

Contents

1	The IET Regulations, BS 7671, and this Guide	1
1.1	The need for this Electrician's Guide	1
1.2	The IET Regulations – BS 7671	2
1.2.1	International basis	2
1.2.2	The Seventeenth Edition	3
1.2.3	Third Amendment to the Seventeenth Edition: a summary	4
1.2.4	Overview of the main changes to BS 7671 with Amendment 3	5
1.2.5	Plan of the Seventeenth Edition	7
1.3	The Electrician's Guide	9
1.3.1	The rationale for this Guide	9
1.3.2	Using this Electrician's Guide	9
2	Installation requirements and characteristics	11
2.1	Introduction	11
2.2	Safety requirements	11
2.2.1	Scope of the Regulations	11
2.2.2	Legal status of the Regulations	12
2.2.3	New inventions or methods	13
2.2.4	Safety requirements	14
2.2.5	Design, equipment, installation and testing	14
2.2.6	Supplies for safety services	15
2.3	Definitions	16
2.4	Assessment of general characteristics	16
2.4.1	Introduction	16
2.4.2	Purposes, supplies and structure	16
2.4.3	External influences	17
2.4.4	Compatibility	18
2.4.5	Maintainability	18
2.5	Low voltage generating sets	19
2.6	Standards	19
2.7	Undervoltage	20
2.8	Over voltage and electromagnetic disturbances	21
3	Installation control and protection	23
3.1	Introduction	23
3.2	Switching	23
3.2.1	Switch positions	23
3.2.2	Emergency switching	25
3.2.3	Switching for mechanical maintenance	27
3.2.4	Functional switching	27

3.3	Isolation	27
3.3.1	Isolator definition	27
3.3.2	Isolator situation	28
3.3.3	Isolator positions	28
3.3.4	Semiconductor isolators	30
3.3.5	Isolator identification	30
3.4	Electric shock protection	30
3.4.1	The nature of electric shock	30
3.4.2	Resistance of the shock path	31
3.4.3	Contact with live conductors	32
3.4.4	Protection from contact	34
3.4.5	Basic protection	35
3.4.6	Fault protection	36
3.4.7	Protection for users of equipment outdoors	36
3.5	High temperature protection	36
3.5.1	Introduction	36
3.5.2	Fire protection	37
3.5.3	Protection from burns	39
3.6	Overcurrent protection	39
3.6.1	Introduction	39
3.6.2	Overload	40
3.6.3	Fuses	41
3.6.4	Circuit breakers	43
3.6.5	Protecting conductors	46
3.7	Protection from faults	47
3.7.1	Introduction	47
3.7.2	Prospective short-circuit current (PSC)	48
3.7.3	Operating time	49
3.7.4	Conductors of reduced current-carrying capacity	50
3.7.5	Back-up protection	50
3.7.6	Insulation monitoring	51
3.8	Short circuit and overload protection	52
3.8.1	Combined protection	52
3.8.2	Current limited by supply characteristic	52
3.8.3	Protection omitted	52
3.8.4	Protection of conductors in parallel	52
3.8.5	Absence of protection	53
3.8.6	Selectivity or Discrimination	53
3.9	Protective measures against fire	54
3.9.1	Introduction	54
3.9.2	What locations are involved?	55
3.9.3	Locations with combustible construction materials	55
3.9.4	Locations with fire risk due to the materials present	55
4	Cables, conduits and trunking	57
4.1	Introduction	57
4.1.1	Cable insulation materials	57
4.2	Cables	59
4.2.1	Non-flexible low voltage cables	59
4.2.2	Cables for overhead lines	61
4.2.3	Flexible low voltage cables and cords	61
4.2.4	Cables carrying alternating currents	63
4.2.5	Corrosion	64
4.3	Cable choice	65
4.3.1	Cable types	65
4.3.2	Current carrying capacity of conductors	66

