfying the requirements of these Regulations for a protective conductor, or
- (iv) be provided with mechanical protection against damage sufficient to prevent penetration of the cable by nails, screws and the like, or
- (v) form part of a SELV or PELV circuit meeting the requirements of Regulation 414.4.

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SELECTION AND ERECTION OF WIRING SYSTEMS TO MINIMIZE THE SPREAD OF FIRE

527.1 Precautions within a fire-segregated compartment

527.1.5 Products having the necessary resistance to flame propagation as specified in the BS EN 61386 series, the appropriate part of BS EN 50085 series, BS EN 50086, BS EN 60439-2 61439-6, BS EN 61534 series, BS EN 61537 or BS EN 60570 may be installed without special precautions. Other products complying with standards having similar requirements for resistance to flame propagation may be installed without special precautions.

527.1.6 Parts of wiring systems other than cables which do not comply, as a minimum, with the flame propagation requirements as specified in the BS EN 61386 series, the appropriate part of BS EN 50085 series, BS EN 50086, BS EN-60439-2 61439-6, BS EN 61534 series or BS EN 61537 but which comply in all other respects with the requirements of their respective product standard shall, if used, be completely enclosed in suitable noncombustible building materials.

CHAPTER 53

PROTECTION, ISOLATION, SWITCHING, CONTROL

AND MONITORING

530.3 General and common requirements

530.3.1 In <u>multipoly</u>phase circuits the moving contacts of all poles of a multipole device shall be so coupled mechanically that they make and break substantially together, except:

- (i) that contacts solely intended for the neutral may close before and open after the other contacts
- (ii) in accordance with Regulation 543.3.3(ii).

NOTE 1: Switching devices, contactors, circuit-breakers, RCDs, isolating switches, control and protective switching devices for equipment (CPS), etc., complying with their relevant standard (see Table 53.4) fulfil this requirement.

NOTE 2: The requirement to make and break substantially together may not apply to control and auxiliary contacts.

530.3.2 Except as provided in Regulation 537.2.2.5, in multipolyphase circuits an independently operated single-pole switching device or protective device shall not be inserted in the neutral conductor. In single-phase circuits an independently operated single-pole switching or protective device shall not be inserted in the neutral conductor alone.

. . .

530.3.4 For an installation with a 230 V single-phase supply rated up to 100 A that is under the control of ordinary persons, switchgear and controlgear assemblies shall either comply with BS EN-60439-3 61439-3 and Regulation 432.1 or be a consumer unit incorporating components and protective devices specified by the manufacturer complying with BS EN-60439-3 61439-3, including the conditional short-circuit test described in Annex ZA of BS EN 60439 3 the standard.

530.3.5 An auto-reclosing device for protection, isolation, switching or control may be installed only in an installation intended to be under the supervision of skilled or instructed persons, and intended to be inspected and tested by competent electrically skilled or electrically instructed persons.

An auto-reclosing device shall ...

531 DEVICES FOR FAULT PROTECTION BY AUTOMATIC DISCONNECTION OF SUPPLY

RCDs 531.2

531.2.6 An RCD which is powered from an independent auxiliary source and which does not operate automatically in the case of failure of the auxiliary source shall be used only if one of the following conditions is fulfilled:

- (i) Fault protection is maintained even in the case of failure of the auxiliary source
- (ii) The device is incorporated in an installation intended to be supervised by a skilled or instructed person, and inspected and tested by a competent electrically skilled or electrically instructed persons.

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533 **DEVICES FOR PROTECTION AGAINST OVERCURRENT**

533.1 **General requirements**

533.1.1 **Fuses**

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533.1.1.2 Fuses having fuse links likely to be removed or replaced by persons other than skilled or instructed persons shall be of a type which complies with BS 88-3, BS 3036 or BS 1362. Such a fuse link shall either:

- (i) have marked on or adjacent to it an indication of the type of fuse link intended to be used, or
- (ii) be of a type such that there is no possibility of inadvertent replacement by a fuse link having the intended rated current but a higher fusing factor than that intended.
- NOTE: In multipolyphase systems additional measures may be needed, e.g. an all-pole switch on the supply side, in order to prevent the risk of unintentional contact with live parts on the load side.

Fuses or combination units having fuse links likely to be removed and replaced only by skilled or instructed persons shall be installed in such a manner that it is ensured that the fuse links can be removed or replaced without unintentional contact with live parts.

533.3 Selection of devices for protection of wiring systems against fault current

The application of the regulations of Chapter 43 shall take into account minimum and maximum fault current conditions, so as to ensure the highest energy let-through is taken into account.

Where the standard covering a protective device specifies both a rated service short-circuit breaking capacity and a rated ultimate short-circuit breaking capacity, it is acceptable to select the protective device on the basis of the ultimate short-circuit breaking capacity for the maximum fault current conditions. Operational circumstances may, however, make it desirable to select the protective device on the service short-circuit breaking capacity, e.g. where a protective device is placed at the origin of the installation.

Where the short-circuit breaking capacity of the protective device is lower than the maximum prospective shortcircuit or earth fault current that is expected at its point of installation, it is necessary to comply with the requirements of the last paragraph of Regulation 536.1 and Regulation 536.5.

NOTE: For calculating maximum and minimum fault currents, the equations given in Technical Report PD CLC/TR 50480 are recommended.

537 **ISOLATION AND SWITCHING**

TABLE 53.4 – Guidance on the selection of protective, isolation and switching devices

		-				
Device	Standard	Isolation ⁽⁴⁾	Emergency switching ⁽²⁾	Functional switching		
Yes = Function provided, (1) Function provided if the identity number S00288	No = Function not prov e device is suitable and 3).	ided marked with the symbolic	ol for isolation (see B	<mark>S EN <u>IEC</u> 60617</mark>		
 ⁽²⁾ See Regulation 537.4.2.5 ⁽³⁾ Device is suitable for on-load isolation, i.e. disconnection whilst carrying load current. ⁽⁴⁾ In an installation forming part of a TT or IT system, isolation requires disconnection of all the live conductors. 						
(5) <u>Circuit-breakers and RC</u> <u>frequent load switching</u> <u>isolation or emergency</u>	CDs are primarily circui Infrequent switching c switching.	it-protective devices ar of circuit-breakers on-l	nd, as such, they are no load is admissible for t	ot intended for he purposes of		
For a more frequent duty, the number of operations and load characteristics according to the manufacturer's instructions should be taken into account or an alternative device from those listed as suitable for functional switching in Table 53.4 should be employed.						
NOTE 1 : An entry of (1,3 symbol for on-lo) means that the device ad isolation	is suitable for on-load	isolation only if it is n	narked with the		
NOTE 2 : In the above tab together with the	le, the functions provide indication of the releva	ed by the devices for is ant product standards.	solation and switching	are summarized,		

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537.5 Functional switching (control)

537.5.3 Control circuits (auxiliary circuits) Moved by BS 7671:2008 Amendment 3 to 557.3.200

A control circuit shall be designed, arranged and protected to limit dangers resulting from a fault between the control circuit and other conductive parts liable to cause malfunction (e.g. inadvertent operation) of the controlled equipment.

CHAPTER 54

EARTHING ARRANGEMENTS AND PROTECTIVE CONDUCTORS

543 PROTECTIVE CONDUCTORS

543.2 Types of protective conductor

543.2.2 Where a metal enclosure or frame of a low voltage switchgear or controlgear assembly or busbar trunking system is used as a protective conductor, it shall satisfy the following three requirements:

- (i) Its electrical continuity shall be assured, either by construction or by suitable connection, in such a way as to be protected against mechanical, chemical or electrochemical deterioration
- (ii) Its cross-sectional area shall be at least equal to that resulting from the application of Regulation 543.1, or verified by test in accordance with <u>the appropriate part of BS EN-60439-1.61439 series</u>
- (iii) It shall permit the connection of other protective conductors at every predetermined tap-off point.

544 PROTECTIVE BONDING CONDUCTORS

544.1 Main protective bonding conductors

544.1.2 The main <u>equipotential protective</u> bonding connection to any gas, water or other service shall be made as near as practicable to the point of entry of that service into the premises. Where there is an insulating section or insert at that point, or there is a meter, the connection shall be made to the consumer's hard metal pipework and before any branch pipework. Where practicable the connection shall be made within 600 mm of the meter outlet union or at the point of entry to the building if the meter is external.

CHAPTER 55

OTHER EQUIPMENT

551 LOW VOLTAGE GENERATING SETS

551.7 Additional requirements for installations where the generating set may operate in parallel with other sources including systems for distribution of electricity to the public

551.7.1 Where a generating set is used as an additional source of supply in parallel with another source, protection against thermal effects in accordance with Chapter 42 and protection against overcurrent in accordance with Chapter 43 shall remain effective in all situations. both of the following conditions shall be fulfilled:

- (i) <u>Protection against thermal effects in accordance with Chapter 42 and protection against overcurrent in accordance with Chapter 43 shall remain effective in all situations</u>
- (ii) An RCD providing additional protection in accordance with Regulation 415.1 for a circuit connecting the generator set to the installation shall disconnect all live conductors, including the neutral conductor.

551.7.2 A generating set used as an additional source of supply in parallel with another source shall be installed:

- on the supply side of all the <u>overcurrent</u> protective devices for the final circuits of the installation, or
- on the load side of all the protective devices for a final circuit of the installation, but in this case all the following additional requirements shall be fulfilled:
 - (i) The conductors of the final circuit shall meet the following requirement:

 $I_{z} \geq I_{n} + I_{g}$

where:

 $I_{\ensuremath{\boldsymbol{Z}}}$ is the current-carrying capacity of the final circuit conductors

 I_n is the rated current of the protective device of the final circuit

 $I_g \mbox{ is the rated output current of the generating set }$

- (ii) A generating set shall not be connected to a final circuit by means of a plug and socket-outlet
- (iii) A residual current device providing additional protection of the final circuit in accordance with Regulation 415.1 shall disconnect all live conductors including the neutral conductor
- (ivii) The line and neutral conductors of the final circuit and of the generating set shall not be connected to Earth
- (iv) Unless the device providing automatic disconnection of the final circuit in accordance with Regulation 411.3.2 disconnects the line and neutral conductors, it shall be verified that the combination of the disconnection time of the protective device for the final circuit and the time taken for the output voltage of the generating set to reduce to 50 V or less is not greater than the disconnection time required by Regulation 411.3.2 for the final circuit.

This regulation does not apply to an uninterruptible power supply provided to supply specific items of current-using equipment within the final circuit to which it is connected.

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557 AUXILIARY CIRCUITS

<u>557.1</u> <u>Scope</u>

This section applies to auxiliary circuits, except those covered by specific product or system standards, e.g. the construction of assemblies of electrical equipment to the appropriate part of the IEC 61439 series.

557.2 Not used

557.3 Requirements for auxiliary circuits

557.3.1 General

The power supply, a.c. or d.c., for an auxiliary circuit may be either dependent or independent of the main circuit according to its required function. If the status of the main circuit has to be signalled, then the signalling circuit shall be able to operate independently of that main circuit.

537.5.3 557.3.200 Control circuits

A control circuit shall be designed, arranged and protected to limit dangers resulting from a fault between the control circuit and other conductive parts liable to cause malfunction (e.g. inadvertent operation) of the controlled equipment.

557.3.2 Power supply for auxiliary circuits dependent on the main circuit

557.3.2.1 General

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Auxiliary circuits with a power supply dependent on the main a.c. circuit shall be connected to the main circuit:

- (i) directly (see Figure 557.1), or
- (ii) via a rectifier (see Figure 557.2), or
- (iii) via a transformer (see Figure 557.3).

It is recommended that auxiliary circuits supplying primarily electronic equipment or systems should not be supplied directly but at least via simple separation from the main circuit.

Figure 557.1 – Auxiliary circuit supplied directly from the main circuit



Figure 557.2 – Auxiliary circuit supplied from the main circuit via a rectifier



Figure 557.3 – Auxiliary circuit supplied from the main circuit via a transformer



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NOTE For an auxiliary circuit supplied from the main circuit, either directly or via a rectifier, the auxiliary circuit begins at the connection point to the main circuit, see Figures 557.1 and 557.2. In the case of a transformer supply, the auxiliary circuit begins on the secondary side of the transformer, see Figure 557.3.

557.3.2.2 Auxiliary circuit supplied from the main circuit via transformer

Where an auxiliary circuit is supplied by more than one transformer, they shall be connected in parallel both on the primary and secondary sides.

557.3.3 Auxiliary circuit supplied by an independent source

Where an independent source is used a loss of supply or undervoltage of the main circuit source shall be detected. An independent auxiliary circuit shall not create a hazardous situation.

NOTE Batteries and a power supply system independent of the mains are examples of independent sources.

557.3.4 Auxiliary circuits with or without connection to earth

557.3.4.1 General

An auxiliary circuit shall comply with the earthing requirements of BS 7671 except as modified by Regulation 557.3.4.2 or 557.3.4.3.

NOTE 1 It depends on the requirements for an auxiliary circuit as to whether it is operated earthed or unearthed. For example, in an earthed auxiliary circuit an earth fault in a non-earthed conductor leads to disconnection of the power supply of the auxiliary circuit; in an unearthed auxiliary circuit, an earth fault in a conductor leads only to a signal from the IMD (see Regulation 557.3.4.3).

NOTE 2 The use of unearthed auxiliary circuits should be considered where high reliability is required.

557.3.4.2 Earthed auxiliary circuit

Earthed auxiliary circuits supplied via a transformer shall be connected to earth only at one point on the secondary side of the transformer. The connection to earth shall be situated close to the transformer. The connection shall be easily accessible and capable of being isolated for insulation measurement.

557.3.4.3 Unearthed auxiliary circuit

If an auxiliary circuit is operated unearthed via a transformer, an insulation monitoring device (IMD) according to BS EN 61557-8 shall be installed on the secondary side. Consideration shall be given to the use of risk assessment to determine whether the signal from the IMD is to initiate an acoustic and/or a flash alarm, or be transmitted to a monitoring system.

557.3.5 Power supplies for auxiliary circuits

557.3.5.1 General

The rated voltage of the auxiliary circuit, and the components used in the circuit, shall be compatible with the supply to that circuit.

NOTE If the supply voltage is too low for the design of the circuit then the operation will not be reliable, e.g. for the proper function of relays.

Account shall be taken of the effects of voltage drop on the electrical equipment of the auxiliary circuit, including inrush and starting currents, e.g.:

- (i) for an a.c. supply, relays and solenoid valves may have an inrush current of 7 to 8 times the holding current
- (ii) for a d.c. supply, the inrush current is equal to the steady current
- (iii) in the case of motors starting direct-on-line, the starting current could reduce the supply voltage of an auxiliary circuit dependent on the main circuit below the minimum operating voltage of the associated switchgear.

557.3.5.2 Standby power supply or power supply for safety services

Where a standby power supply or a power supply from a generating set is used to supply auxiliary circuits, the frequency variation shall be taken into account.

