دائـــرة الـــطـــاقـــة
DEPARTMENT OF ENERGY

THE ELECTRICITY WIRING REGULATIONS

2020

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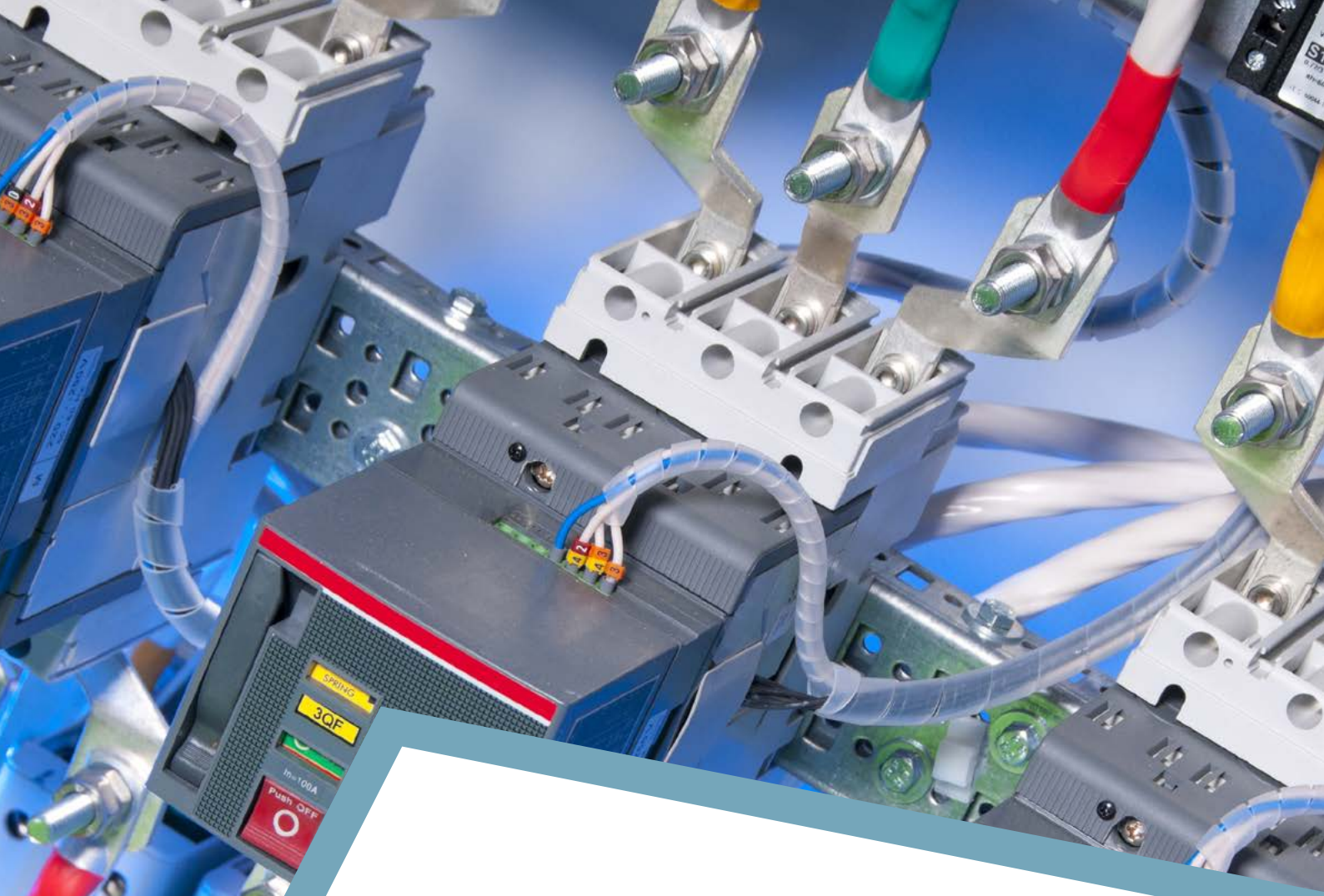

Foreword

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The Department of Energy (DoE) is established in Abu Dhabi pursuant to Law No.11 of 2018 (the Law). Under that Law, the DoE is the successor entity of the Regulation and Supervision Bureau (RSB) and Abu Dhabi Water and Electricity Authority (ADWEA). Accordingly, any references to the Regulation and Supervision Bureau, the Bureau, RSB, the Authority or ADWEA in any document, template or correspondence shall now be interpreted as referring to the DoE.

