

Contents

About the Authors	xvii
Preface to the Fourth Edition	xix
Acknowledgements	xxv
1 Introduction	1
1.1 Layout of chapters	1
1.2 Wiring regulations	2
1.3 Terminology	2
1.4 Competence and responsibility	3
1.5 Procedures	3
1.5.1 Design	3
1.5.2 Installation	4
1.6 Inspection and test	4
1.7 Completion	5
1.8 Working methods and materials	5
1.9 Operatives	5
1.10 Materials	5
1.11 Amendments to <i>BS 7671: 2008</i>	6
1.12 Voltages	6
1.13 Voltage drop	6
2 Three Bedroom House	8
2.1 The bare minimum	9
2.2 Standards	9
2.2.1 National House Building Council (NHBC)	9
2.2.2 Relevant wiring regulations	9
2.3 Building regulations	11
2.3.1 Smoke detectors	11
2.4 Load assessment	11

2.5	A typical domestic supply	12
2.6	Project specification	12
2.7	Wiring systems and cable sizes	12
2.8	Lighting	12
2.9	13 A socket-outlets	13
2.10	Cable sizes	15
2.11	Circuit protection	15
	2.11.1 Rewireable fuses	15
	2.11.2 Cartridge fuses	15
	2.11.3 Circuit-breakers (cb)	15
2.12	Additional protection for socket-outlets	15
2.13	Arrangement of circuits	16
	2.13.1 Residual current protection	16
	2.13.2 Circuit-breakers (cb)	16
2.14	Arrangement of consumer unit	16
2.15	Main switch	17
2.16	Earthing and bonding	17
2.17	Gas services bonding and external meters	18
2.18	Supplementary bonding	19
3	A Block of Retirement Flatlets	21
3.1	Two schemes	21
3.2	Early considerations	21
	3.2.1 Metering and distribution	21
3.3	Other interested parties	22
3.4	Building details	22
	3.4.1 Construction	22
3.5	Part 1 – Flats	24
	3.5.1 Mains distribution	24
	3.5.2 Electrical requirements in flats	24
	3.5.3 Load assessment and maximum demand	25
	3.5.4 Wiring system	25
	3.5.5 Wiring hints	25
	3.5.6 Wiring in false ceilings	26
	3.5.7 Wiring in roof space	27
	3.5.8 Cable sizes	27
	3.5.9 Arrangement of circuits	27
	3.5.10 Consumer unit	28
	3.5.11 Earthing and bonding	28
	3.5.12 Earthing terminal	29
	3.5.13 Bonding	29
3.6	Part 2 – Landlord's areas	29
	3.6.1 Meter cupboard	29
	3.6.2 Supplies to flats	29

3.6.3	Landlord's electrical requirements	30
3.6.4	Diversity	30
3.6.5	Lighting	31
3.6.6	Socket-outlets	31
3.6.7	Other equipment	31
3.6.8	Total load	31
3.6.9	Cable sizes and circuitry	31
3.6.10	Lighting	32
3.6.11	Socket-outlets	32
3.6.12	Other equipment	33
3.6.13	Distribution board	33
3.6.14	Residual current protection	33
3.6.15	Switchgear	33
3.6.16	Switching	34
3.6.17	Wiring	34
3.6.18	Earthing	34
3.6.19	Emergency systems	34
4	Overcurrent Protection	35
4.1	Overload	35
4.2	Overload protection	36
4.3	Overload protective devices	37
4.3.1	Rewirable fuses	37
4.3.2	High Breaking Capacity (HBC) fuses	37
4.3.3	Circuit-breakers	37
4.3.4	The 'type' of circuit-breaker	37
4.4	Fault current	38
4.5	Fault Current Protection	39
4.6	Omission of fault current protection	39
4.7	Short-circuit rating	39
4.8	Disconnection times	41
4.9	Earth loop impedance	42
4.10	Summary of cb specification	42
4.11	Conclusion	43
5	An Architect's Office	44
5.1	Other interested parties	44
5.2	Building structure and finishes	45
5.3	Electrical requirements	46
5.3.1	Loading and diversity	47
5.3.2	Storage heaters	49
5.3.3	Print machine	50
5.3.4	Socket-outlets	50

8.3	Motor vehicle repair premises	91
8.4	Other interested parties	91
8.5	Building structure and finishes	91
8.6	Construction	94
8.7	Electrical requirements	94
8.8	Health and safety executive guidance and regulations	94
8.9	Health and safety guidance note HSG 261	95
8.10	Wiring regulations	96
8.11	Load assessment and maximum demand	96
8.12	Maximum demand load and diversity	96
8.13	Lighting	97
	8.13.1 Office lighting load	99
	8.13.2 Workshop lighting load	99
8.14	Welder	99
8.15	Compressor	99
8.16	Gas blowers	100
	8.16.1 Provision for spray area	100
8.17	Phase balance	100
8.18	Estimate of maximum demand	101
8.19	What about a distribution circuit (sub-main)?	102
8.20	Wiring systems	102
8.21	Workshop	102
	8.21.1 Steel conduit and trunking	102
	8.21.2 Steel Wire Armoured (SWA) cable	103
8.22	Office	105
8.23	Arrangement of circuits	105
8.24	Distribution boards	105
8.25	Cable sizes	105
8.26	Isolation and switching	107
8.27	Machinery	107
8.28	Cooker	107
8.29	Gas boiler	107
8.30	110 V transformer	108
8.31	Earthing and bonding	108
8.32	Main earthing terminal	109
8.33	Protective conductors at distribution board B	109
8.34	Armoured cable glands	109
8.35	Steel conduit and trunking	110