557.3.5.3 AC supply

The nominal voltage of control circuits shall preferably not exceed

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- (i) 230 V for circuits with 50 Hz nominal frequency
- (ii) 277 V for circuits with 60 Hz nominal frequency

respectively, taking into account voltage tolerances according to BS EN 60038.

NOTE The dimensioning of cable length with respect to the conductor capacitances, e.g. connection to a limit switch, needs to be coordinated with the selected relays or solenoid valves. The standing voltage caused by high conductor capacitances may impair the switching off of relays or solenoid valves.

557.3.5.4 DC supply 557.3.5.4.1 Supply by a power system

The nominal voltage of control circuits shall preferably not exceed 220 V.

557.3.5.4.2 Supply by batteries

Where batteries are used as a power supply for auxiliary circuits, the voltage fluctuation due to charging or discharging shall not exceed voltage tolerances specified in BS EN 60038, unless the auxiliary circuit is specifically designed to compensate for such voltage fluctuation.

557.3.6 Protective measures

557.3.6.1 Protection of wiring systems

NOTE 1 In the case of extended auxiliary circuits it is necessary to ensure that the required tripping current of the protective device will be achieved also at the far end of the respective cables or conductors, Regulation 433.1.

Single-phase earthed a.c. or d.c. auxiliary circuits supplied on the secondary side of the transformer for an auxiliary supply are permitted to be protected by single-pole devices. The protective devices shall only be inserted in conductors which are not connected directly to the earth.

In unearthed a.c. or d.c. auxiliary circuits, short-circuit protection shall be provided for all line conductors.

NOTE 2 The use of protective devices which disconnect all lines of an unearthed auxiliary circuit will aid fault diagnosis and maintenance activities.

If the short-circuit protective device on the primary side of the transformer for an auxiliary circuit is selected so that it also protects against short-circuit current on the secondary side, a protective device on the secondary side of the transformer may be omitted.

NOTE 3 For a fault on the transformer secondary side, the magnitude of the short-circuit current on the primary side depends also on the impedance of the transformer.

537.3.6.2 Protection against short-circuit

Switching contacts of electrical switching devices of the auxiliary circuit shall be protected against damage caused by short-circuit currents, according to the manufacturer's instructions.

557.4 Characteristics of cables and conductors

557.4.1 Minimum cross-sectional areas

In order to ensure adequate mechanical strength, the following minimum cross-sectional areas indicated in Table 557.1 shall be met. If there are special mechanical strength requirements for cables or conductors, then a larger cross-sectional area of conductor, selected in accordance with Chapter 52, may be required.

Table 557	.1 – Minimum cross-sectional area of copper conductors in mm ²	

	<u>Type of cable</u>								
	Single-core		<u>Two-core</u>		<u>Multicore</u>				
<u>Application</u>	Single-wire	<u>Stranded</u>	<u>Screened</u>	<u>Unscreened</u>	Screened or unscreened				
<u>Control circuits^a</u>	<u>0.5</u>	<u>0.5</u>	<u>0.5</u>	<u>0.5</u>	<u>0.1</u>				
<u>Data transfer</u>	=	Ξ	Ξ	Н	<u>0.1</u>				
^a Other auxiliary circuits may need a larger cross-sectional area of copper conductor, e.g. for measuring.									
NOTE The cross-sectional area of copper conductors is derived from Section 524.									

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557.5 Requirements for auxiliary circuits used for measurement

557.5.1 General

Measuring circuits are auxiliary circuits with dedicated requirements which are given in the following subclauses.

557.5.2 Auxiliary circuits for direct measurement of electrical quantities

An auxiliary circuit for direct measurement of electrical quantities shall be protected against the effects of a fault by one of the following means:

- (i) Provision of a device for protection against fault current in accordance with Section 434. Where operation of the device could cause danger, or lead to a hazardous situation, such operation shall also cause disconnection of the main circuit.
- (ii) Simultaneous fulfilment of conditions (v) and (vi) of Regulation 434.3.

557.5.3 <u>Auxiliary circuits for measurement of electrical quantities via a transformer</u> 557.5.3.1 Current transformer

Where a measurement device is connected to the main circuit via a current transformer, the following requirements shall be taken into account:

- (i) The secondary side of the transformer in a low voltage installation shall not be earthed, except where the measurement can only be carried out with a connection to earth
- (ii) Protective devices interrupting the circuit shall not be used on the secondary side of the transformer
- (iii) Conductors on the secondary side of the transformer shall be insulated for the highest voltage of any live parts or shall be installed such that their insulation cannot come into contact with other live parts, e.g. contact with busbars
- (iv) Terminals for temporary measurements shall be provided.

The above requirements do not apply to summation current transformers where hazardous voltages do not occur, e.g. equipment for insulation fault location according to BS EN 61557-9.

557.5.3.2 Voltage transformer

The secondary side of a voltage transformer shall be protected by a short-circuit protective device.

557.6 Functional considerations

557.6.1 Voltage supply

Where loss of voltage, i.e. voltage fluctuation, overvoltage or undervoltage, could cause the auxiliary circuit to be unable to perform its intended function, means to ensure continued operation of the auxiliary circuit shall be provided.

557.6.2 Quality of signals depending on the cable characteristics

The operation of an auxiliary circuit shall not be adversely affected by the characteristics, including impedance and length, of the cable between operational components.

The capacitance of the cable shall not impair the proper operation of an actuator in the auxiliary circuit. The cable characteristics and length shall be taken into account for the selection of switchgear and controlgear or electronic circuits.

NOTE For an extensive auxiliary circuit, the use of a d.c. power supply or bus-system is recommended.

557.6.3 Measures to avoid the loss of functionality

An auxiliary circuit serving a special function where reliability is a concern will require additional design considerations to minimize the likelihood of wiring faults. These wiring faults could result in loss of function and/or loss of signal. Among the design considerations are

- (i) selection of appropriate installation methods for cables
- (ii) selection of equipment where a line to exposed-conductive-parts fault is not possible, e.g. Class II equipment
- (iii) use of inherently short-circuit and earth fault proof installation and equipment.

For the design of inherently short-circuit and earth fault proof installations and equipment, the following shall be considered:

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- (a) <u>Arrangements of single conductors with basic insulation, together with measures to prevent mutual</u> <u>contact and contact with exposed-conductive-parts. This may be achieved by:</u>
 - <u>–</u> installation in (insulated) cable trunking systems, or
 - <u>installation in (insulated) conduit.</u>
- (b) Arrangements of
 - <u>– single-core cables, or</u>
 - <u>single-core, non-metallic-sheathed cables, or</u>
 - <u>rubber-insulated flexible cables.</u>
- (c) <u>Provision of protection against mechanical damage and of safe distance from flammable material for</u> <u>non-metallic sheathed cables.</u>
- (d) Arrangements of non-metallic-sheathed cables with nominal voltage U_0/U at least 0.6/1 kV (U_0 = conductor to earth voltage, U = conductor to conductor voltage).
- (e) Use of cables with an insulation which is self-extinguishing and flame-retardant.
- (f) Use of cables that are afforded physical protection by being buried, e.g. installation of cables in soil or concrete.

557.6.4 Current-limiting signal outputs

In earthed or unearthed auxiliary circuits with current-limiting signal outputs or electronically controlled protection against short-circuit conditions, respectively, the signal circuit shall be disconnected within 5 s if the respective measure operates. In special cases, a shorter disconnection time may be required.

For current-limiting signal outputs or electronically controlled protection of the signal output, respectively, automatic disconnection of supply may be omitted if a hazardous situation is not likely to occur.

557.6.5 Connection to the main circuit

557.6.5.1 Auxiliary circuits without direct connection to the main circuit

Electrical actuators, e.g. actuating relays, contactors, signalling lights, electromagnetic locking devices, shall be connected to the common conductor (see Figure 557.4):

- (a) in earthed auxiliary circuits, at the earthed (common) conductor;
- (b) in unearthed auxiliary circuits, at the common conductor.

Figure 557.4 – Configuration of an auxiliary circuit



Exception: Switching elements of protective relays, e.g. overcurrent relays, which may be installed between the earthed or the non-earthed conductor and a coil, provided that

- (i) this connection is contained inside a common enclosure, or
- (ii) it leads to a simplification of external control devices, e.g. conductor bars, cable drums, multiple connectors, and taking into account the requirements of Regulation 557.3.6.2.

557.6.5.2 Auxiliary circuits with direct connection to the main circuit

If the auxiliary circuit is:

- (a) supplied between two line conductors (e.g. L1 and L2 of an IT system), two-pole switching contacts shall be used;
- (b) connected to the earthed neutral of the main circuit, the requirements of Chapter 43 apply.

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557.6.6 Plug-in connections

Interchangeability between multiple plug-in connections is permitted only where it will not result in mechanical damage or introduce a risk of fire, electric shock or injury to persons.

NOTE 1 These plug-in connections form a part of the auxiliary circuit(s) and may conduct different signals.

NOTE 2 Protection against interchangeability may be achieved by marking, polarization, design or electronic interlocking.

The connectors shall be secured by a means to prevent unintended disconnection.

559 LUMINAIRES AND LIGHTING INSTALLATIONS

559.1 Scope

This section applies to the selection and erection of luminaires and lighting installations intended to be part of the fixed installation and to highway power supplies and street furniture.

NOTE 1: For lighting installations in special locations, refer to Part 7.

Particular requirements are given for:

(i) fixed outdoor lighting installations

(ii) extra low voltage lighting installations supplied from a source with a maximum rated voltage of 50 V a.c. or 120 V d.c.

(iii) lighting for display stands.

The requirements of this section do not apply to:

- $(i\mathbf{v})$ high voltage signs supplied at low voltage (such as neon tubes)
- (vii) signs and luminous discharge tube installations operating from a no-load rated output voltage exceeding 1 kV but not exceeding 10 kV (BS EN 50107).

(iii) temporary festoon lighting.

NOTE 2: The requirements for high voltage signs are given in BS 559 and the BS EN 50107 series.

559.2 Not used

559.3 Outdoor lighting installations

An outdoor lighting installation comprises one or more luminaires, a wiring system and accessories.

The following are included:

(i) Lighting installations such as those for roads, parks, car parks, gardens, places open to the public, sporting areas, illumination of monuments and floodlighting

(ii) Other lighting arrangements in places such as telephone kiosks, bus shelters, advertising panels and town plans
 (iii) Road signs.

The following are excluded:

- (iv) Equipment of the owner or operator of a system for distribution of electricity to the public

(v) Temporary festoon lighting

- (vi) Luminaires fixed to the outside of a building and supplied directly from the internal wiring of that building - (vii) Road traffic signal systems.

559.4<u>3</u> General requirements for installations

NOTE: See Table 55.2 for an explanation of the symbols used in luminaires, in controlgear for luminaires and in the installation of luminaires.

559.43.1 Every luminaire shall comply with the relevant standard for manufacture and test of that luminaire and shall be selected and erected in accordance with to take account of the manufacturer's instructions.

559.43.2 For the purposes of this section, luminaires without transformers or convertors but which are fitted with extra-low voltage lamps connected in series shall be considered as low voltage equipment not extra-low voltage equipment. These luminaires shall be either Class I or Class II equipment.

559.43.3 Where a luminaire is installed in a pelmet, there shall be no adverse effects due to the presence or operation of curtains or blinds.

559.43.4 A track system for luminaires shall comply with the requirements of BS EN 60570.

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559.54 Protection against fireof the surroundings against thermal effects

559.54.1 General

In the selection and erection of a luminaire the thermal effects of radiant and convected energy on the surroundings shall be taken into account, including:

- (i) the maximum permissible power dissipated by the lamps
- (ii) the fire-resistance of adjacent material
 - at the point of installation, and
 - in the thermally affected areas
- (iii) the minimum distance to combustible materials, including material in the path of a spotlight beam-
- (iv) the relevant markings on the luminaire.

559.65 Wiring systems

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559.6.1 Common rules

559.6.1.1.5.1 Connection to the fixed wiring

At each fixed lighting point one of the following shall be used for the termination of the wiring system:

- (i) A ceiling rose to BS 67
- (ii) A luminaire supporting coupler to BS 6972 or BS 7001
- (iii) A batten lampholder or a pendant set to BS EN 60598
- (iv) A luminaire to BS EN 60598
- (v) A suitable socket-outlet to BS 1363-2, BS 546 or BS EN 60309-2
- (vi) A plug-in lighting distribution unit to BS 5733
- (vii) A connection unit to BS 1363-4
- (viii) Appropriate terminals enclosed in a box complying with the relevant part of BS EN 60670 series or BS 4662
- (ix) A device for connecting a luminaire (DCL) outlet according to IEC 61995-1-
- (x) An installation coupler BS EN 61535.

NOTE: In suspended ceilings one plug-in lighting distribution unit may be used for a number of luminaires.

559<u>.6.1.2.5.1.200</u> A ceiling rose or lampholder for a filament lamp shall not be installed in any circuit operating at a voltage normally exceeding 250 volts.

559.6.1.3.5.1.201 A ceiling rose shall not be used for the attachment of more than one outgoing flexible cable unless it is specially designed for multiple pendants.

559.6.1.4.5.1.202 Luminaire supporting couplers <u>and devices for the connection of luminaires</u> are designed specifically for the mechanical support and electrical connection of luminaires and shall not be used for the connection of any other equipment.

559.6.1.6.5.1.203 Lighting circuits incorporating B15, B22, E14, E27 or E40 lampholders shall be protected by an overcurrent protective device of maximum rating 16A.

559.6.1.7.5.1.204 Bayonet lampholders B15 and B22 shall comply with BS EN 61184 and shall have the temperature rating T2 described in that standard.

559.6.1.8.5.1.205 In circuits of a TN or TT system, except for E14 and E27 lampholders complying with BS EN 60238, the outer contact of every Edison screw or single centre bayonet cap type lampholder shall be connected to the neutral conductor. This regulation also applies to track mounted systems.

559<u>.6.1.9</u>.**5.1.206** A lighting installation shall be appropriately controlled.

NOTE: See Table 53.4 for guidance on the selection of suitable protective, isolation and switching devices.

559.6.1.100.5.1.207 Consideration shall be given to the provision of the neutral conductor, at each switch position, to facilitate the installation of electronic switching devices.
559.5.2 Fixing of luminaires

559.6.1.5 Adequate means to fix luminaires shall be provided.

The fixing means may be mechanical accessories (e.g. hooks or screws), boxes or enclosures which are able to support luminaires or supporting devices for connecting a luminaire.

In places where the fixing means is intended to support a pendant-luminaire, the fixing means shall be capable of carrying a mass of not less than 5 kg. If the mass of the luminaire is greater than 5 kg, the installer shall ensure that the fixing means is capable of supporting the mass of the pendant-luminaire.

The installation of the fixing means shall be in accordance with the manufacturer's instructions.

The weight of luminaires and their eventual accessories shall be compatible with the mechanical capability of the ceiling or suspended ceiling or supporting structure where installed.