The DoE's role is to regulate the economic and technical activities of entities operating in the energy sector in the Emirate of Abu Dhabi.

Moreover, the DoE has certain responsibilities towards the general public, including the assurance of safe and efficient electricity supplies to customers and these Regulations have been produced with this primary aim in mind.

These Regulations promote the installation and operation of safe electricity wiring systems in premises and are based on the general principles defined in British Standard BS 7671 (otherwise known as the IET Wiring Regulations,UK), which are also similar to the International Standard IEC 60364. Such principles are common practice in Abu Dhabi and were adopted in previous documents, including the first Wiring Regulations issued by the old Water and Electricity Department (WED) in 1972.

These Regulations also take account of the physical environment in Abu Dhabi and the skills and language diversity of the region.

These Regulations are issued by the DoE pursuant to the powers conferred to it under the Law and shall replace the provious regulations issued by the RSB, ADWEA or WED.

These Regulations shall be effective from 1st April 2020 and can be downloaded via the link in DoE's website **https://www.doe.gov.ae/en/Publications.**

MOHAMMED BIN JARSH AL FALASI

Undersecretary-Department of Energy

Acknowledgements

The DoE gratefully acknowledges the contributions and comments provided by the following organisations:

(i) Al Ain Distribution Company (AADC)

(ii) Abu Dhabi Distribution Company (ADDC)

(iii) Abu Dhabi Quality and Conformity Council (QCC)

(iv) Abu Dhabi City Municipality (ADCM)

In particular, the DoE wishes to acknowledge the previous permission granted by the Institute of Engineering Technology and the British Standards Institute for the use in this document of data and information taken from BS 7671

BS 7671 (IET Wiring Regulations Eighteenth Edition) can be purchased in hardcopy format only from the IET website http://electrical.theiet.org/ and the BSI online shop: http://shop.bsigroup.com .

History of revisions

Revision	Date	Prepared by	Checked by	Issued to
ED/R01/010 Issue 1	Dec 2007	T Khan	L. Hill	Publication
ED/R01/010 Revision 1	Jan 2009	T Khan	L. Hill	Publication
ED/R01/010 Third Edition	Mar 2014	M Yousif C K Lee	M Preece	Publication
DoE/PD/R01/001 (2020 Edition issued by DoE)	Apr 2020	K Al Marzooqi M Iskeirjeh M Sattari M Yousif	S Alshkeili	Publication

Document numbering

These Regulations use the following numbering system:

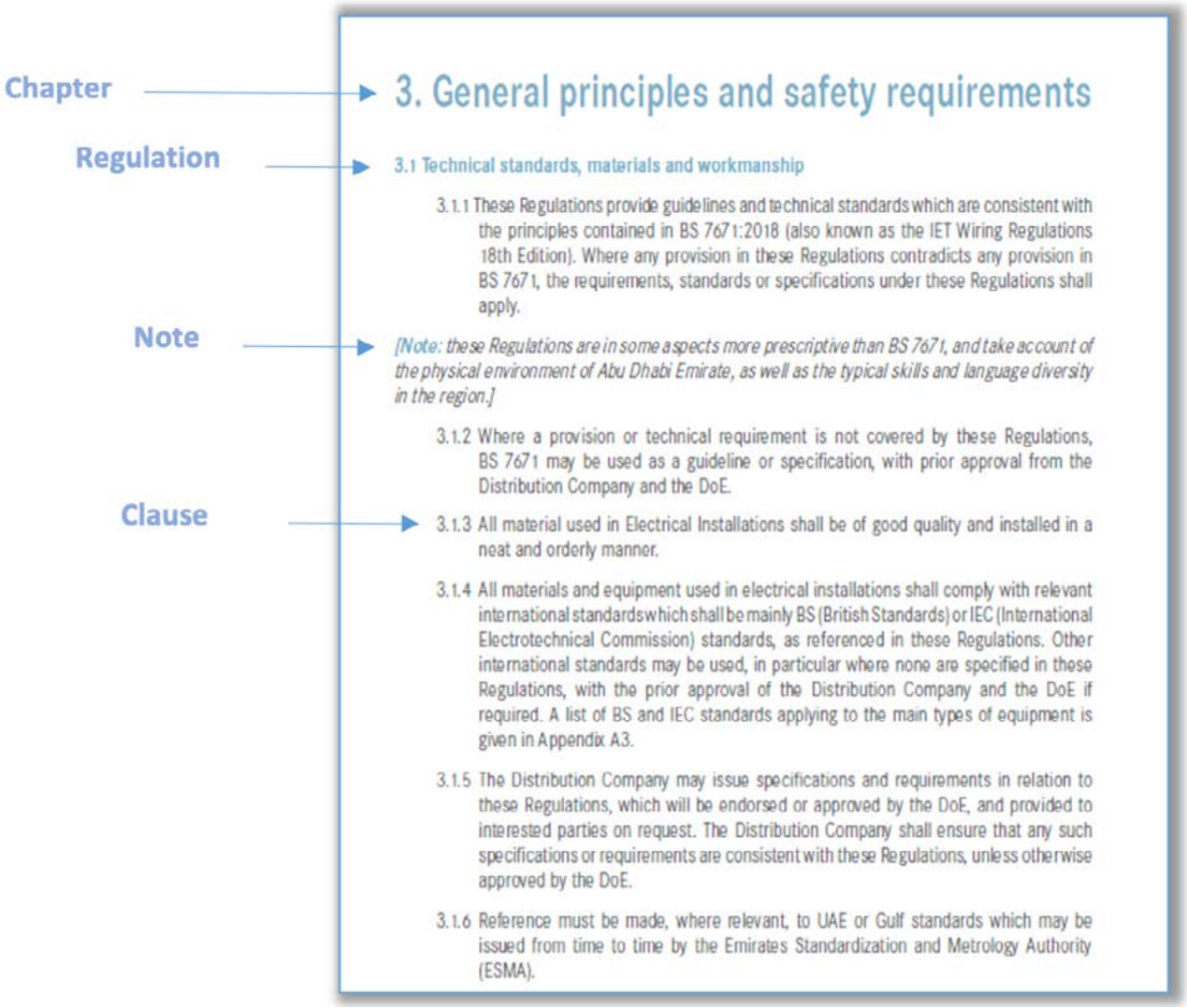
Parts are referenced by integers (e.g. 1, 2, 3, etc.)