9	Circuits	111
9.1	Terminology	111
9.2	Colours of three phases	111

9.3	Conventional circuits	112
9.4	Lighting circuits	112
9.5	Induction	113
9.6	Socket-outlet circuits	113
9.7	Changing methods	113
9.8	Ring main obsolescence	113
9.9	History of the ring final circuit	114
9.10	Times have changed	114
9.11	Alternative methods	116
	9.11.1 Multiple plug sizes	116
9.12	Radial circuits	117
9.13	Introducing the tree	117
9.14	20 A tree	117
	9.14.1 Domestic	117
	9.14.2 Commercial and similar	117
9.15	32 A tree	118
	9.15.1 Domestic	119
	9.15.2 Commercial and similar	119
9.16	Switching and control	119
9.17	Comparison of systems	120
9.18	32 A ring final circuit	120
	9.18.1 Disadvantages	120
	9.18.2 Advantage	120
9.19	20 A tree	121
	9.19.1 Disadvantage	121
	9.19.2 Advantages	121
9.20	Composite circuits	121
10	Farming and Horticulture	123
10.1	Why farms are different	124
	10.1.1 Environment	124
	10.1.2 Livestock	124
	10.1.3 Equipotential zones	124
	10.1.4 Electrical systems	125
10.2	Special earthing requirements on farms with TT systems	126
	10.2.1 Warning	126
10.3	Earth electrodes	127
10.4	Alternative electrodes	127
	10.4.1 Earth tapes and wires	127
	10.4.2 Structural steelwork	128
	10.4.3 Concrete reinforcement	128
	10.4.4 Earthing grids or plates	128
	10.4.5 Pipework of other services	128

10.5	Bonding	128
	10.5.1 Main bonding	128
10.6	Supplementary bonding	129
10.7	Residual current devices	129
	10.7.1 Discrimination	129
10.8	Shock protection	130
10.9	General requirements for automatic disconnection of supply (ADS)	131
10.10	Fire protection	132
10.11	Automatic life support for high density livestock rearing	132
10.12	Switchgear	133
10.13	Wiring systems	134
10.14	Overhead or underground wiring	134
	10.14.1 Metallic conduit	134
10.15	Non-metallic wiring systems	135
10.16	Steel Wire Armoured (SWA) cable	136
10.17	Twin and earth cable	136
10.18	General rules regarding farm electrical installations	136
11	Isolation and Switching	138
11.1	Isolation and switching	138
11.2	Isolation	139
	11.2.1 Main switch	139
11.3	Mechanical maintenance	140
11.4	Emergency switching	141
	11.4.1 Domestic	142
	11.4.2 Industrial	142
	11.4.3 Emergency stopping decisions	142
11.5	Labelling and notices	143
12	A Village Sports Centre	145
12.1	Special conditions	145
12.2	Codes of practice	145
12.3	Other interested parties	146
12.4	Building details	146
12.5	Structure and finishes	147
12.6	Electricity supply and requirements	148
12.7	Off-peak tariff	148
12.8	Normal tariff	148
12.9	Load assessment and diversity	150
12.10	Off-peak heating	150
12.11	Normal tariff	150
	12.11.1 Showers	150
	12.11.2 Changing room	150

12.11.3	Sink water heaters	151
12.11.4	Cooker	151
12.11.5	Socket-outlets	151
12.11.6	Beer chiller	151
12.11.7	Lighting	151
12.12	Total estimated maximum current demand	152
12.13	Wiring systems	152
12.13.1	Insulated and sheathed cables	152
12.13.2	Steel conduit and trunking	153
12.13.3	Emergency systems	154
12.13.4	Plastic conduit and trunking	154
12.14	Circuitry and cable sizing	154
12.15	Cable grouping factors	155
12.16	Arrangement of circuits	156
12.17	Switchgear	157
12.18	Shock protection	157
12.19	Earthing	157
12.20	Bonding	157
12.21	An occasional problem	157
12.22	Solutions	158
12.23	Requirements for a TT installation	159
13	An Indoor Swimming Pool	160
13.1	Special conditions	160
13.2	Other interested parties	161
13.3	Building details	161
13.3.1	Construction	161
13.3.2	Electrical requirements	162
13.4	Application of zoning to this project	162
13.4.1	Zone 0	163
13.4.2	Zone 1	164
13.4.3	Zone 2	166
13.4.4	Other current-using equipment of swimming pools	166
13.5	Dehumidifiers	167
13.6	Changing room/shower area	167
13.6.1	Switchgear, controlgear and accessories	168
13.6.2	Current-using equipment	168
13.7	Loading and diversity for the swimming pool project	168
13.7.1	Lighting	168
13.7.2	Dehumidifiers	169
13.7.3	Socket-outlets and hair dryer	169
13.8	Wiring systems	169
13.9	Cable sizes	170