Any flexible cable between the fixing means and the luminaire shall be installed so that any expected stresses in the conductors, terminals and terminations will not impair the safety of the installation. (See also Table 4F3A of Appendix 4.)

559.6.2.5.3 Through wiring

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559.6.2.1.5.3.1 The installation of through wiring in a luminaire is only permitted if the luminaire is designed for such wiring.

559.6.2.2.5.3.2 A cable for through wiring shall be selected in accordance with the temperature information on the luminaire or on the manufacturer's instruction sheet, if any, as follows:

- (i) For a luminaire complying with BS EN 60598 but with temperature marking, cables suitable for the marked temperature shall be used
- (ii) Unless specified in the manufacturer's instructions, for a luminaire complying with BS EN 60598 but with no temperature marking, heat-resistant cables are not required
- (iii) In the absence of information, heat-resistant cables and/or insulated conductors of type H05S-U, H05S-K, H05SJ-K, H05SS-K (BS 6007 EN 50525 series) or equivalent shall be used.

559.5.4 Devices for connection of luminaires to the supply

If the luminaire does not provide a connecting device for connection to the supply, the connecting device shall be:

- (i) terminals according to BS EN 60998, or
- (ii) a Device for Connecting a Luminaire (DCL) plug according to BS EN 61995, or
- (iii) an installation coupler according to BS EN 61535, or
- (iv) another suitable and appropriate connecting device.
- **NOTE:** For the installation of supply cables, see also Regulation 522.2.

559.6.2.3 559.5.5 Groups of luminaires

Groups of luminaires divided between the three line conductors of a three-phase system <u>circuit</u> with only one common neutral conductor shall be provided with at least one device that simultaneously disconnects <u>disconnecting simultaneously</u> all line conductors.

NOTE: See also Section 536.

559.5.6 Protection against heat and UV radiation effects within luminaires

External cables and cores of cables connected within a luminaire or passing through shall be so selected and erected that they will not suffer damage or deterioration due to heat and UV radiation generated by the luminaire or its lamps (e.g. shielding).

559.76 Independent lamp controlgear, e.g. ballasts

Only independent lamp controlgear marked as suitable for independent use, according to the relevant standard, shall be used external to a luminaire.

Only the following are permitted to be mounted on flammable surfaces:

- (i) A "class P" thermally protected ballast(s)/transformer(s).
- (ii) A temperature declared thermally protected ballast(s)/transformer(s)-with a marked value equal to or below 130 °C.

NOTE: For an explanation of symbols used see Table 55.2.

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559.87 Compensation capacitors

Compensation capacitors having a total capacitance exceeding 0.5 μ F shall only be used in conjunction with discharge resistors. Capacitors and their marking shall be in accordance with BS EN 61048.

This requirement does not apply to capacitors forming part of the equipment.

559.8 Protection against electric shock for display stands for luminaires

Protection against electric shock for circuits supplying display stands for luminaires shall be provided by either:

- (i) <u>a SELV or PELV supply, or</u>
- (ii) a residual current device having a rated residual operating current not exceeding 30 mA which provides both automatic disconnection of supply according to Section 411 and additional protection according to Regulation 415.1.

559.9 Stroboscopic effect

In the case of lighting for premises where machines with moving parts are in operation, consideration shall be given to stroboscopic effects which can give a misleading impression of moving parts being stationary. Such effects may be avoided by selecting luminaires with suitable lamp controlgear, such as high frequency controlgear, or by distributing lighting loads across all the phases of a three-phase supply.

559.10 Ground-recessed luminaires

For ground-recessed luminaires the selection and erection shall take account of the guidance given in Table A.1 of BS EN 60598-2-13.

559.10 Requirements for outdoor lighting installations, highway power supplies and street furniture

Moved by BS 7671:2008 Amendment 3 to Section 714

559.11 Requirements for extra-low voltage lighting installations Moved by BS 7671:2008 Amendment 3 to Section 715

TABLE 55.2 – Explanation of symbols used in luminaires, in controlgear for Iuminaires and in the installation of luminaires

Editor's Note, there have been no changes to this table other than to the last item: Independent ballast <u>BS</u> EN 60417 sheet No. 5138 also add "Table 55.2" to Appendix 1's entry for BS EN 60417.

PART 6

INSPECTION AND TESTING

CHAPTER 61 INITIAL VERIFICATION

610 GENERAL

610.5 The verification shall be made by <u>a competent person electrically skilled persons, competent in such work</u>.

612 TESTING

612.1 General

The tests of Regulations 612.2 to 13, where relevant, shall be carried out and the results compared with relevant criteria.

Measuring instruments and monitoring equipment and methods shall be chosen in accordance with the relevant parts of BS EN 61557. If other measuring equipment is used, it shall provide no less degree of performance and safety.

When undertaking testing in a potentially explosive atmosphere, appropriate safety precautions in accordance with BS EN 60079-17 and BS EN 61241-17 are necessary.

The tests of Regulations 612.2 to 6, where relevant, shall be carried out in that order before the installation is energized. Where the installation incorporates an earth electrode, the test of Regulation 612.7 shall also be carried out before the installation is energized.

If any test indicates a failure to comply, that test and any preceding test, the results of which may have been influenced by the fault indicated, shall be repeated after the fault has been rectified.

Some methods of test are described in IET Guidance Note 3, Inspection & Testing, published by the Institution of Engineering and Technology. Other methods of testing are not precluded provided they give valid results.

612.3 Insulation resistance

612.3.4 Functional extra-low voltage circuits shall meet all the test requirements for low voltage circuits.

612.4 Protection by SELV, PELV or by electrical separation

612.4.4 Functional extra-low voltage circuits <u>Moved by BS 7671:2008 Amendment 3 to 612.3.4.</u>

Functional extra-low voltage circuits shall meet all the test requirements for low voltage circuits.

612.12 Check of phase sequence

For multipolyphase circuits, it shall be verified that the phase sequence is maintained.

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CHAPTER 62 PERIODIC INSPECTION AND TESTING

621 GENERAL

621.5 Periodic inspection and testing shall be undertaken by a competent person electrically skilled persons, competent in such work.

CHAPTER 63 CERTIFICATION AND REPORTING

631 GENERAL

631.4 Electrical Installation Certificates, Electrical Installation Condition Reports and Minor Electrical Installation Works Certificates shall be compiled and signed or otherwise authenticated by a competent person or persons electrically skilled persons, competent in such work.

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PART 7

SPECIAL INSTALLATIONS OR LOCATIONS

PARTICULAR REQUIREMENTS

SECTION 701

LOCATIONS CONTAINING A BATH OR SHOWER

701.41 Protection for safety: protection against electric shock

701.411.3.3 Additional protection by RCDs

Additional protection shall be provided for all low voltage circuits <u>of serving or passing through</u> the location, by the use of one or more RCDs having the characteristics specified in Regulation 415.1.1.

NOTE: See also Regulations 314.1(iv) and 531.2.4 concerning the avoidance of unwanted tripping.

SECTION 704

CONSTRUCTION AND DEMOLITION SITE INSTALLATIONS

704.1 Scope

704.1.1 The particular requirements of this section apply to temporary installations for construction and demolition sites during the period of the construction or demolition work, including, for example, the following:

- (i) Construction work of new buildings
- (ii) Repair, alteration, extension, or demolition of existing buildings or parts of existing buildings
- (iii) Engineering works
- (iv) Earthworks
- (v) Work of similar nature.

The requirements apply to fixed-or and movable installations.

The regulations do not apply to:

- (vi) installations covered by the IEC 60621 series 2, where equipment of a similar nature to that used in surface mining applications is involved
- (vii) installations in administrative locations of construction sites (e.g. offices, cloakrooms, meeting rooms, canteens, restaurants, dormitories, toilets), where the general requirements of Parts 1 to 6 apply.

SECTION 708

ELECTRICAL INSTALLATIONS IN CARAVAN / CAMPING PARKS AND SIMILAR LOCATIONS

Figure 708 – Example of a 2-pole and protective conductor supply system between the caravan pitch supply equipment and the caravan or motor caravan

NOTE: Typical requirements for cord-cable extension sets

The means of connection between the caravan pitch socket-outlet and the leisure accommodation vehicle should be an assembly of the following:

- a plug complying with BS EN 60309-2;
- a flexible cable type H05RN-F (BS 7919) or equivalent, with a protective conductor and having the following characteristics:
 - length: 25 m (±2 m) continuous length 25 m max
 - for current rating 16A: minimum cross-sectional area: 2.5 mm². For higher current ratings, the crosssectional area must be chosen so that secure tripping of the overcurrent protective device is achieved at the lowest fault current calculated at the end of the <u>cord-cable</u> extension set
 - conductors to be identified in accordance with Table 51-
- a connector complying with BS EN 60309-2.

SECTION 709

MARINAS AND SIMILAR LOCATIONS

Figure 709.3 – Example of an instruction notice to be placed in marinas

- **NOTE 1:** It is recommended that the marina operator provides every pleasure craft operator who wishes to connect a pleasure craft to an electrical supply with an up-to-date copy of this instruction notice.
- **NOTE 2:** The instruction notice should contain, at least, the following:

INSTRUCTIONS FOR ELECTRICITY SUPPLY

BERTHING INSTRUCTIONS FOR CONNECTION TO SHORE SUPPLY

This marina provides power for use on your pleasure craft with a direct connection to the shore supply which is connected to $e\underline{E}$ arth. Unless you have an isolating transformer fitted on board to isolate the electrical system on your craft from the shore supply system, corrosion through electrolysis could damage your craft or surrounding craft.

ON ARRIVAL

(i) Ensure the supply is switched off and ...

SECTION 711

EXHIBITIONS, SHOWS AND STANDS

711.5 Selection and erection of equipment

711.55 Other equipment

711.55.6 ELV transformers and electronic convertors

A manual reset protective device shall protect the secondary circuit of each transformer or electronic convertor.

Particular care shall be taken when installing ELV transformers, which shall be mounted out of arm's reach of the public and shall have adequate ventilation. Access by a competent person for testing and by a skilled person competent in such work for maintenance shall be provided to facilitate inspection, testing and maintenance.

Electronic convertors shall conform with BS EN 61347-1.

SECTION 712

SOLAR PHOTOVOLTAIC (PV) POWER SUPPLY SYSTEMS

712.4 Protection for safety

712.41 Protection against electric shock

712.411 Protective measure: Automatic disconnection of supply

712.411.3.2.1.1 On the a.c. side, the PV supply cable shall be connected to the supply side of the <u>overcurrent</u> protective device for automatic disconnection of circuits supplying current-using equipment.

712.411.3.2.1.2 Where an electrical installation includes a PV power supply system without at least simple separation between the a.c. side and the d.c. side, an RCD installed to provide <u>either</u> fault protection by automatic disconnection of supply <u>or additional protection in accordance with Regulation 415.1</u>, for the PV supply cable, shall be type B according to IEC 62423.

Where the PV convertor is, by construction, not able to feed d.c. fault currents into the electrical installation, an RCD of type B according to IEC 62423 is not required.



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SECTION 714

OUTDOOR LIGHTING INSTALLATIONS

714.1 Scope

This section applies to outdoor lighting installations comprising one or more luminaires, a wiring system and accessories, and to highway power supplies and street furniture.

The following are included:

- (i) Lighting installations such as those for roads, parks, car parks, gardens, places open to the public, sporting areas, illumination of monuments and floodlighting
- (ii) Other lighting arrangements in places such as telephone kiosks, bus shelters, advertising panels and town plans
- (iii) Road signs.

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The following are excluded:

- (iv) Temporary festoon lighting
- (v) Luminaires fixed to the outside of a building and supplied directly from the internal wiring of that building
- (vi) Road traffic signal systems.

714.4 Protection for safety

714.41 Protection against electric shock

714.410.3 General requirements

714.410.3.6 The protective measures of non-conducting location (Regulation 418.1) and earth-free local equipotential bonding (Regulation 418.2) are not permitted.

714.411 Protective measure: Automatic disconnection of supply

714.411.200 Where the protective measure automatic disconnection of supply is usedall live parts of electrical equipment shall be protected by insulation or by barriers or enclosures providing basic protection. A door in street furniture, used for access to electrical equipment, shall not be used as a barrier or an enclosure

714.411.201 A maximum disconnection time of 5 s shall apply to all circuits feeding fixed equipment used in highway power supplies for compliance with Regulation 411.3.2.3 (TN system) or 411.3.2.4 (TT system).

714.411.202 Where an earth connection to a distributor's PME network has been provided for a street electrical fixture, the earthing conductor of a street electrical fixture shall have a minimum copper equivalent cross-sectional area not less than that of the supply neutral conductor at that point or not less than 6 mm², whichever is the smaller.

714.411.2.200 Provisions for basic protection

NOTE: This regulation is taken from IEC 60364-7-714.41 Annex A and is only renumbered.

For every accessible enclosure live parts shall only be accessible with a key or a tool, unless the enclosure is in a location where only skilled or instructed persons have access.

A door giving access to electrical equipment and located less than 2.50 m above ground level shall be locked with a key or shall require the use of a tool for access. In addition, basic protection shall be provided when the door is open either by the use of equipment having at least a degree of protection IPXXB or IP2X by construction or by installation, or by installing a barrier or an enclosure giving the same degree of protection.

For a luminaire at a height of less than 2.80 m above ground level, access to the light source shall only be possible after removing a barrier or an enclosure requiring the use of a tool.

714.411.3.1 Protective earthing and protective equipotential bonding

714.411.3.1.2 Protective equipotential bonding

A metallic structure (such as a fence, grid etc.) which is in the proximity of but is not part of the outdoor lighting installation need not be connected to the main earthing terminal.

714.411.3.3 Additional protection

Lighting in places such as telephone kiosks, bus shelters and town plans shall be provided with additional protection by an RCD having the characteristics specified in Regulation 415.1.1.

714.5 Selection and erection of equipment

714.51 Common rules

714.512 Operational conditions and external influences

714.512.2 External influences

714.512.2.1 The following classes are generally recommended:

- (i) Ambient temperature: AA2 and AA4 (from -40 °C to +40 °C)
- (ii) Climatic conditions: AB2 and AB4 (relative humidity between 5 % and 100 %).

The classes given for the following external influences are minimum requirements:

- (iii) Presence of water: AD3 (sprays)
- (iv) Presence of foreign bodies: AE2 (small objects).

714.512.2.105 Electrical equipment shall have, by construction or by installation, a degree of protection of at least IP33.

714.514.12 Notices

714.514.12.200 The requirements for notices for:

- (i) periodic inspection and testing (Regulation 514.12.1) and
- (ii) the testing of RCDs (Regulation 514.12.2)

need not be applied where the installation is subject to a programmed inspection and testing procedure.

714.514.12.201 On every temporary supply unit there shall be an externally mounted durable label stating the maximum sustained current to be supplied from that unit.