Regulations are referenced by one full stop between numbers (e.g. 1.1, 1.2, etc.)

Clauses are referenced by two full stops between numbers (e.g. 3.1.2, etc.)

Notes are indicated below the Clause in square brackets and italic text. For example,

***[Note:** this Clause does not apply to Installations that have been ...]*



1.

Introduction

1. Introduction

1.1 Citation

1.1.1 These Regulations shall be cited as the Electricity Wiring Regulations 2020 (The Regulations)

1.2 Commencement

1.2.1 These Regulations come into force on 1st April 2020 (Commencement Date)

1.2.2 These Regulations are issued by the Department of Energy pursuant to Law No (11) of 2018.

1.2.3 These Regulations supersede and replace the following regulations:

- The Electricity Wiring Regulations (3rd Edition 2014 issued by former RSB) and its EVSE Addendum No 1 issued in 2016
- ADWEA's Wiring Rules and Regulations (3rd Edition 2003);
- WED's Regulations for Electrical Installation Works (1980); and
- Earth Leakage Protection Regulations (2001).

1.3 Purpose

1.3.1 The purpose of these Regulations is to establish standards and principles that promote the design, construction, installation, maintenance and operation of safe and efficient Low Voltage (LV) Electrical Installations in all Premises within the Emirate of Abu Dhabi.

1.3.2 The document is structured into parts, regulations and Clauses. Regulations and Clauses are mandatory. Notes which are included below Clauses, in italic text, are for guidance, clarification or provide supporting technical information.

1.3.3 Appendices contain mandatory information and Guidance notes contain supporting information.

1.4 Scope and enforcement

1.4.1 These Regulations apply to all Distribution Companies, Customers, Owners, Licensed Contractors, or any other persons involved in the design, construction, installation, maintenance or operation of LV Electrical Installations in all Premises within the Emirate of Abu Dhabi. Such locations include, but are not limited to apartments, villas, offices, shops, warehouses, hotels, commercial complexes, leisure complexes, public buildings, parks and public realm, farms, temporary Electrical Installations, entertainment arenas, construction sites, tents, outbuildings, caravans, Roadway lighting, and traffic signs.

*[**Note:** certain Premises such as industrial, manufacturing, railway, oil and gas etc., due to the*

nature of their operation, may have specific requirements or standards that are not covered in these Regulations. In such cases, evidence of compliance with such requirements or standards must be provided to the relevant Distribution Company.]