4.3.3	Methods of cable installation	67
4.3.4	Ambient temperature correction factors	67
4.3.5	Cable grouping correction factors	68
4.3.6	Thermal insulation correction factors	69
4.3.7	When a number of correction factors applies	70
4.3.8	Protection by semi-enclosed (rewirable) fuses	71
4.3.9	Cable rating calculation	71
4.3.10	Special formulas for grouping factor calculation	76
4.3.11	Cable volt drop	76
4.3.12	Harmonic currents and neutral conductors	79
4.3.13	Low smoke-emitting cables	80
4.3.14	The effects of animals, insects & plants	80
4.3.15	Maximum conductor operating temperatures	81
4.4	Cable supports, joints and terminations	81
4.4.1	Cable supports and protection	81
4.4.2	Cable bends	83
4.4.3	Joints and terminations	84
4.5	Cable enclosures	85
4.5.1	Plastic and metal conduits	85
4.5.2	Ducting and trunking	85
4.5.3	Cable capacity of conduits and trunking	87
4.6	Conductor identification	90
5	Earthing	93
5.1	The earthing principle	93
5.1.1	What is earthing?	93
5.1.2	The advantages of earthing	94
5.1.3	The disadvantages of earthing	94
5.2	Earthing systems	95
5.2.1	System classification	95
5.2.2	TT systems	95
5.2.3	TN-S system	96
5.2.4	TN-C-S system	96
5.2.5	TN-C system	96
5.2.6	IT system	97
5.3	Earth-fault loop impedance	97
5.3.1	Principle	97
5.3.2	The importance of earth fault loop impedance	98
5.3.3	The resistance/impedance relationship	99
5.3.4	Earth-fault loop impedance values	100
5.3.5	Maximum circuit conductor length	103
5.4	Protective conductors	105
5.4.1	Earthing conductors	105
5.4.2	Protective conductor types	106
5.4.3	Bonding conductors	108
5.4.4	Protective conductor cross-section assessment	111
5.4.5	Protective conductor cross-section calculation	111
5.4.6	Unearthing metalwork	112
5.5	Earth electrodes	112
5.5.1	Why must we have earth electrodes?	112
5.5.2	Earth electrode types	112
5.6	Protective multiple earthing (PME)	113
5.6.1	What is protective multiple earthing?	113
5.6.2	Increased fire risk	114
5.6.3	Broken neutral conductor	114
5.6.4	Special requirements PME-fed installations	115

5.7	Earthed concentric wiring	115
5.7.1	What is earthed concentric wiring?	115
5.7.2	Requirements for earthed concentric wiring	115
5.8	Other protection methods	116
5.8.1	Class II equipment	116
5.8.2	Non-conducting location	117
5.8.3	Earth-free equipotential bonding	117
5.8.4	Electrical separation	118
5.9	Residual current devices (RCDs)	118
5.9.1	Why we need residual current devices	118
5.9.2	Principle of the residual current device	119
5.9.3	Regulations for residual current devices	121
5.9.4	Fault-voltage operated circuit breakers	122
5.10	Combined functional and protective earthing	123
5.11	Surge protective devices	123
5.11.1	What are surge protective devices?	123
5.11.2	Protection from lightning surges	124
5.11.3	Protection from switching surges	124
6	Circuits	125
6.1	Basic requirements for circuits	125
6.2	Maximum demand and diversity	127
6.2.1	Maximum demand	127
6.2.2	Diversity	128
6.2.3	Applied diversity	129
6.3	BS 1363 socket outlet circuits	130
6.3.1	The fused plug	131
6.3.2	The ring final circuit	133
6.3.3	The radial circuit	134
6.4	Industrial socket outlet circuits	135
6.4.1	Introduction	135
6.4.2	BS 546 socket outlet circuits	135
6.4.3	BS EN 60309-2 socket outlet circuits	136
6.5	Other circuits	136
6.5.1	Lighting circuits	136
6.5.2	Cooker circuits	138
6.5.3	Off-peak appliance circuits	139
6.6	Circuit segregation	140
6.6.1	Segregating circuits	140
6.6.2	Electro-magnetic compatibility (EMC)	140
6.6.3	Lift and hoist shaft circuits	141
6.7	Auxiliary circuits	142
6.7.1	Power supplies	142
6.7.2	Protective measures	143
6.7.3	Cables and conductors	143
7	Inspection and testing	145
7.1	Introduction	145
7.1.1	The tester	145
7.1.2	Why do we need inspection and testing?	145
7.1.3	Information needed by the tester	146
7.2	Inspection	147
7.2.1	Notices and other identification	147
7.2.2	Inspection	148
7.2.3	Periodic inspection and testing	149
7.3	Testing sequence	151