714.537 Isolation and switching

714.537.2 Isolation

714.537.2.1 General

714.537.2.1.1 Every circuit shall be capable of being individually isolated from each of the live supply conductors, except as detailed in Regulation 537.1.2.

714.537.2.1.200 Where it is intended that isolation and switching is carried out only by instructed persons and subject to suitable provisions being made so that precautions can be taken to prevent any equipment from being inadvertently or unintentionally energized, for TN systems, the means of switching the supply on load and the means of isolation is permitted to be provided by a suitably rated fuse carrier.

714.537.2.1.201 Where the distributor's cut-out is used as the means of isolation of a highway power supply the approval of the distributor shall be obtained.

Editor's Note, this version of Section 714 shows the changes made to 559.10 in order to create the new Section 714 as shown above.



OUTDOOR LIGHTING INSTALLATIONS

714.1 Scope

559.3 Outdoor lighting installations

An-<u>This section applies to</u> outdoor lighting installations comprises one or more luminaires, a wiring system and accessories, and to highway power supplies and street furniture.

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The following are included:

- (i) Lighting installations such as those for roads, parks, car parks, gardens, places open to the public, sporting areas, illumination of monuments and floodlighting
- (ii) Other lighting arrangements in places such as telephone kiosks, bus shelters, advertising panels and town plans
- (iii) Road signs.

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The following are excluded:

- (iv) Equipment of the owner or operator of a system for distribution of electricity to the public
- $(\underline{i}v)$ Temporary festoon lighting
- (vi) Luminaires fixed to the outside of a building and supplied directly from the internal wiring of that building
- (vii) Road traffic signal systems.

559.10 Requirements for outdoor lighting installations, highway power supplies and street furniture

714.4 Protection for safety

- 714.41 Protection against electric shock
- 714.410.3 General requirements

559.10.1 Protective measures: Placing out of reach and obstacles

The protective measures of placing out of reach and obstacles shall not be used.

Except where the maintenance of equipment is to be restricted to skilled persons who are specially trained, where items of street furniture are within 1.5 m of a low voltage overhead line, basic protection of the low voltage overhead line shall be provided by means other than placing out of reach.

559.10.2-714.410.3.6 Protective measures: Non-conducting location and earth-free local equipotential bonding

The protective measures <u>of</u> non-conducting location (Regulation 418.1) and earth-free local equipotential bonding (Regulation 418.2) shall not be used are not permitted.

559.10.3 714.411 Protective measure: Automatic disconnection of supply

559.10.3.1 714.411.200 Where the protective measure automatic disconnection of supply is used:

(i) all live parts of electrical equipment shall be protected by insulation or by barriers or enclosures providing basic protection. A door in street furniture, used for access to electrical equipment, shall not be used as a barrier or an enclosure

559.10.3.3 <u>714.411.201</u> A maximum disconnection time of 5 s shall apply to all circuits feeding fixed equipment used in highway power supplies for compliance with Regulation 411.3.2.3 (TN system) or 411.3.2.4 (TT system).

559.10.3.4 714.411.202 Where an earth connection to a distributor's PME network has been provided for a street electrical fixture, the earthing conductor of a street electrical fixture shall have a minimum copper equivalent cross-sectional area not less than that of the supply neutral conductor at that point or not less than 6 mm², whichever is the smaller.

714.411.2.200 Provisions for basic protection

NOTE: This regulation is taken from IEC 60364-7-714.41 Annex A and is only renumbered.

(ii) For every accessible enclosure live parts shall only be accessible with a key or a tool, unless the enclosure is in a location where only skilled or instructed persons have access.

(iii) A door giving access to electrical equipment and located less than 2.50 m above ground level shall be locked with a key or shall require the use of a tool for access. In addition, basic protection shall be provided when the door is open either by the use of equipment having at least a degree of protection IPXXB or IP2X by construction or by installation, or by installing a barrier or an enclosure giving the same degree of protection.

(iv) For a luminaire at a height of less than 2.80 m above ground level, access to the light source shall only be possible after removing a barrier or an enclosure requiring the use of a tool.

714.411.3.1 Protective earthing and protective equipotential bonding

714.411.3.1.2 Protective equipotential bonding

(v) for an outdoor lighting installation, A metallic structure (such as a fence, grid etc.), which is in the proximity of but is not part of the outdoor lighting installation need not be connected to the main earthing terminal.

714.411.3.3 Additional protection

559.10.3.2 Lighting in places such as telephone kiosks, bus shelters and town plans shall be provided with additional protection by an RCD having the characteristics specified in Regulation 415.1.1.

559.10.4 Protective measure: Double or reinforced insulation

For an outdoor lighting installation, where the protective measure for the whole installation is by double or reinforced insulation, no protective conductor shall be provided and the conductive parts of the lighting column shall not be intentionally connected to the earthing system.

714.5 Selection and erection of equipment

714.51 Common rules

714.512 Operational conditions and external influences

559.10.5-714.512.2 External influences

559.10.5.1 714.512.2.1 Classification of external influences

The following classes are generally recommended:

- (i) Ambient temperature: AA2 and AA4 (from -40 °C to +40 °C)
- (ii) Climatic conditions: AB2 and AB4 (relative humidity between 5 % and 100 %).

The classes given for the following external influences are minimum requirements:

- (iii) Presence of water: AD3 (sprays)
- (iv) Presence of foreign bodies: AE2 (small objects).

559.10.5.2 <u>714.512.2.105</u> Electrical equipment shall have, by construction or by installation, a degree of protection of at least IP33.

559.10.7 714.514.12 Warning nNotices

559.10.7.1 714.514.12.200 The requirements for notices for:

- (i) periodic inspection and testing (Regulation 514.12.1) and
- (ii) the testing of RCDs (Regulation 514.12.2)

need not be applied where the installation is subject to a programmed inspection and testing procedure.

559.10.7.2 <u>714.514.12.201</u> On every temporary supply unit there shall be an externally mounted durable label stating the maximum sustained current to be supplied from that unit.

559.10.6-714.537Devices for Isolation and switching714.537.2Isolation714.537.2.1General

<u>714.537.2.1.1</u> Every circuit shall be capable of being individually isolated from each of the live supply conductors, except as detailed in Regulation 537.1.2.

559.10.6.1 <u>714.537.2.1.200</u> Where it is intended that isolation and switching is carried out only by instructed persons and subject to suitable provisions being made so that precautions can be taken to prevent any equipment from being inadvertently or unintentionally energized, for TN systems, the means of switching the supply on load and the means of isolation is permitted to be provided by a suitably rated fuse carrier.

559.10.6.2 <u>714.537.2.1.201</u> Where the distributor's cut-out is used as the means of isolation of a highway power supply the approval of the distributor shall be obtained.

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SECTION 715

EXTRA-LOW VOLTAGE LIGHTING INSTALLATIONS

715.1 Scope

This section applies to extra-low voltage lighting installations supplied from a source with a maximum rated voltage of 50 V a.c. or 120 V d.c.

715.4 Protection for safety

715.41 Protection against electric shock

715.411.7.200 Functional Extra-Low Voltage (FELV)

FELV shall not be used.

715.414 Protective measure: Extra-low voltage provided by SELV or PELV

An extra-low voltage luminaire without provision for the connection of a protective conductor shall be installed only as part of a SELV system. Where bare conductors are used, the nominal voltage shall not exceed 25 V a.c. or 60 V d.c. according to Regulation 414.4.5.

A safety isolating transformer for an extra-low voltage lighting installation shall comply with BS EN 61558-2-6 and shall meet at least one of the requirements of Regulation 715.422.106.

NOTE: For an explanation of symbols used see Table 55.2.

Parallel operation of transformers in the secondary circuit is allowed only if they are also paralleled in the primary circuit and the transformers have identical electrical characteristics.

An electronic convertor for an extra-low voltage lighting installation shall comply with BS EN 61347-2-2 Annex 1 for incandescent lamps or BS EN 61347-2-13, Annex 1 for LEDs.

NOTE: For an explanation of symbols used see Table 55.2.

Parallel operation of convertor to BS EN 61347-2-2 or BS EN 61347-2-13 is not permitted.

715.42 Protection against thermal effects

715.422.106 Fire risk of transformers/convertors

Transformers shall be either:

- (i) protected on the primary side by a protective device complying with the requirements of Regulation 715.422.107.2, or
- (ii) short-circuit proof (both inherently and non-inherently).

NOTE: For an explanation of symbols used see Table 55.2.

715.422.107 Fire risk due to short-circuit

715.422.107.1 Where both the live circuit conductors are uninsulated, either:

- (i) they shall be provided with a protective device complying with the requirements of Regulation 715.422.107.2, or
- (ii) the system shall comply with BS EN 60598-2-23, or
- (iii) supplied from a transformer or convertor, the power of which does not exceed 200 VA.

715.422.107.2 A device providing protection against the risk of fire shall meet all the following requirements:

- (i) The device shall continuously monitor the power demand of the luminaires
- (ii) The device shall automatically disconnect the supply circuit within 0.3 s in the case of a short-circuit or failure which causes a power increase of more than 60 W
- (iii) The device shall provide automatic disconnection while the supply circuit is operating with reduced power (for example, by gating control or a regulating process or a lamp failure) if there is a failure which causes a power increase of more than 60 W
- (iv) The device shall provide automatic disconnection upon connection of the supply circuit if there is a failure which causes a power increase of more than 60 W
- (v) The device shall be fail-safe.

NOTE: Account needs to be taken of starting currents.

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715.43 Protection against overcurrent

715.430.104 Protection against overcurrent in ELV lighting installations

The use of self-resetting overcurrent protective devices is permitted only for transformers up to 50 VA.

- 715.5 Selection and erection of equipment
- 715.52 Wiring systems

715.521 Types of wiring system

715.521.1 The following wiring systems shall be used:

- (i) Insulated conductors in conduit systems according to BS EN 61386 series or cable trunking/ducting systems according to BS EN 50085 series
- (ii) Rigid cables
- (iii) Flexible cables
- (iv) Systems for ELV lighting according to BS EN 60598-2-23
- (v) Track systems according to BS EN 60570
- (vi) Bare conductors (see Regulation 715.521.106).

Where parts of the ELV lighting installation are accessible, the requirements of Section 423 also apply.

Metallic structural parts of buildings, for example, pipe systems or parts of furniture, shall not be used as live conductors.

715.521.106 Bare conductors

If the nominal voltage does not exceed 25 V a.c. or 60 V d.c., bare conductors may be used providing that the extralow voltage lighting installation complies with all the following requirements:

- (i) The lighting installation shall be designed, and installed or enclosed in such a way that the risk of a shortcircuit is reduced to a minimum
- (ii) The conductors used shall have a cross-sectional area according to Regulation 715.524
- (iii) The conductors shall not be placed directly on combustible material.

For suspended bare conductors, at least one conductor and its terminals shall be insulated for that part of the circuit between the transformer and the short-circuit protective device to prevent a short-circuit.

715.521.107 Suspended systems

Suspension devices for extra-low voltage luminaires, including supporting conductors, shall be capable of carrying five times the mass of the luminaires (including their lamps) intended to be supported, but not less than 5 kg.

Terminations and connections of conductors shall be made by screw terminals or screwless clamping devices complying with BS EN 60998-2-1 or BS EN 60998-2-2.

Safety of the installation due to expected stresses in the conductors shall be in accordance with Regulation 559.5.2.

Insulation piercing connectors and termination wires which rely on counterweights hung over suspended conductors to maintain the electrical connection shall not be used.

The suspended system shall be fixed to walls or ceilings by insulated distance cleats and shall be continuously accessible throughout the route.

715.524 Cross-sectional area of conductors

715.524.200 The minimum cross-sectional area of the extra-low voltage conductors shall be:

- (i) 1.5 mm² copper, but in the case of flexible cables with a maximum length of 3 m a cross-sectional area of 1 mm² copper may be used
- (ii) 4 mm² copper in the case of suspended flexible cables or insulated conductors, for mechanical reasons
- (iii) 4 mm² copper in the case of composite cables consisting of braided tinned copper outer sheath, having a material of high tensile strength inner core.

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715.525 Voltage drop in consumers' installations

In ELV lighting installations, if the voltage drop between the transformer and the furthest luminaire does not exceed 5 % of the nominal voltage of the ELV installation it shall be deemed to comply with Regulation 525.

715.53 Isolation, switching and control

715.530.3 General and common requirements

715.530.3.104 Protective devices shall be easily accessible.

Protective devices may be located above false ceilings, which are movable or easily accessible, provided that information is given about the presence and location of such devices.

If the identification of a protective device for a circuit is not immediately evident, a sign or diagram (label) close to the protective device shall identify the circuit and its purpose.

SELV sources, protective devices or similar equipment mounted above false ceilings or in a similar place shall be permanently connected.

SELV sources and their protective devices shall be installed so as to:

- (i) avoid mechanical stress on their electrical connections, and
- (ii) be adequately supported, and
- (iii) avoid overheating of the equipment due to thermal insulation.

715.536 Isolation and switching

715.536.1.1 Where transformers are operated in parallel, the primary circuits shall be permanently connected to a common isolating device.

Editor's Note, this version of Section 715 shows the changes made to 559.11 in order to create the new Section 715 as shown above.

SECTION 715

EXTRA-LOW VOLTAGE LIGHTING INSTALLATIONS

<u>715.1</u> <u>Scope</u>

This section applies to extra-low voltage lighting installations supplied from a source with a maximum rated voltage of 50 V a.c. or 120 V d.c.

559.11 Requirements for extra-low voltage lighting installations

715.4 Protection for safety

715.41 Protection against electric shock

559.11.1 715.411.7.200 Protective measure: Functional Extra-Low Voltage (FELV)

The protective measure FELV shall not be used.

559.11.2-715.414 Protective measure: eExtra-low voltage provided by SELV and or PELV

An extra-low voltage luminaire without provision for the connection of a protective conductor shall be installed only as part of a SELV system. Where bare conductors are used, the nominal voltage shall not exceed 25 V a.c. or 60 V d.c. according to Regulation 414.4.5.

559.11.3 Transformers and convertors

559.11.3.1 A safety isolating transformer for an extra-low voltage lighting installation shall comply with BS EN 61558-2-6 and shall meet at least one of the following-requirements: of Regulation 715.422.106.

NOTE: For an explanation of symbols used see Table 55.2.

<u>Parallel operation of transformers in the secondary circuit is allowed only if they are also paralleled in the primary circuit and the transformers have identical electrical characteristics.</u>

559.11.3.2 An electronic convertor for an extra-low voltage lighting installation shall comply with BS EN 61347-2-2 Annex 1 for incandescent lamps or BS EN 61347-2-13, Annex 1 for LEDs.

NOTE: For an explanation of symbols used see Table 55.2.

Parallel operation of convertor to BS EN 61347-2-2 or BS EN 61347-2-13 is not permitted.

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715.42 Protection against thermal effects

715.422.106 Fire risk of transformers/convertors

Transformers shall be either:

- (i) The transformer shall be protected on the primary side by a protective device complying with the requirements of Regulation <u>559.11.4.2</u> <u>715.422.107.2</u>, or
- (ii) The transformer shall be short-circuit proof (both inherently and non-inherently).