1.4.2 The scope of these Regulations does not include the design and technical requirements of the High Voltage (HV) and LV electricity distribution networks belonging to Distribution Companies.

***[Note:** requirements governing Distribution Companies' networks are covered under the Electricity Supply Regulations, as well as relevant Licences, codes and standards.]*

1.4.3 These Regulations shall apply to all new Electrical Installations constructed on or after the Commencement Date. Requirements for extensions, alterations and repairs to existing Electrical Installations are covered under Regulation 3.2

***[Note:** where the design of an Electrical Installation has been completed before the Commencement Date of these Regulations, advice must be sought from the Distribution Company before construction is commenced.]*

1.4.4 For Electrical Installations constructed before the date of commencement (1 January 2008), the table in Appendix A4 lists those Clauses that either do not apply or that apply on the date of their next inspection or re-certification.

1.4.5 These Regulations shall be enforced by the relevant Distribution Company in the Emirate of Abu Dhabi, in accordance with Distribution Company relevant procedures approved by the DoE, which shall be published by the Distribution Company on their official website.

1.4.6 Compliance with these Regulations requires compliance with other relevant technical standards, see Regulation 3.1, References to British Standards or other standards means the current edition of the standard cited or its replacement. For existing Electrical Installations Clause 1.4.4 applies.

1.4.7 Failure to comply with these Regulations, or any part thereof, shall be deemed as contrary to the Law and subject to punishment by the imposition of a fine and/or administrative sanction. Any such failures will be addressed in accordance with the Law and Part 15 of these regulations. Action may be taken against any Distribution Company, Customer, Owner, Licensed Contractor or other person to which these Regulations apply.

1.4.8 Relaxation of any of the requirements of the Regulations shall be raised to the DoE for approval via a written request from any Distribution Company, Customer, Owner, Licensed Contractor or other person. Such requests may be referred to a dispensation panel established for such purpose by the DoE.

***[Note:** relaxation requests from a Customer, Owner, Licensed Contractor or other person must be directed to the relevant Distribution Company in the first instance for assessment by the Distribution Company in accordance with the procedures published by the Company.]*

1.4.9 In the event of a dispute between any parties mentioned in Clause 1.4.1, the matter

may be referred to the DoE to advise a solution or recommended action. This does not preclude any party referring a matter to the relevant Court of Abu Dhabi.

1.4.10 These Regulations and the rights and duties of any parties thereunder shall be governed by, construed and applied in accordance with, the Laws of Abu Dhabi Emirate and the Federal Laws of the UAE as applied by the Courts of Abu Dhabi.

1.4.11 These Regulations may be amended or revoked by the DoE at any time.

1.4.12 Nothing in these Regulations is intended to conflict with, or affect the operation of any relevant existing Federal or Abu Dhabi Law, Regulation, Decree, Order or other Ordinance.

1.4.13 Where a conflict appears to exist between these Regulations and other regulations, codes, or any governmental legislation, the matter should be referred to DoE for a binding decision in accordance with Part 14 of these Regulations.

1.5 Responsibility for Implementation

1.5.1 All parties mentioned in Clause 1.4.1 are responsible for implementing this document.

1.6 References

Refer to Appendix A2 Recommended Books and references

Refer to Appendix A3 Reference standards

1.7 Distribution

Soft copy of these regulations is available on DoE website

2.

Definitions

2. Definitions

2.1 Interpretation

2.1.1 Words defined in this Part begin with capital letters when used in the Regulations. For example, “all Earth Conductors within Premises shall be ...”.

2.1.2 Terms in common use are not defined here and normal dictionary definitions apply (e.g. circuit breaker, plug, and conduit).

2.1.3 Words and expressions other than those defined in these Regulations which are defined in the Law or in Law No (2), shall have the meanings ascribed to them in these laws.

2.1.4 Words using the singular or plural number also include the plural or the singular number respectively.

2.1.5 Unless otherwise specified, days shall mean calendar days.

2.2 Definitions

Accessory: a device, other than current-using equipment, associated with an Electrical Installation.

Appliance: an item of current-using equipment.

Arm’s Reach: a zone of accessibility to touch, extending from any point on a surface where a person may stand or move about, to the limits which such person may reach without assistance (i.e. without any tool or ladder, etc.). Such a distance may be taken as 2.5m height from the standing surface, and 1.25m horizontally from the standing position.

Cable Tray: a cable support consisting of a continuous base with raised edges and no covering. A Cable Tray is considered to be perforated where more than 30% of the material is removed from the base.