7.3.1	Why is correct sequence important?	151
7.3.2	Correct testing sequence	151
7.4	Continuity tests	152
7.4.1	Protective conductor continuity	152
7.4.2	Ring final circuit continuity	154
7.4.3	Correct polarity	157
7.4.4	Measurement of $R_1 + R_2$	158
7.5	Insulation tests	158
7.5.1	Testing insulation resistance	158
7.5.2	Tests of non-conducting floors and walls	160
7.5.3	Tests of barriers and enclosures	160
7.5.4	Tests for electrical separation of circuits	161
7.6	Earth testing	161
7.6.1	Testing earth electrodes	161
7.6.2	Measuring earth-fault loop impedance and prospective short-circuit current	163
7.6.3	Testing residual current devices (RCDs)	165
7.7	Test instrument requirements	167
7.7.1	Basic requirements	167
7.7.2	Accuracy and resolution	169
7.8	Supporting paperwork	170
7.8.1	Why bother with paperwork?	170
7.8.2	Electrical installation condition report	171
7.8.3	Installation alterations and additions	172
7.8.4	Periodic inspection and testing	172
7.8.5	Minor electrical installation works certificate	174
8	Special installations	175
8.1	Introduction	175
8.2	Locations containing bath tubs and shower basins	176
8.2.1	Introduction	176
8.2.2	Bath and shower room requirements	180
8.3	Swimming pools and other basins	180
8.3.1	Introduction	180
8.3.2	Special requirements for swimming pools	181
8.3.3	Fountains	182
8.4	Rooms containing sauna heaters	183
8.4.1	Introduction	183
8.4.2	Special requirements for saunas	183
8.5	Construction and demolition sites	184
8.5.1	Introduction	184
8.5.2	Special regulations for construction sites	185
8.6	Agricultural and horticultural premises	187
8.6.1	Introduction	187
8.6.2	Agricultural installations	187
8.6.3	Horticultural installations	189
8.7	Conducting locations with restricted movement	189
8.7.1	Introduction	189
8.7.2	Special requirements	189
8.8	Electrical installations in caravan / camping parks and similar locations	190
8.8.1	Introduction	190
8.8.2	Leisure vehicle park installations	190
8.9	Electrical installations in caravans and motor caravans	191
8.9.1	Introduction	191
8.9.2	Caravan installations	191
8.9.3	Tent installations	194