NOTE: For an explanation of symbols used see Table 55.2.

559.11.4-715.422.107 Fire risk due to short-circuit

559.11.4.1 <u>715.422.107.1</u> Where both the live circuit conductors are uninsulated, either:

- (i) they shall be provided with a protective device complying with the requirements of Regulation 559.11.4.2 715.422.107.2, or
- (ii) the system shall comply with BS EN 60598-2-23, or

(iii) supplied from a transformer or convertor, the power of which does not exceed 200 VA.

559.11.4.2715.422.107.2A device providing protection against the risk of fire in accordance with
Regulation 559.11.4.1 shall meet all the following requirements:

- (i) The device shall continuously monitor the power demand of the luminaires
- (ii) The device shall automatically disconnect the supply circuit within 0.3 s in the case of a short-circuit or failure which causes a power increase of more than 60 W
- (iii) The device shall provide automatic disconnection while the supply circuit is operating with reduced power (for example, by gating control or a regulating process or a lamp failure) if there is a failure which causes a power increase of more than 60 W
- (iv) The device shall provide automatic disconnection upon connection of the supply circuit if there is a failure which causes a power increase of more than 60 W
- (v) The device shall be fail-safe.

NOTE: Account needs to be taken of starting currents.

715.43 Protection against overcurrent

715.430.104 Protection against overcurrent in ELV lighting installations

The use of self-resetting overcurrent protective devices is permitted only for transformers up to 50 VA.

715.5 Selection and erection of equipment

559.11.5 715.52 Wiring systems

715.521 Types of wiring system

- **<u>715.521.1</u>** The following wiring systems shall be used:
 - (i) Insulated conductors in conduit systems according to BS EN 61386 series or cable trunking/ducting systems according to BS EN 50085 series
 - (ii) Rigid cables
 - (iii) Flexible cables
 - (iv) Systems for ELV lighting according to BS EN 60598-2-23
 - (v) Track systems according to BS EN 60570
 - (vi) Bare conductors (see Regulation 715.521.106).

Where parts of the ELV lighting installation are accessible, the requirements of Section 423 also apply.

559.11.5.1 Metallic structural parts of buildings, for example, pipe systems or parts of furniture, shall not be used as live conductors.

559.11.5.3 715.521.106 Bare conductors

If the nominal voltage does not exceed 25 V a.c. or 60 V d.c., bare conductors may be used providing that the extralow voltage lighting installation complies with all the following requirements:

- (i) The lighting installation shall be designed, and installed or enclosed in such a way that the risk of a shortcircuit is reduced to a minimum
- (ii) The conductors used shall have a cross-sectional area-of at least 4 mm², for mechanical reasons according to <u>Regulation 715.524</u>
- (iii) The conductors shall not be placed directly on combustible material.

For suspended bare conductors, at least one conductor and its terminals shall be insulated for that part of the circuit between the transformer and the short-circuit protective device to prevent a short-circuit.

559.11.6 715.521.107 Suspended systems

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Suspension devices for extra-low voltage luminaires, including supporting conductors, shall be capable of carrying five times the mass of the luminaires (including their lamps) intended to be supported, but not less than 5 kg.

Terminations and connections of conductors shall be made by screw terminals or screwless clamping devices complying with BS EN 60998-2-1 or BS EN 60998-2-2.

Safety of the installation due to expected stresses in the conductors shall be in accordance with Regulation 559.5.2.

Insulation piercing connectors and termination wires which rely on counterweights hung over suspended conductors to maintain the electrical connection shall not be used.

The suspended system shall be fixed to walls or ceilings by insulated distance cleats and shall be continuously accessible throughout the route.

715.524 Cross-sectional area of conductors

559.11.5.2 <u>715.524.200</u> The minimum cross-sectional area of the extra-low voltage conductors shall be:

- (i) 1.5 mm² copper, but in the case of flexible cables with a maximum length of 3 m a cross-sectional area of 1 mm² copper may be used
- (ii) 4 mm² copper in the case of suspended flexible cables or insulated conductors, for mechanical reasons
- (iii) 4 mm² copper in the case of composite cables consisting of braided tinned copper outer sheath, having a material of high tensile strength inner core.

715.525 Voltage drop in consumers' installations

In ELV lighting installations, if the voltage drop between the transformer and the furthest luminaire does not exceed 5 % of the nominal voltage of the ELV installation it shall be deemed to comply with Regulation 525.

715.53 Isolation, switching and control

715.530.3 General and common requirements

715.530.3.104 Protective devices shall be easily accessible.

<u>Protective devices may be located above false ceilings, which are movable or easily accessible, provided that information is given about the presence and location of such devices.</u>

If the identification of a protective device for a circuit is not immediately evident, a sign or diagram (label) close to the protective device shall identify the circuit and its purpose.

<u>SELV</u> sources, protective devices or similar equipment mounted above false ceilings or in a similar place shall be permanently connected.

SELV sources and their protective devices shall be installed so as to:

- (i) avoid mechanical stress on their electrical connections, and
- (ii) be adequately supported, and
- (iii) avoid overheating of the equipment due to thermal insulation.

715.536 Isolation and switching

<u>715.536.1.1</u> Where transformers are operated in parallel, the primary circuits shall be permanently connected to a common isolating device.

SECTION 717

MOBILE OR TRANSPORTABLE UNITS

717.1 Scope

The particular requirements of this section apply to a.c. and d.c. installations for mobile or transportable units.

For the purposes of this section, the term "unit" is intended to mean a vehicle and/or mobile or transportable structure in which all or part of an electrical installation is contained, which is provided with a temporary supply by means of, for example, a plug and socket outlet.

Units are either:

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- (i) of the mobile type, e.g. vehicles (self-propelled or towed), or
- (ii) of the transportable type, e.g. containers or cabins.

Examples of the units include technical and facilities vehicles for the entertainment industry, medical or health screening services, welfare units, promotion & demonstration, firefighting, workshops, offices, transportable catering units etc.

The requirements are not applicable to:

- (iii) generating sets
- (iv) marinas and pleasure craft
- (v) mobile machinery in accordance with BS EN 60204-1
- (vi) caravans to Section 721
- (vii) traction equipment of electric vehicles
- (viii) electrical equipment required by a vehicle to allow it to be driven safely or used on the highway.

Additional requirements shall be applied where necessary for units including showers, or for medical locations, etc.

NOTE: Guidance on temporary electrical systems for entertainment and related purposes is given in BS 7909.

717.132 The design of the installation within a mobile or transportable unit shall take into account the characteristics of the variety of supplies to which the unit might be connected and any limitation shall be clearly stated in the user documentation. See also Regulation 717.514.

717.313 Supplies

One or more of the following methods shall be used to supply a unit:

- (i) Connection to a low voltage generating set in accordance with Section 551 (see Figures 717.1-and 717.2)
- (ii) Connection to a fixed electrical installation in which the protective measures are effective (see Figure 717.3)
- (iii) Connection through means providing simple separation, in accordance with Section 413, from a fixed electrical installation (see Figures 717.4, <u>717.5 and 717.7</u>)
- (iv) Connection through means providing electrical separation from any type of electrical supply (see Figure 717.8).
- **NOTE 1:** In cases (i), (ii) and (iii), an earth electrode may be provided where supplies are used external to the vehicle (see Regulation 717.411.4).

NOTE 2: In the case of Figure 717.4, an earth electrode may be necessary for protective purposes (see Regulation 717.411.6.2(ii)).

NOTE 3: Simple separation or electrical separation is appropriate, for example, where information technology equipment is used in the unit or where a reduction of electromagnetic disturbances is necessary, or if high <u>leakage-protective</u> <u>conductor</u> currents are to be expected (use of frequency convertors), and/or if the supply to the unit comes from alternative supply systems (as is the case in disaster management).

The sources, means of connection or separation may be within the unit.

- **NOTE 4:** Where there is a potential hazard due to moving the unit whilst connected to an external installation, it is recommended that the unit is equipped with an electrical interlock, warning, alarm or other appropriate means to reduce the risk.
- **NOTE 5:** For the purpose of this section, power inverters or frequency convertors supplied from the unit's electrical system or an auxiliary system driven by the unit's prime mover are also considered as generating sets.

Power inverters or frequency convertors shall include electrical separation where both the d.c. supply and the a.c. neutral point are earthed.

717.4 Protection for safety

717.41 Protection against electric shock

717.410.3 General requirements

717.410.3.5 The protective measures of obstacles and placing out of reach (Section 417) are not permitted.

717.410.3.6 The protective measure of non-conducting location (Regulation 418.1) is not permitted.

The protective measure of earth-free local equipotential bonding (Regulation 418.2) is not recommended.

717.411 Protective measure: Automatic disconnection of supply

717.411.1 General

Automatic disconnection of the supply shall be provided by means of an RCD.

For a supply in accordance with Regulation 717.313(ii), automatic disconnection of supply shall be provided by an RCD with a rated residual operating current not exceeding 30 mA.

717.411.3.1.2 Protective equipotential bonding

Accessible conductive parts of the unit, such as the <u>chassis conductive structure of the unit</u>, shall be connected through the main protective bonding conductors to the main earthing terminal within the unit. The main protective bonding conductors shall be finely stranded.

NOTE: Cable types H05V-K and H07V-K to BS 6004-EN 50525-2-31 are considered appropriate.

717.411.4 TN system

A PME earthing facility shall not be used as the means of earthing for an installation falling within the scope of this section except:

- (i) where the installation is continuously under the supervision of an <u>electrically</u> skilled or <u>an electrically</u> instructed person <u>competent in such work</u>, and
- (ii) the suitability and effectiveness of the means of earthing has been confirmed before the connection is made.

717.411.6 IT system

717.411.6.2 An IT system can be provided by:

- (i) an isolating transformer or a low voltage generating set, with an insulation monitoring device or an insulation fault location system, both without automatic disconnection of the supply in case of the first fault and without a need of connection to an earthing installation (see Figure 717.7); the second fault shall be automatically disconnected by overcurrent protective devices according to Regulation 411.6.4, or
- (ii) a transformer providing simple separation, e.g. in accordance with BS EN 61558-1, with an RCD and an earth electrode installed to provide automatic disconnection in the case of failure in the transformer providing the simple separation (see Figure 717.4)

717.413 Protective measure: Electrical separation

A transformer providing electrical separation in accordance with Regulation 413.1.3 shall be used only where:

- (i) an insulation monitoring device is installed to provide automatic disconnection of the supply in the case of a first fault between live parts and the conductive structure of the unit (see Figure 717.5), or
- (ii) a residual current device and an earth electrode are installed to provide automatic disconnection in the case of failure in the transformer providing the electrical separation (see Figure 717.4). Each socket-outlet intended to supply current-using equipment outside the unit shall be protected individually by an RCD having the characteristics specified in Regulation 415.1.1.

717.415 Additional protection

717.415.1 Additional protection by an RCD having the characteristics specified in Regulation 415.1.1, shall be provided for every socket-outlet intended to supply current-using equipment outside the unit, with the exception of socket-outlets which are supplied from circuits with protection by:

- (i) SELV, or
- (ii) PELV, or
- (iii) electrical separation with an insulation monitoring device; see Regulation 717.413(i).

717.5 Selection and erection of equipment

717.51 Common requirements

717.514 Identification and notices

A permanent notice of such durable material as to be likely to remain easily legible throughout the life of the installation, shall be fixed to the unit in a prominent position, preferably adjacent to each supply inlet connector. The notice should state in clear and unambiguous terms the following:

- (i) The types of suppliesy which may be connected to the unit and any limitations on use imposed by the designer
- (ii) The voltage rating of the unit
- (iii) The number of supplies, phases and their configuration
- (iv) The on-board earthing arrangement
- (v) The maximum power requirement of the unit.

717.52 Wiring systems

717.52.1 Where the supply to the mobile or transportable unit is provided by means of a plug and socketoutlet, <u>Ff</u>lexible cables in accordance with H07RN-F (BS 7919 <u>EN 50525-2-21</u>), or cables of equivalent design, having a minimum cross-sectional area of 2.5 mm² copper, shall be used for connecting the unit to the supply. The flexible cable shall enter the unit by an insulating inlet in such a way as to minimize the possibility of any insulation damage or fault which might energize the exposed-conductive-parts of the unit.

717.52.2 The wiring system shall be installed using one or more of the following:

- (i) Unsheathed flexible cable with thermoplastic or thermosetting insulation to <u>BS 6004 or BS 7211 BS EN 50525-2-3 or BS EN 50525-3-41</u> installed in conduit in accordance with the appropriate part of the BS EN 61386 series or in trunking or ducting in accordance with the appropriate part of the BS EN 50085 series
- (ii) Sheathed flexible cable with thermoplastic or thermosetting insulatedion to BS 6004, BS 7211 or BS 7919 BS EN 50525-2-11, -2-21, -3-11 or -3-21, if precautionary measures are taken such that no mechanical damage is likely to occur due to any sharp-edged parts or abrasion.

All cables shall, as a minimum, meet the requirements of BS EN 60332-1-2.

Conduits shall comply with BS EN 61386-21, BS EN 61386-22 or BS EN 61386-23.

717.528.3 Proximity to non-electrical services

717.528.3.4 No electrical equipment, including wiring systems, except ELV equipment for gas supply control, shall be installed in any gas cylinder storage compartment.

ELV cables and electrical equipment may only be installed within the LPG cylinder compartment if the installation serves the operation of the gas cylinder (e.g. indication of empty gas cylinders), or is for use within the compartment. Such electrical installations and components shall be constructed and installed so that they are not a potential source of ignition.

Where cables have to run through such a compartment, they shall be protected against mechanical damage by installation within a conduit system complying with the appropriate part of the BS EN 61386 series or within a ducting system complying with the appropriate part of the BS EN 50085 series.

Where installed, this conduit or ducting system shall be able to withstand an impact equivalent to AG3 without visible physical damage.

717.55 Other equipment

717.55.1 Connecting devices mounted, accessed or used outside the unit and used to connect the unit to the supply, or supply other equipment, shall comply with the appropriate parts of BS EN 60309-2 series and shall meet with the following requirements:

- (i) Connecting devices shall be within <u>Plugs shall have</u> an enclosure of insulating material
- (ii) Connecting devices, <u>plugs and socket-outlets</u>, with an enclosure as necessary, shall afford a degree of protection not less than of at least IP44 when in use or connected and protection of at least IP55 when not connected, e.g. when the unit is in transit
- (iii) Enclosures containing the connecting devices shall provide a degree of protection of at least IP55 when no cable connections are made to the unit. When cable connections are made to the unit the enclosure shall provide a degree of protection not less than IP44
- (iii) The inlet (with "male" contacts) shall be situated on the unit.

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717.55.2 Moved by BS 7671:2008 Amendment 1 to 717.55.1(iii) and subsequently absorbed into 717.55.1(ii) by Amendment 3.