Cable Trunking: a manufactured enclosure for the protection of cables, normally of rectangular cross-section, of which one side is removable or hinged.

Category 1 Circuit: a Circuit (other than a fire alarm or emergency lighting Circuit) operating at LV.

Category 2 Circuit: a Circuit (other than a fire alarm or emergency lighting Circuit) which supplies telecommunications equipment (such as telephones, intruder alarms, data transmission, call bells, etc.).

Category 3 Circuit: a fire alarm or emergency lighting Circuit

Charging Modes: An operating mode in which energy transfer from a power source to the Electrical Vehicle’s (EV) battery; below are related definitions:

(a) Mode-1: Connection of the EV to the AC supply network utilising standardised socket-outlets not exceeding 16A and not exceeding a nominal supply Voltage of 230V AC

single-phase or 400V AC three-phase, at the supply side, and utilizing the power and Circuit Earth Conductors (according to BS EN 61851-1). Mode 1 charging period is relatively long, typically 6 to 8 hours.

(b) Mode-2: Connection of the EV to the AC supply network utilising standardised socket-outlets not exceeding 32A and not exceeding a nominal Voltage of 230V AC single-phase or 400V AC three-phase, at the supply side, and utilizing the power and Circuit Earth Conductors together with a Control Pilot function and system of personnel protection against electric shock (RCD) between the EV and the plug or as part of the In-Cable Control Box and protection device for mode-2 charging of electric road vehicles (IC-CPD) complying with IEC 62752 standard or other similar standards.

(c) Mode-3: Connection of the EV to the AC supply network utilising dedicated EVSE and a charging cable assembly. The control pilot cable of the charging cable assembly allows communication between the EVSE and the On-Board Charger of an EV platform functions including verification of connection with the EV, continuous checking of Circuit Earth Conductor integrity, energisation and de-energisation of the supply and selection of charging rate. The charging equipment are typically in the form of charging posts or wall mounted charging units, and come in a variety of current ratings e.g. 13A, 16A,32A and 250A.

(d) Mode-4: Connection of the EV to the AC supply network utilising an Off-Board Charger where the Control Pilot function extends to control equipment permanently connected to the AC supply. In this Mode, Direct Current Electrical Power is delivered to the vehicle. In Mode-4 either a single-phase or three phase AC is converted to AC within the EVSE. Such charging equipment units are considered not to be suitable for domestic Electrical Installations due to the higher Voltages and currents used (typically, 500V, 125A).

Circuit: a set of phase and neutral conductors installed as a group to supply power to a location and which originate from one Protective Device. The following are related definitions:

(a) Ring Circuit: a Circuit which is wired from a single Protective Device, being run through an area to be supplied (via appropriate socket-outlets, switched flex outlets, etc.) and returning back to the same Protective Device, thus forming an electrically continuous loop;

(b) Radial Circuit: a Circuit which is wired in a 'radial' or 'branch' configuration, emanating from a Protective Device, to the area to be supplied;

(c) Final Circuit: a Circuit which directly supplies Appliances (normally via socket-outlets, switched flex outlets, isolators, ceiling roses, etc.); and

Distribution Circuit: a Circuit connecting between Distribution Boards (may also be referred to as a 'sub-Circuit').

Class I Equipment: equipment which includes a means for connection of Exposed-Conductive- Parts of the equipment to the Earth Conductor, thus providing protection against electric shock in case of failure of the basic insulation of the equipment or other fault condition.

Class II Equipment: equipment which does not include a means for connection to an Earth Conductor, and which provides supplementary insulation in addition to the basic insulation of the equipment such that a breakdown of the basic insulation will not present a dangerous Voltage on required to comply with BS 2754. See Appendix A18(b).

Class III Equipment: equipment in which protection against electric shock relies on supply at SELV and in which Voltages higher than SELV are not generated in the equipment, see BS 2754.

Competency Licence: a specific licence issued by a Distribution Company to a Licenced Contractor assessed as competent for work on LV Electrical Installations

Connected Load: the aggregate load of Appliances and other electrical equipment at a Premises, summated using the method described under Clause 3.2.7. See Guidance note G2.

Control Pilot: The control conductor in the charging cable assembly connecting the In-Cable Control Box or the fixed part of the charging facilities, and the EV earth through the control circuitry on the vehicle. It may be used to perform several functions.

Customer: any person, corporate body, or company who has an agreement with a Distribution Company for the supply of electricity.