8.10	Outdoor lighting installations including highway power supply and street furniture	194
8.10.1	Scope	194
8.10.2	Safety	194
8.10.3	Switching and isolation	195
8.11	Marinas	195
8.11.1	Introduction	195
8.11.2	The marina electrical installation	195
8.12	Medical locations	198
8.13	Exhibitions, shows and stands	199
8.13.1	Introduction	199
8.13.2	Requirements	199
8.14	Solar photovoltaic (PV) Power Supply Systems	200
8.14.1	Introduction	201
8.14.2	Principles	201
8.14.3	Protection systems	201
8.15	Floor and Ceiling Heating Systems	202
8.15.1	Introduction	202
8.15.2	Electric shock and overheating protection	202
8.15.3	Identification	203
8.15.4	Bathrooms and swimming pools	203
8.16	Extra-low Voltage Lighting Installations	203
8.16.1	Introduction	203
8.16.2	Basic requirements	204
8.16.3	Wiring Systems	204
8.17	Mobile Transportable Units	205
8.17.1	Introduction	205
8.17.2	Problems and solutions	205
8.17.3	Detailed requirements	206
8.18	Temporary electrical installations for structures, amusement devices and booths at fairgrounds, amusement parks and circuses	206
8.18.1	Introduction	206
8.18.2	Special requirements	206
8.19	Operating and maintenance gangways	208
8.20	Electrical vehicle charging	208
9	Other installations and equipment	209
9.1	Introduction	209
9.2	Earthing for installations having high protective conductor currents	209
9.2.1	Introduction	209
9.2.2	Equipment with protective conductor current exceeding 3.5 mA	209
9.2.3	Equipment with protective conductor currents exceeding 10 mA	210
9.2.4	Final circuits where the protective conductor is likely to exceed 10 mA	210
9.2.5	Connection of duplicate protective conductors	210
9.2.6	Final circuits feeding socket outlets	211
9.3	Heating appliances and installations	211
9.3.1	Electrode boilers and water heaters	211
9.3.2	Instantaneous water heaters	212
9.3.3	Surface, floor, soil and road warming installations	214
9.4	Discharge lighting	215
9.4.1	Low voltage discharge lighting	215
9.4.2	High voltage discharge lighting	216
9.5	Underground and overhead wiring	217
9.5.1	Overhead wiring types	217
9.5.2	Maximum span lengths and minimum heights	217
9.5.3	Underground wiring	218

9.6	Outdoor installations and garden buildings	219
9.6.1	Temporary garden buildings	219
9.6.2	Garden installations	220
9.7	Installation of machines and transformers	220
9.7.1	Rotating machines	220
9.7.2	Transformers	222
9.8	Reduced voltage systems	222
9.8.1	Types of reduced voltage	222
9.8.2	Separated extra-low voltage (SELV)	223
9.8.3	Protective extra-low voltage (PELV)	223
9.8.4	Functional extra-low voltage (FELV)	224
9.8.5	Reduced low voltage	224
9.9	Small-scale Embedded Generators (SSEG)	225
9.9.1	Introduction	225
9.9.2	Installation requirements	226
10	Alarm systems	229
10.1	Introduction	229
10.2	Fire Alarm Systems	229
10.2.1	Domestic smoke alarms	230
10.2.2	Detection devices	230
10.2.3	Control panels	231
10.2.4	Fire alarm sounders	232
10.2.5	Types of fire alarm systems	232
10.2.6	Power supplies and cables	232
10.2.7	Record keeping	233
10.2.8	False alarms	234
10.2.9	Servicing	235
10.2.10	Certification	236
10.3	Intruder Alarm Systems	237
10.3.1	Detection devices	237
10.3.2	Control panels	238
10.3.3	Alarm sounders	238
10.3.4	Wiring intruder alarm systems	239
10.3.5	Servicing and certification	239
11	Emergency Lighting	241
11.1	Introduction	241
11.2	Escape routes and exits	241
11.3	Safety signs	241
11.4	Escape luminaire siting	242
11.5	Installation of emergency lighting	243
11.6	Maintenance of emergency lighting	244
11.7	Duration of emergency luminaire output	245
12	Part P of the Building Regulations	247
12.1	The Building Regulations	247
12.2	The Electrical Regulations	247
12.3	To which installations does Part P apply?	248
12.4	Self-certification	248
12.5	Non-certified electricians	249
12.6	The penalties	250
12.7	DIY work	250
12.8	Publicity	250
12.9	What must be notified?	251
12.10	Non-notifiable works	251

12.11 Work in the UK excluding England	251
12.12 Building regulations approved document A - Structure	251
12.13 Building regulations approved document B – Fire safety	252
12.14 Building regulations approved document E – Resistance to passage of sound	252
12.15 Building regulations approved document F – Ventilation	252
12.16 Building regulations approved document L1 – Conservation of fuel & power	253
12.17 Building regulations approved document M – Access to and use of buildings	254
12.18 Building regulations approved document P – Electrical safety	254
12.19 Dwellings subject to flooding	254
List of abbreviations	255
Cross-reference index	257
Index	259

Copyright