717.55.3 Generating sets able to produce voltages other than SELV or PELV, mounted in a mobile unit, shall automatically be switched off in case of an accident to the unit (e.g. event causing the release of airbags). If this requirement is difficult to implement an emergency switch, easily accessible, shall be installed.

717.551.6 Additional requirements for installations where the generating set provides a supply as a switched alternative to the normal supply to the installation

Live conductors from different power supplies shall not be interconnected.

<u>Protective conductors, including functional earthing conductors, from different earthing systems shall only be interconnected where suitable precautions have been taken into account; see also Regulation 542.1.3.3.</u>

Plugs and socket-outlets shall comply with the appropriate parts of BS EN 60309 series, except those intended for special equipment, such as broadcasting equipment where combined connectors for information signals and power supply are used.

717.551.7.2 Additional requirements for installations where the generating set may operate in parallel with other sources including systems for distribution of electricity to the public

A generating set used as an additional source of supply in parallel with another source shall only be installed on the supply side of all the protective devices for the final circuits of the installation.

Protective conductors, including functional earthing conductors, from different earthing systems shall only be interconnected where suitable precautions have been taken into account; see also Regulation 542.1.3.3.

Figure 717.1 – Example of connection to low voltage generating set located inside the unit, with or without an earth electrode







Figure 717.3 – Example of connection to a TN or TT <u>electrical installationearthing arrangement of</u> <u>a fixed electrical supply or an external generator</u>, with or without an earth electrode at the unit



NOTE: Where a PME earthing facility is used, see Regulation 717.411.4.

Figure 717.4 – Example of connection to a fixed electrical installation <u>or generator</u> with any type of earthing system using a simple separation transformer and an internal IT system, with an earth electrode



Figure 717.5 – Reserved for future use Example of connection to any type of electrical supply using an on-board simple separation transformer and an IT system with an insulation monitoring device and disconnection of supply after a first fault, with earth electrode



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Figure 717.7 – Example of connection to a fixed electrical installation with any type of earthing system by using an IT system without automatic disconnection in the event of first fault



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Figure 717.8 – Example of connection from a fixed electrical installation or generator with any type of earthing system using electrical separation provided by an isolating transformer



Key to Figures 717.1 to 78

- **1a** Connection of the unit to a supply through a transformer with simple separation
- **1b** Connection of the unit to a supply in which the protective measures are effective
- 1c Connection to an LV generator set in accordance with Section 551
- 2 Class II or equivalent enclosure up to the first protective device providing automatic disconnection of supply
- 4 Conductive external staircase, if any
- 5 Connection of the neutral point (or, if not available, a line conductor) to the conductive structure of the unit
- 5a Connection of the main earthing terminal or bar (PE bar) to the conductive structure of the unit
- 6 Socket-outlets for use exclusively within the unit
- **6a** Socket-outlets for use exclusively within the unit for reasons of continuity of supply in the event of first fault
- **6b** Socket-outlets for general use if explicitly required (operation of the RCD in the event of first fault cannot be excluded)
- 7 Main equipotential bonding in accordance with Regulation 717.411.3.1.2
- 7a to an antenna pole, if any
- 7b to the conductive external stairs, if any, in contact with the ground
- 7c to a functional earth electrode, if required
- 7d to the conductive structure of the unit
- 7e to an earth electrode for protective purposes, if required
- 8 Protective devices, if required, for overcurrent and/or for protection by disconnection of supply in case of a second fault
- **9** Protective devices for overcurrent and for automatic disconnection of supply in case of a second fault
- 10 Socket-outlets for current-using equipment for use outside the unit
- 13 Current-using equipment for use exclusively within the unit
- 14 Overcurrent protective device, if required
- **15** Overcurrent protective device
- **16a** RCD having the characteristics specified in Regulation 415.1.1 for protection by automatic disconnection of supply for circuits of equipment for use outside the unit
- **16b** RCDResidual current device for protection by automatic disconnection of supply for circuits of equipment for use inside the unit; see Regulations 411.4.4 and 411.5.3. Where an internal IT system is installed, see also Regulation 411.6.4
- 18 Main earthing terminal or bar
- 21 Transformer with at least simple separation e.g. 230 V current-using equipment outside the unit
- 25 Insulation monitoring device or insulation fault location system including monitoring of the N conductor if distributed (disconnection only in the event of second fault)
- **28** Possible connection point to an existing lightning <u>connection protection</u> system in the vicinity (if any) for protection against lightning electromagnetic pulse (if any).

SECTION 721

ELECTRICAL INSTALLATIONS IN CARAVANS AND MOTOR CARAVANS

721.5 Selection and erection of equipment

721.55 Other equipment

721.55.2 Accessories

721.55.2.6 The means of connection to the caravan pitch socket-outlet shall be supplied with the caravan and shall comprise the following (see Figure 708):

- (i) A plug complying with BS EN 60309-2, and
- (ii) a flexible cable of 25 m (±2 m) continuous length 25 m max, harmonized code designation H05RN-F (BS 7919) or equivalent, incorporating a protective conductor, with conductors to be identified according to Table 51 and of a cross-sectional area in accordance with Table 721, and
- (iii) a connector, if any, compatible with the appliance inlet installed under Regulation 721.55.1.

SECTION 740

TEMPORARY ELECTRICAL INSTALLATIONS FOR STRUCTURES, AMUSEMENT DEVICES AND BOOTHS AT FAIRGROUNDS, AMUSEMENT PARKS AND CIRCUSES

740.5 Selection and erection of equipment

740.55 Other equipment

740.55.5 Safety isolating transformers and electronic convertors

Safety isolating transformers shall comply with BS EN 61558-2-6 or provide an equivalent degree of safety.

A manually reset protective device shall protect the secondary circuit of each transformer or electronic convertor.

Safety isolating transformers shall be mounted out of arm's reach or be mounted in a location that provides equal protection, e.g. in a panel or room that can only be accessed by an <u>electrically</u> skilled or <u>electrically</u> instructed person, and shall have adequate ventilation. Access<u>by a competent person for testing and by a skilled person</u> competent in such work for maintenance shall be provided to facilitate inspection, testing and maintenance.

Electronic convertors shall conform to BS EN 61347-2-2.

Enclosures containing rectifiers and transformers shall be adequately ventilated and the vents shall not be obstructed when in use.

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APPENDICES

APPENDIX 1 (Normative)

BRITISH STANDARDS TO WHICH REFERENCE IS MADE IN THE REGULATIONS

BS 5266	Emergency lighting	110.1.3(ii) 528 1 note 2
		560.9.1 note 2
		560.8.1 Hote 2
		560.9
BS 5266-1 <u>:2011</u>	Emergency lighting. Code of practice for the emergency lighting of	560.8.1 note $1(1)$
	premises	
BS 6346:1997 (2005)	Electric cables. PVC insulated, armoured cables for voltages of 600/1000 V	522.6.103(i)
	and 1900/3300 V	Appx 4 Table 4A3
	NOTE: This is not obsolete, it is current with a proposal for withdrawal (2005)	Appx 7 Table 7C
	has been withdrawn but is retained within BS 7671 for historical purposes.	
BS 7846:2009	Electric cables. 600/1000 V-Thermosetting insulated, armoured fire-	522.6.100(ii)
	resistant cables having thermosetting insulation and of rated voltage	522.6.101(i)
	600/1000 V, having low emission of smoke and corrosive gases when	522.6.103(i)
	affected by fire. Specification	560.8.1 note 2
		Appx 4 Table 4A3
BS EN 61000	Electromagnetic compatibility (EMC)	444.1(vi)
	BS EN 61000 is a multiple part standard	515.2
		Appx 4 sec 5.5.1
BS EN 61000-2	Electromagnetic compatibility (EMC). Environment.	Appx 5 AM
BS EN 61000-4	Electromagnetic compatibility (EMC). Testing and measurement	Appx 5 AM
	techniques.	**
BS EN 61000-5-2	Electromagnetic compatibility (EMC). Installation and mitigation	444.1(vi)
	guidelines. Earthing and cabling	
BS EN 61000-6	Electromagnetic compatibility (EMC). Generic standards.	Table A444.1
IEC 60621-2 Ed 2	Electrical installations for outdoor sites under heavy conditions (including	704.1.1(vi)
	open-cast mines and quarries). Part 2: General protection requirements	
	Withdrawn – no replacement.	

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APPENDIX 3 (Informative) TIME/CURRENT CHARACTERISTICS OF OVERCURRENT PROTECTIVE DEVICES AND RCDs

Maximum earth fault loop impedance

Regulation 411.3.2 specifies maximum disconnection times for circuits. Regulations 411.4.6 to 9 provide maximum earth fault loop impedances (Z_S) that will result in protective devices operating within the required disconnection times.

The maximum earth fault loop impedance for a protective device is given by:

$$Z_{\rm s} = \frac{U_0 \times C_{\rm min}}{I_{\rm a}}$$

where:

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- U_0 is the nominal a.c. rms line voltage to Earth-
- <u>Cmin</u> is the minimum voltage factor to take account of voltage variations depending on time and place, changing of transformer taps and other considerations

NOTE 1: For a low voltage supply given in accordance with the Electricity Safety, Quality and Continuity Regulations 2002 as amended, C_{min} is given the value 0.95.

 I_a is the current causing operation of the protective device within the specified time.

7

The tabulated values are applicable for supplies from distribution network operators. For other supplies the designer will need to determine the nominal voltage and calculate Z_S accordingly.

Figure 3A3(a) – Fuses to BS 88-2 fuse systems E and G

Maximum operating time/current characteristics for						
Fuse	Tuses to BS 88-2 fuse systems E and G Current for time					
rating	0.1 sec	0.2 sec	0.4 sec	1 sec	5 secs	
<u>2 A</u>	<u>7.6 A</u>	<u>7.1 A</u>	<u>6.6 A</u>	<u>5.9 A</u>	<u>5.0 A</u>	
6 A	36 A	32 A	28 A	24 A	18A	
20 A	180 A	150 A	130 A	110 A	78A	
32 A	310 A	260 A	220 A	180 A	125 A	
50 A	550 A	460 A	380 A	300 A	220 A	
80 A	1100 A	900 A	750 A	580 A	400 A	
125 A	1750 A	1500 A	1250 A	1000 A	680 A	
200 A	3100 A	2600 A	2200 A	1700 A	1200 A	
Note: Fuses	s to BS 88-2 t	ype G have ra	tings up to 12	25 A.		

Figure 3A3(b) – Fuses to BS 88-2 fuse systems E and G

Maximum operating T time/current characteristics							
	for fuses to BS 88-2 fuse systems E and G						
Fuse		Current for time					
rating	0.1 sec	0.2 sec	0.4 sec	1 sec	5 secs		
<u>4 A</u>	<u>18 A</u>	<u>16 A</u>	<u>14 A</u>	<u>12.2 A</u>	<u>10.5 A</u>		
10 A	60 A	54 A	47 A	40 A	32 A		
16 A	115 A	100 A	90 A	75 A	55 A		
25 A	220 A	190 A	170 A	140 A	100 A		
40 A	400 A	340 A	290 A	230 A	170 A		
63 A	720 A	600 A	500 A	400 A	280 A		
100 A	1400 A	1200 A	1000 A	780 A	520 A		
160 A	2400 A	2000 A	1600 A	1300 A	820 A		
Note: Fuses	s to BS 88-2 t	ype G have ra	tings up to 12	25 A.			

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onsequential change to these graphs will be made after the DPC period.

Editor's note.

Figure 3A3(c) – Fuses to BS 88-2 fuse system E



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Maximum operating time/current characteristics						
	<u>for</u>	fuses to BS 8	8-2 fuse syste	em E		
Fuse		<u>C</u>	urrent for ti	ne		
rating	<u>0.1 sec</u>	<u>0.2 sec</u>	<u>0.4 sec</u>	<u>1 sec</u>	<u>5 secs</u>	
<u>250 A</u>	<u>4000 A</u>	<u>3350 A</u>	<u>2800 A</u>	<u>2200 A</u>	<u>1440 A</u>	
<u>315 A</u>	<u>5400 A</u>	<u>4600 A</u>	<u>3800 A</u>	<u>3050 A</u>	<u>2000 A</u>	
<u>400 A</u>	<u>7150 A</u>	<u>6000 A</u>	<u>5000 A</u>	<u>3850 A</u>	<u>2580 A</u>	
<u>500 A</u>	<u>10000 A</u>	<u>8300 A</u>	<u>6900 A</u>	<u>5400 A</u>	<u>3590 A</u>	
<u>630 A</u>	<u>12500 A</u>	<u>10500 A</u>	<u>8700 A</u>	<u>6700 A</u>	<u>4420 A</u>	
<u>800 A</u>	<u>19000 A</u>	<u>15800 A</u>	<u>12500 A</u>	<u>10500 A</u>	<u>6970 A</u>	
<u>1000 A</u>	<u>22500 A</u>	<u>18800 A</u>	<u>15500 A</u>	<u>12200 A</u>	<u>8000 A</u>	
<u>1250 A</u>	<u>32000 A</u>	<u>26300 A</u>	<u>22000 A</u>	<u>17300 A</u>	<u>10950 A</u>	

Figure 3A6 – Type D circuit-breakers to BS EN 60898 and RCBOs to BS EN 61009-1

Time/current characteristics for Type D circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1				
Dating	Current for	r time		
Kating	0.1 to 3 secs	<u>5 secs</u>		
6 A	120 A	<u>60 A</u>		
10 A	200 A	<u>100 A</u>		
16 A	320 A	<u>160 A</u>		
20 A	400 A	<u>200 A</u>		
25 A	500 A	<u>250 A</u>		
32 A	640 A	<u>320 A</u>		
40 A	800 A	<u>400 A</u>		
50 A	1000 A	<u>500 A</u>		
63 A	1260 A	<u>630 A</u>		
80 A	1600 A	<u>800 A</u>		
100 A	2000 A	<u>1000 A</u>		
125 A	2500 A	<u>1250 A</u>		

APPENDIX 4 (Informative) CURRENT-CARRYING CAPACITY AND VOLTAGE DROP FOR CABLES

2 CIRCUIT PARAMETERS

2.3 Groups of cables containing more than one circuit

2.3.3 Groups of cables containing different sizes

2.3.3.1 Groups in conduit systems, cable trunking systems or cable ducting systems

For a group containing different sizes of non-sheathed or sheathed cables in conduit systems, cable trunking systems or cable ducting systems, a simpleified formula for <u>the</u> calculation of the group rating factor $\underline{C_g}$ is:

$$F = \frac{1}{\sqrt{n}}$$
 $C_g = \frac{1}{\sqrt{n}}$

where

F is the group rating factor

n is the number of circuits in the group.

The group rating factor obtained by this equation will reduce the danger of overloading the smaller sizes but may lead to under-utilization of the larger sizes. Such under-utilization can be avoided if large and small sizes of non-sheathed or sheathed cable are not mixed in the same group.