13.10	Distribution board	170
13.11	Isolation	171
13.12	110 V system	171
13.13	Earthing	172
13.14	Local supplementary bonding	172
13.15	Floor grid	172
14	Cables and Wiring Systems	174
14.1	External influences	174
14.2	Cost considerations	175
14.3	Choosing suitable cable routes	175
14.4	Is armouring always necessary?	175
14.5	Fire barriers	175
14.6	Holes through fire barriers	176
14.7	Sealing the wiring system	176
14.8	Work in progress	176
14.9	Records	177
14.10	Hidden cables	177
14.11	Cables within a floor	177
14.12	Cables above false ceilings	178
14.13	Cables in walls	178
14.14	Mechanically protected cables	179
14.15	Fire and smoke	179
14.16	Thermoplastic (PVC) insulation	180
14.17	Thermosetting (XLPE)	181
14.18	Silicone rubber	181
14.19	Low smoke zero halogen (LSOH)	181
14.20	Mineral insulated copper sheathed (MICS) cables	182
14.21	Heat transference from cables	182
14.22	Wiring systems and cable management	182
14.23	Emergency systems	182
14.24	Care with wiring systems	183
14.25	Thermoplastic (PVC) insulated and sheathed cables	183
14.26	Thermosetting (PVC) insulated conduit cables	183
14.27	Steel conduit systems and trunking	184
14.28	Plastic conduit systems and trunking	184
14.29	MICS cables	184
14.30	Steel wire armoured cables	185
14.31	Silicone insulated PVC sheathed cables	185
15	Inspection, Testing and Certification	186
15.1	Labelling and documentation	187
15.2	Specification and manual	187

15.3	Regulations	187
15.4	Electrical installation certificate (EIC)	187
15.5	Signatories	190
15.5.1	Designer	190
15.5.2	Installer	192
15.5.3	Inspection and testing	192
15.6	Alterations and additions	192
15.7	Limits of responsibility	192
15.8	Deviations and departures	193
15.9	New materials and inventions	193
15.10	Particulars of the installation	194
15.11	Inspections and test schedules	194
15.12	Inspection procedures	194
15.13	Testing	197
15.14	Continuity testing	198
15.15	Polarity	198
15.16	Continuity of protective conductors	198
15.17	Continuity of ring circuit conductors	198
15.17.1	Test no. 1	198
15.17.2	Test no. 2	198
15.18	Insulation resistance	200
15.19	Earth fault loop impedance	202
15.20	Supply impedance Z_e	204
15.21	Earth loop impedance of circuits Z_s	205
15.22	Prospective fault current	206
15.23	Operation of residual current devices	206
16	A Caravan Park	208
16.1	Measures for protection against electric shock	208
16.2	Earthing arrangements	209
16.3	PME must not be used for caravans	209
16.4	Electrical equipment (external influences)	210
16.5	Wiring systems	210
16.6	Cables buried in the ground	210
16.7	Overhead cables	210
16.8	Caravan pitch electrical supply equipment	211
16.9	Plugs and socket-outlets	211
17	Residual Current Devices	213
17.1	How does an RCD work?	214
17.2	Fault protection	214
17.3	Additional protection	217
17.4	Requirements to provide additional protection by RCDs	217

17.5	RCDs incorporated into a consumer unit, to meet the requirements for additional protection	218
17.6	Protection against fire	220
17.7	Avoiding a hazard and/or minimising an inconvenience due to the tripping of an RCD	221
17.8	Reducing the possibility of unwanted tripping of RCDs	221
17.9	Use of a ‘front-end’ 30 mA RCD is generally considered unacceptable practice	222
17.10	Installations forming part of a TT system	222
17.11	RCDs connected in series	223
17.12	Labelling	223
18	Flood Lighting (Outdoor Lighting) Project	224
18.1	Lighting arrangement	224
18.2	General requirements	224
18.3	Wiring system	225
18.4	Protective measures	226
18.5	Load assessment	226
18.6	Rating of the overcurrent protective device	227
18.7	Circuit design	227
18.8	Voltage drop consideration	228
18.9	Switchgear	230
19	Circuit Design Calculations	231
19.1	Design process	231
19.1.1	Step 1: Determine the characteristics of supply and the load	232
19.1.2	Step 2: Select the cable and protective device	232
19.1.3	Step 3: Check that the voltage drop is acceptable	233
19.1.4	Step 4: Check that electrical shock protection is acceptable	233
19.1.5	Step 5: Check that the conductors are protected against prospective fault current	234
19.2	Protective conductors	235
19.3	Worked example	235
19.4	Solution	236
Index		239