The use of a method of calculation specifically intended for groups containing different sizes of non-sheathed or sheathed cable in conduit will produce a more precise group rating factor.

2.5 Other calculations

In addition to calculations related to current-carrying capacity, overload protection and voltage drop described in this appendix, other calculations are also required for the design of an electrical installation. These include calculations of fault current under various conditions. The equations given in Technical Report PD CLC/TR 50480 are recommended for calculating circuit impedances, fault currents and other parameters. National Annex NA of PD CLC/TR 50480 provides details of additional and alternative calculation methods that are intended for use in the UK.

The UK National Annex includes calculation methods for the following:

- (i) Cable resistance and reactance
- (ii) Earth fault loop impedance for:
 - <u>a)</u> <u>Cables in steel conduit</u>
 - b) Cables in steel trunking
 - c) Steel wire armoured cables
 - <u>d)</u> External cpc in parallel with armour
 - e) <u>Aluminium wire armoured single-core cables</u>
- (iii) Ring circuits.

5.2 Where overload protection is not required

Where Regulation 433.3.1 applies, and the cable under consideration is not required to be protected against overload, the design current of the circuit (I_b) is to be divided by any applicable rating factors, and the size of the cable to be used is to be such that its tabulated current-carrying capacity (I_t) for the installation method concerned is not less than the value of I_b adjusted as above, i.e.:

 $I_t \geq \frac{I_b}{C_g C_a C_s C_d C_i C_c}$

Equation 5

NOTE: When overload protection is not required $C_c = 1$.

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5.6 Harmonic currents in line conductors

Section 5.5 covers the effect of additive harmonic currents flowing in the neutral conductor. The rating factors given in section 5.5 take account of the heating effect of the third harmonic in the neutral as well as the heating effect of the third harmonic in each of the line conductors.

Where other harmonics are present, e.g. 5th, 7th etc, the heating effect of these harmonics in the line conductors has to be taken into account. For smaller sizes, less than 50 mm², the effect of harmonic currents can be taken into account by applying the following factor, C_h, to the fundamental design current.

$$C_{h} = \sqrt{\frac{I_{f}^{2} + I_{hn}^{2} + ... + I_{hn}^{2}}{I_{f}^{2}}} \qquad C_{h} = \sqrt{\frac{I_{f}^{2} + ... + I_{hn}^{2}}{I_{f}^{2}}}$$

where: $I_f = 50$ Hz current

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I_{h5} = 5th harmonic current

 $I_{hn} = n^{th}$ harmonic current

For larger conductor sizes the increase in conductor resistance, due to skin and proximity effects, at higher frequencies has to be taken into account. The resistance at harmonic frequencies can be calculated using the equations given in BS IEC 60287-1-1.

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Specification	Specification title	Applicable	Conductor
number		current	operating
20.04/2		rating Tables	temperature
BS 5467	Electric cables – Thermosetting insulated, armoured cables for voltages of 600/1000 V and 1900/3300 V.	4E3, 4E4, 4J3, 4J4	90 °C
BS 6004	Electric cables – PVC insulated, non-armoured cables for voltages up to and including 450/750 V, for electric power, lighting and internal wiring(fixed installation).	4D1, 4D2 <u>4D5</u>	70 °C
BS 6004	Thermoplastic insulated and sheathed flat cable with protective conductor to Table 8. Low temperature PVC insulated and sheathed flexible cable (flexible cables).	4 D5<u>4F3</u>	70-<u>60</u> °C
BS 6231	Electric cables — single core PVC insulated flexible cables of rated voltage 60/1000 V for switchgear and controlgear wiring.	4 D1	70-°C*
BS 6346 (obsoletewithdrawn) Retained here for historical purposes	Electric cables – PVC insulated, armoured cables for voltages of 600/1000 V and 1900/3300 V.	4D3, 4D4, 4H3, 4H4, 4J3, 4J4	70 °C
BS 6500	Electric cables — Flexible cords rated up to 300/500 V, fr use with appliances and equipment intended for domestic, office and similar environments.	4 F3	60- ° C, 90- °€
BS 6724	Electric cables – Thermosetting insulated, armoured cables for voltages of 600/1000 V and 1900/3300 V, having low emission of smoke and corrosive gases when affected by fire.	4E3, 4E4, 4J3, 4J4	90 °C
BS 7211	Electric cables – Thermosetting insulated, non-armoured cables for voltages up to and including 450/750 V, for electric power, lighting and internal wiring, and having low emission of smoke and corrosive gases when affected by fire.	4E1, 4E2	90 °C
BS 7629-1	<u>Electric cables –</u> Specification for 300/500 V fire-resistant electric cables having low emission of smoke and corrosive gases when affected by fire - Part 1: Multicore cables.	4D2	70 °C
BS 7846	Electric cables – 600/1000 V armoured fire resistant cables having t <u>T</u> hermosetting insulationed, armoured, fire-resistant cables of rated voltage 600/1000 V having and-low emission of smoke and corrosive gases when affected by fire. Specification	4E3, 4E4 , , 4J4	90 °C
BS 7889	Electric cables – Thermosetting insulated, <u>PVC sheathed</u> , unarmoured cables for a voltage of 600/1000 V.	4E1 <u>, 4E2</u>	90 °C
BS 7919	Electric cables Flexible cables rated up to 450/750 V, for use with appliances and equipment intended for industrial and similar environmes.	4 F1, 4F2, 4 F3	60 -° C, 90 -°€ 180 -°€
BS 8436	Electric cables – 300/500 V screened electric cables having low emission of smoke and corrosive gases when affected by fire, for use in walls, partitions and building voids - multicore cables.	4D2	70 °C
<u>BS 8573</u>	Electric cables – Thermosetting insulated, non-armoured cables with a voltage of 600/1000 V, for fixed installations, having low emission of smoke and corrosive gases when affected by fire	<u>4E1, 4E2</u>	<u>90°C</u>
BS EN 50525-2- 11, 2-12, 2-21, 2-51, 2-82, 3-11, 3-21	Electric cables – Low voltage energy cables of rated voltages up to and including 450/750 V (flexible cables)	<u>4F1, 4F2, 4F3</u>	<u>60 °C 90 °C</u> <u>110 °C</u> 180 °C
BS EN 50525- 2-31, 3-41	Electric cables – Low voltage energy cables of rated voltages up to and including 450/750 V (fixed installation)	<u>4D1, 4E1</u>	<u>70 °C</u> <u>90 °C</u>
BS EN 60702-1	Mineral insulated cables and their terminations with a rated voltage not exceeding 750 V $-$ <u>Part 1</u> : Cables	4G1, 4G2	70 °C**, 105 °C**

ABLE 4A3 – Schedule of	cable specifications and	current rating tables
	came operations and	••••••••••••••••••••••••••••••••••••••

* Cables to BS 6231 when installed in conduit r trunking are rated to 70 °C

** Sheath operating temperature.

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TABLE 4C3 – Rating factors for more than one circuit, <u>single</u> cables in ducts buried in the ground – Reference Method D in Tables 4D4A to 4J4A (Multicore cables in single-way ducts)

Number of eables	Duct-to-duct clearance (α)					
ducts	Nil (ducts touching)	0.25 m	0.5 m	1.0 m		
2	0.85	0.90	0.95	0.95		
3	0.75	0.85	0.90	0.95		

- 11 - 1 - - -

Editor's note, add this to existing rating factors	non-armoured (COPPER CONDUCTORS)			>,	,		
<u>110 °C flexible cable:</u>							
Ambient temperature Rating factor	<u>35 to 80 °C</u> <u>1.0</u>	<u>85 °C</u> <u>0.96</u>	<u>90 °C</u> <u>0.85</u>	<u>95 °C</u> <u>0.74</u>	<u>100 °C</u> <u>0.60</u>	<u>105 °C</u> <u>0.42</u>	

TABLE 4F3B

NOTE: * The tabulated values above are for 60 °C thermoplastic or thermosetting insulated flexible cables and for other types of flexible cable they are to be multiplied by the following factors:

For	90 °C thermoplastic or thermosetting insulated	1.09
	<u>110 °C</u>	<u>1.17</u>
	150 °C	1.31
	185 °C glass fibre	1.43

APPENDIX 5 (Informative)

CLASSIFICATION OF EXTERNAL INFLUENCES

BB	Electrical resistance of the	human body Under-construction consideration	
BC	Contact of persons with Ea	rth potential	
		Class of equipment according to BS EN 61140	
BC1	None	0-0I I II III A Y A A	
BC2	Low	AAAA	
BC3	Frequent	ХААА	413.3 of HD 60364-4-41
BC4	Continuous	Under-construction consideration A = equipment permitted X = equipment prohibited Y = permitted if used as Class 0	
		-	

CA1	Non-combustible	Normal ^b	
CA2	Combustible	Under-construction consideration Wooden buildings	HD 60364-4-42

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APPENDIX 6 (Informative) MODEL FORMS FOR CERTIFICATION AND REPORTING

Introduction

- (i) The Electrical Installation Certificate required by Part 6 should be made out and signed or otherwise authenticated by <u>a competent an electrically skilled</u> person or persons in respect of the design, construction, inspection and testing of the work.
- (ii) The Minor Works Certificate required by Part 6 should be made out and signed or otherwise authenticated by a competent an electrically skilled person in respect of the design, construction, inspection and testing of the minor work.
- (iii) The Electrical Installation Condition Report required by Part 6 should be made out and signed or otherwise authenticated by <u>a competent an electrically skilled</u> person in respect of the inspection and testing of an installation.
- (iv) Competent-Electrically skilled persons will, as appropriate to their function under (i) (ii) and (iii) above, have a sound knowledge and experience relevant to the nature of the work undertaken and to the technical standards set down in these Regulations, be fully versed in the inspection and testing procedures contained in these Regulations and employ adequate testing equipment.
- (xi) The IET Guidance Note 3 provides further information on inspection and testing and for periodic inspection, testing and reporting.

ELECTRICAL INSTALLATION CERTIFICATE

(REQUIREMENTS FOR ELECTRICAL INSTALLATIONS - BS 7671 [IET WIRING REGULATIONS])

FOR DESIGN

Details of departures from BS 7671 (Regulations 120.3 and 133.5):

Details of permitted exceptions (Regulation 411.3.3). Where applicable, a suitable risk assessment(s) must be attached to this Certificate.

The extent of liability of the signatory or the signatories is limited to the work described above as the subject of this Certificate.

Earthing conductor:	material	csamm ²	Continuity a	and connection verified	
Main protective bonding conductors	material	csamm ²	Continuity a	and connection verified	
To incoming water and/or gas service To other elements:					
To incoming water service	To incoming gas service	To incoming oil servi	<u>ce</u>	To structural steel	
To lightning protection	To other incoming service(s	<u>s) 🔲 Specify</u>			

ELECTRICAL INSTALLATION CERTIFICATE NOTES

. . .

4. The time interval recommended before the first periodic inspection must be inserted (see IET Guidance Note 3 for guidance).

ELECTRICAL INSTALLATION CERTIFICATE GUIDANCE FOR RECIPIENTS (to be appended to the Certificate)

For safety reasons, the electrical installation will need to be inspected at appropriate intervals by <u>a competent an</u> <u>electrically skilled</u> person. The maximum time interval recommended before the next inspection is stated on Page 1 under "NEXT INSPECTION".

This Certificate is intended to be issued only for a new electrical installation or for new work associated with an addition or alteration to an existing installation. It should not have been issued for the inspection of an existing electrical installation. An "Electrical Installation Condition Report" should be issued for such an inspection.

This Certificate is only valid if accompanied by the Schedule of Inspections and the Schedule(s) of Test Results.

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MINOR ELECTRICAL INSTALLATION WORKS CERTIFICATE (REQUIREMENTS FOR ELECTRICAL INSTALLATIONS - BS 7671 [IET WIRING REGULATIONS]) To be used only for minor work which does not include the provision of a new circuit

PART 1:Description of minor works				
1. Description of the minor works				
2. Location/Address				
3. Date minor works completed				
4. Details of departures, if any, from BS 7671:2008 as amended				
PART 2:Installation details				
1. System earthing arrangement TN-C-S TN-S TT				
2. Method of fault protection				
3. Protective device for the modified circuit Type	Rating A			
Comments on quisting installation, including edecucery of participation and heading empressments (see Deculation 122.10).				
Comments on existing installation, including adequacy of earthing and bonding arrangements (see Regulation 132.16):				
DADT 0. Free with Track				
Earth continuity satisfactory				
Insulation resistance:				
Line/neutral-Live/Live	2			
Line/earth_Live/Earth				
Neutral/earthΜΩ				
Earth fault loop impedance \dots Ω				
Polarity satisfactory				
RCD operation (if applicable). Rated residual operating current				
$I_{\Delta n}$ mA and operating time ofms (at $I_{\Delta n}$) <u>5$I_{\Delta n}$mA and operating time ofms (at 5$I_{\Delta n}$)</u>				
Satisfactory test button operation(√/X)				
PART 4:Declaration	applicable a suitable risk assessment(s) must be attached			
to this Certificate.				
I/We CERTIFY that the said works do not impair the safet designed, constructed, inspected and tested in accordance	y of the existing installation, that the said works have been with BS 7671:2008 (IET Wiring Regulations), amended to			
	y/our knowledge and belief, at the time of my/our inspection,			
	Cisnatura			
Name:	Signature:			
For and on behalf of:	Position:			
Address:				
	Date:			


The existing "Schedule of inspections (for new work only)", shown below, is deleted:

It is replaced by "Examples of items requiring inspection during initial verification" shown over the next three pages.

Consequently the "Electrical installation certificates" *final box* "Schedules" *will be modified to become:*

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Examples of items requiring inspection during initial verification.

All items inspected in order to confirm, as appropriate, compliance with the relevant clauses in BS 7671.

The list of items is not exhaustive.

ELECTRICAL INTAKE EQUIPMENT

- Service cable
- Service cut-out/fuse
- Meter tails Distributor
- Meter tails Consumer
- Metering equipment
- Isolator

PARALLEL OR SWITCHED ALTERNATIVE SOURCES OF SUPPLY

- Presence of adequate arrangements where generator to operate as a switched alternative Dedicated earthing arrangement independent of that of the public supply
- Presence of adequate arrangements where generator to operate in parallel with the public supply system
- <u>1. Correct connection of generator in parallel</u> Compatibility of characteristics of means of generation Means to provide automatic disconnection of generator in the event of loss of public supply system or voltage or frequency deviation beyond declared values Means to prevent connection of generator in the event of loss of public supply system or voltage or frequency deviation beyond declared values Means to prevent connection of generator in the event of loss of public supply system or voltage or frequency deviation beyond declared values Means to isolate generator from the public supply system
 - Means to isolate generator from the public supply system

AUTOMATIC DISCONNECTION OF SUPPLY

- Protective earthing/protective equipotential bonding arrangements (411.3; Chap 54)
- Presence and adequacy of
 - 1. Distributor's earthing arrangement (542.1.2.1; 542.1.2.2), or installation earth electrode arrangement (542.1.2.3)
 - 2. Earthing conductor and connections, including accessibility (542.3; 543.1.1; 542.3.2; 526)
 - 3. Main protective bonding conductors and connections, including accessibility (544.1; 543.3.2; 544.1.2; 526)
 - 4. Earthing/bonding labels at all appropriate locations
 - **5.** Accessibility of (514.1.11)
- FELV requirements satisfied (411.7; 411.7.1)

OTHER METHODS OF PROTECTION

(Where any of the methods listed below are employed details should be provided on separate pages)

BASIC AND FAULT PROTECTION where used, confirmation that the requirements are satisfied:

- SELV (Section 414)
- PELV (Section 414)
- Double insulation (Section 412)
- Reinforced insulation (Section 412)

BASIC PROTECTION:

- Insulation of live parts (416.1)
- Barriers or enclosures (416.2; 416.2.1)
- Obstacles (417; 417.2.1; 417.2.2)
- Placing out of reach (417; 417.3)

FAULT PROTECTION:

- Non-conducting location Earth-free local equipotential bonding (418.2)
- Electrical separation (Section 413; 418.3)

ADDITIONAL PROTECTION:

- RCDs not exceeding 30 mA as specified (Section 415; 415.1)
- Supplementary bonding (Section 415; 415.2)

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SPECIFIC INSPECTION EXAMPLES as appropriate to the installation

DISTRIBUTION EQUIPMENT

- Adequacy of working space/accessibility to equipment (132.12; 513.1)
- Security of fixing (134.1.1)
- Insulation of live parts not damaged during erection (416.1)
- Adequacy / security of barriers (416.2)
- Suitability of enclosures for IP and fire ratings (416.2; 421.1.6; 526.5)
- Enclosures not damaged during installation (621.2(iii))
- Presence and effectiveness of obstacles (417.2)
- Placing out of reach (417.3)
- Presence of main switch(es), linked where required (537.1.2; 537.1.4)
- Operation of main switch(es) (functional check) (612.13.2)
- Manual operation of circuit-breakers and RCDs to prove functionality (612.13.2)
- Confirmation that integral test button/switch causes RCD(s) to trip when operated (functional check) (612.13.1)
- RCD(s) provided for fault protection, where specified (414.4.9; 411.5.2; 531.2)
- RCD(s) provided for additional protection, where specified (411.3.3; 415.1)
- Confirmation overvoltage protection (SPDs) provided where specified (534.2.1)
- Confirmation of indication that SPD is functional (534.2.8)
- Presence of RCD quarterly test notice at or near the origin (514.12.2)
- Presence of diagrams, charts or schedules at or near each distribution board, where required (514.9.1)
- Presence of non-standard (mixed) cable colour warning notice at or near the appropriate distribution board, where required (514.14)
- Presence of alternative supply warning notice at or near (514.15)
 - 1. The origin
 - 2. The meter position, if remote from origin
 - . The distribution board to which the alternative/additional sources are connected
 - 4. All points of isolation of ALL sources of supply
- Presence of next inspection recommendation label (514.12.1)
- Presence of other required labelling (Section 514)
- Selection of protective device(s) and base(s); correct type and rating (421.1.3)
- Single-pole protective devices in line conductor only (132.14.1; 530.3.2)
- Protection against mechanical damage where cables enter equipment (522.8.1; 522.8.11)
- Protection against electromagnetic effects where cables enter ferromagnetic enclosures (521.5.1)

<u>CIRCUITS</u>

- Identification of conductors (514.3.1)
- Cables correctly supported throughout (522.8.5)
- Examination of cables for signs of mechanical damage during installation (522.6.2; 522.8.1)
- Examination of insulation of live parts, not damaged during erection (522.6.1; 522.8.1)
- Non-sheathed cables protected by enclosure in conduit, ducting or trunking (521.10.1)
- Suitability of containment systems (including flexible conduit) (Section 522)
- Correct temperature rating of cable insulation (522.1.1; Table 52.1)
- Adequacy of cables for current-carrying capacity with regard for the type and nature of installation (Section 523)
- Adequacy of protective devices: type and fault current rating for fault protection (411.3)
- Presence and adequacy of circuit protective conductors (411.3.1; 543.1)
- Coordination between conductors and overload protective devices (433.1; 533.2.1)
- Wiring systems and cable installation methods / practices with regard to the type and nature of installation and external influences (Section 522)
- Cables concealed under floors, above ceilings, in walls adequately protected against damage by contact with fixings (522.6.101; 522.6.103)

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- Provision of additional protection by RCDs having rated residual operating current (I_{Δn}) not exceeding 30 mA
 For circuits used to supply mobile equipment not exceeding 32 A rating for use outdoors in all cases (411.3.3)
 - For all socket-outlets of rating 20 A or less provided for use by ordinary persons unless exempt (411.3.)
 - 3. For cables concealed in walls at a depth of less than 50 mm (522.6.101; 522.6.103)
- Provision of fire barriers, sealing arrangements so as to minimize the spread of fire (Section 527)
- Band II cables segregated/separated from Band I cables (528.1)
- Cables segregated/separated from non-electrical services (528.3)
- Termination of cables at enclosures (Section 526)
 - 1. Connections under no undue strain (526.6)
 - 2. No basic insulation of a conductor visible outside enclosure (526.8)
 - 3. Connections of live conductors adequately enclosed (526.5)
 - 4. Adequately connected at point of entry to enclosure (glands, bushes etc.) (522.8.5)
- Suitability of circuit accessories for external influences (512.2)
- Circuit accessories not damaged during erection
- Single-pole devices for switching in line conductor only (132.14.1; 530.3.2)
- Adequacy of connections, including cpc's, within accessories and at fixed and stationary equipment (Section 526)

ISOLATION AND SWITCHING

- Isolators (537.2)
 - **1.** Presence and location of appropriate devices (537.2.2)
 - 2. Capable of being secured in the OFF position (537.2.1.2)
 - 3. Correct operation verified (functional check)
 - 4. The installation, circuit or part thereof that will be isolated is clearly identified by location and/or durable marking (537.2.2.6)
 - 5. Warning label posted in situations where live parts cannot be isolated by the operation of a single device (514.11.1; 537.2.1.3)
- Switching off for mechanical maintenance (537.3)
- 1. Presence of appropriate devices (537.3.1.1)
 - . Acceptable location state if local or remote from equipment in question (537.3.2.4)
- **3.** Capable of being secured in the OFF position (537.3.2.3)
- 4. Correct operation verified (functional check)
- 5. The circuit or part thereof to be disconnected clearly identified by location and/or durable marking (537.3.2.4)
- Emergency switching/stopping (537.4)
 - 1. Presence of appropriate devices (537.4.1.1)
 - 2. Readily accessible for operation where danger might occur (537.4.2.5)
 - 3. Correct operation verified (functional check) (537.4.2.6)
 - 4. The installation, circuit or part thereof to be disconnected, clearly identified by location and/or durable marking (537.4.2.7)
- Functional switching (537.5)
 - 1. Presence of appropriate devices 537.5.1.1)
 - 2. Correct operation verified (functional check) (537.5.1.3; 537.5.2.2)

CURRENT-USING EQUIPMENT (PERMANENTLY CONNECTED)

- Suitability of equipment in terms of IP and fire ratings (416.2)
- Enclosure not damaged/deteriorated during installation so as to impair safety
- Suitability for the environment and external influences (512.2)
- Security of fixing (134.1.1)
- Cable entry holes in ceilings above luminaires, sized or sealed so as to restrict the spread of fire
- Provision of undervoltage protection, where specified (Section 445)
- Provision of overload protection, where specified (443.2)
- Recessed luminaires (downlighters)
 - 1. Correct type of lamps fitted
 - **2.** Installed to minimise build-up of heat (421.1.2; 559.5.1)

PART 7 SPECIAL INSTALLATIONS OR LOCATIONS

Particular requirements for special locations are fulfilled.

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ELECTRICAL INSTALLATION CONDITION REPORT

SECTION D. EXTENT AND LIMITATIONS OF INSPECTION AND TESTING Extent of the electrical installation covered by this report	
Agreed limitations including the reasons (see Regulation 634.2)	
Agreed with:	
The inspection and testing detailed in this report and accompanying schedules have been carried out in accordance with BS 7671: 2008 (IE	 ЕТ

Wiring Regulations) as amended to It should be noted that cables concealed within trunking and conduits, under floors, in roof spaces, and generally within the fabric of the building or

underground, have not been inspected unless specifically agreed between the client and inspector prior to the inspection. An inspection should be made within an accessible roof space where electrical equipment is present.

Main Protective Conductors								
Earthing conductor	Material	<mark>€c</mark> samm²	Connection / continuity verified					
Main protective bonding conductors	Material	<mark>€</mark> csamm²	Connection / continuity verified					
To incoming water service	To incoming gas service 🛛	To incoming oil service	To structural steel					
To lightning protection	To other incoming service(s)	☐ Specify						

CONDITION REPORT Notes for the person producing the Report:

The Report, normally comprising at least six-five pages, should include schedules of both the inspection and the test 2. results. Additional pages may be necessary for other than a simple installation_and for the "Guidance for recipients". The number of each page should be indicated, together with the total number of pages involved.

CONDITION REPORT GUIDANCE FOR RECIPIENTS (to be appended to the Report)

This Report is an important and valuable document which should be retained for future reference.

- For items classified in Section K as C1 ("Danger present"), the safety of those using the installation is at risk, and it 7. is recommended that a competent an electrically skilled or electrically instructed person undertakes the necessary remedial work immediately.
- For items classified in Section K as C2 ("Potentially dangerous"), the safety of those using the installation may be at risk 8. and it is recommended that a competent an electrically skilled or electrically instructed person undertakes the necessary remedial work as a matter of urgency.
- 10 For safety reasons, the electrical installation should be re-inspected at appropriate intervals by a competent an electrically skilled or electrically instructed person. The recommended date by which the next inspection is due is stated in Section F of the Report under 'Recommendations' and on a label at or near to the consumer unit / distribution board.

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CONDITION REPORT INSPECTION SCHEDULE FOR DOMESTIC AND SIMILAR PREMISES WITH UP TO 100 A SUPPLY

Note: This form is suitable for many types of smaller installation not exclusively domestic.

OUT	COMES	Acceptable condition	\checkmark	Unacceptable condition	State C1 or C2	Improvement recommended	State C3	Not veri	fied N/V	Limitation	LIM	Not applicable	N/A
ITEM NO	A DESCRIPTION								OUTCOME (Use codes above. Provide additional comment where appropriate. C1, C2 and C3 coded items to be recorded in Section K of the Condition Report)				
									Edit both	or's note pages c	, this of the	applies to report.]
3.3	Provision	of earthing / b	onding	labels at all appro	opriate locat	tions (514 .11<u>.13.1</u>)						
3.8	Accessib	ility and condit	ion of <mark>a</mark>	Lother protective	bonding co	nnections (543.3.	2)						
5.17	Terminati (Section	ion of cables a 526)	t enclos	ures – indicate e	xtent of sam	npling in Section E) of the repo	rt					
	 Conne No bas 	ctions soundly sic insulation o	made a	and under no und luctor visible outs	ue strain (5 ide enclosu	26.6) ire (526. 9 8)							
6.3	Shaver so	ockets comply	with BS	EN 61558-2-5- 1 6	ormally form	nerly BS 3535 (70	1.512.3)						
6.7	Suitability (701.512	/ of equipment .3)	for inst	allation in <u>access</u>	ories and co	ontrol gear etc. for	a particular	zone					
(GENERIC GENERIC DBreference no Location Za at DB (Q)	RIC SCHE	ESULTS Details of ci testing	E OF TEST	RESUI	LTS Details of feet (noticinents used jetze is Continuty Insulation resistance Each fact from readers	efal and/or asset numbers)]					

GENERIC SCHEDULE OF TEST RESULTS



EXAMPLES OF ITEMS REQUIRING INSPECTION FOR AN ELECTRICAL INSTALLATION CONDITION REPORT

AUTOMATIC DISCONNECTION OF SUPPLY

- Main earthing / bonding arrangements (411.3; Chap 54)
 - 8. Provision of earthing / bonding labels at all appropriate locations (514.11.13)
- FELV

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APPENDIX 14 (Informative) MEASUREMENT OF EARTH FAULT LOOP IMPEDANCE: CONSIDERATION OF THE INCREASE OF THE RESISTANCE OF CONDUCTORS WITH INCREASE OF TEMPERATURE

When impedance measurements are made at ambient temperature the procedure hereinafter described may be followed to take into account the increase of resistance of the conductors with the increase of temperature due to load current, to verify, for TN and TT systems in which protection by automatic disconnection is provided by overcurrent devices, compliance of the measured values of earth fault loop impedance with the appropriate requirements of Regulation 411.4 or 411.5.

The requirements of Regulation 411.4.5 or 411.5.4, as appropriate, are considered to be met when the measured value of earth fault loop impedance satisfies the following equation:

$$Z_{s}(m) \ge 0.8 \text{ x} \frac{U_{0}}{I_{a}}$$
 $Z_{s}(m) \le 0.8 \text{ x} \frac{U_{0} \text{ x} C_{min}}{I_{a}}$

where:

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- $Z_s(m)$ is the measured impedance of the earth fault current loop up to the most distant point of the relevant circuit from the origin of the installation (Ω)
 - U_0 is the nominal a.c. rms line voltage to Earth (V)
 - I_a is the current causing the automatic operation of the protective device within the time stated in Table 41.1 or within 5 s according to the conditions stated in Regulation 411.3.2.3 (A).
- <u>Cmin</u> is the minimum voltage factor to take account of voltage variations depending on time and place, changing of transformer taps and other considerations.

NOTE 1: For a low voltage supply given in accordance with the Electricity Safety, Quality and Continuity Regulations 2002 as amended, C_{min} is given the value 0.95.

Where the measured value of the earth fault loop impedance exceeds $0.8U_0/I_a$ the value given by the above equation, a more precise assessment of compliance with Regulation 411.4.5 or 411.5.4, as appropriate, may be made, evaluating the value of the earth fault loop impedance according to the following procedure:

- (i) The line conductor to protective conductor loop impedance of the supply is first measured at the origin of the installation
- (ii) The resistances of the line conductor and protective conductor of the distribution circuit(s) are then measured
- (iii) The resistances of the line conductor and protective conductor of the final circuit are then measured
- (iv) The values of resistance measured in accordance with (ii) and (iii) are increased on the basis of the increase of conductor temperature, taking into consideration the design current, (I_b)
- (v) The values of resistance increased in accordance with (iv) are finally added to the value measured at (i) to obtain a realistic value of Z_s under earth fault conditions.

NOTE 2: Other methods are not precluded.

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APPENDIX 15 (Informative) RING AND RADIAL FINAL CIRCUIT ARRANGEMENTS, REGULATION 433.1

Figure 15B – Radial final circuit arrangements, Regulation 433.1



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