Connection Point (CP): the point which defines the boundary between the Owner's Electrical Installation installed at a Premises and the main cable or equipment owned by the Distribution Company.

Danger: risk of injury to people or animals from fire, electric shock, burns, explosion or from mechanical movement of electrically controlled equipment, or the risk of damage to property.

Direct Contact: the contact with electricity by a person (accidental or otherwise) through the phase or neutral conductors of an Electrical Installation or Appliance, leading to an electric shock, see Guidance note G4(a).

Distribution Company: a company or body holding a distribution licence, granted by the DoE, pursuant to the Law.

Distribution Board: an assembly designed for housing isolation switches and Protective Devices and for connecting multiple Circuits, including their associated neutral and Earth Conductors. The following are related definitions:

(a) Main Distribution Board (MDB): the Distribution Board which accepts the main incoming LV supply from the Distribution Company or Owner's transformer;

(b) Sub Main Distribution Board (SMDB): any Distribution Board which is neither a Main Distribution Board nor a Final Distribution Board; and

(c) Final Distribution Board (FDB): a Distribution Board which supplies Final Circuits only.

Diversified Load: the load at a Distribution Board, at the Electricity Intake or at any other point in an Electrical Installation, calculated using diversity factors as illustrated in Guidance note G2.

DoE: the Department of Energy is the regulator for the Water, Wastewater and Electricity Sector

Double Insulated Equipment: see Class II Equipment.

Earth: the conductive mass of Earth, whose electrical potential (Voltage) at any point is conventionally taken as zero. The following are related definitions:

(a) Locally Earthed System (TT): a system of supply where the Owner provides a Main Earth Terminal for the Electrical Installation, which is connected to a sufficient number of local Earth Electrodes to provide a maximum Earth Resistance measured at the Owner's Main Earth Terminal of not more than 10 Ohms.

(b) Distribution Company Earthed System (TN-S): a system of supply where the Distribution Company provides a connection to the Owner's Main Earth Terminal, using the distribution network Earthing System

Earthing or Earthed: a general term used to describe the connection of conductive parts of an Electrical Installation or an Appliance to Earth.

Earth Conductor: a conductor used to connect Exposed- Conductive-Parts of an Electrical Installation and associated Appliances to Earth, and providing a means for the safe passage of earth fault current. This includes the following defined terms:

(a) Main Earth Conductor (MEC): conductors connected between Earth Electrodes and Main Earth Terminals; and

(b) Circuit Earth Conductor (CEC): conductors connecting all Circuits emanating from Main Distribution Boards, Sub Main Distribution Boards, Final Distribution Boards including Circuits connecting to equipment and Appliances. Outside these Regulations, these may also be known as the Circuit Protective Conductor (CPC) or Earth Continuity Conductor (ECC).

Earth Electrode: a conductor or group of conductors in intimate contact with Earth, providing an electrical connection to Earth, and normally having a known and measurable value of Earth Resistance

Earthed Equipotential Bonding (EEB): the connection of Extraneous-Conductive-Parts within Premises using designated conductors such that potential Touch Voltages are kept to a safe value during the passage of earth fault current (also known outside these Regulations as 'PME Bonding'). This definition includes the following:

(a) Main Equipotential Bonding: the connection of major Extraneous- Conductive- Parts, such as pipe services and metallic structures, at their point of entry into a premises to the Main Earth Terminal in an Electrical Installation, using designated conductors; and

(b) Supplementary Equipotential Bonding the connection of Extraneous- Conductive-Parts with each other or with Exposed-Conductive-Parts within an area where such parts are simultaneously accessible to persons, such that the potential Touch Voltage during an earth fault is kept to safe limits.

*[**Note:** for disconnection times greater than 0.4 Sec, a safe Touch Voltage limit may be taken as 50V for dry conditions and 25V for wet conditions.]*

Earthed Equipotential Bonded System (EEBS): a system where protection against electric shock due to Indirect Contact is achieved by the provision of Earthed Equipotential Bonding conductors, in association with Protective Devices for the automatic disconnection of supply.

Earth Leakage Protection (ELP): the provision of protection against electric shock due to Indirect Contact by the use of RCDs or other sensitive earth leakage Protective Devices which automatically disconnect the supply sufficiently quickly so as to prevent Danger to persons.

Earth Leakage Protected System (ELPS): a system of supply where Earth Leakage Protection is provided on Final Circuits and an additional ELP is provided at the Electricity Intake.

Earth Resistance: the resistance (in Ohms) from any point on an Electrical Installation to Earth, being measured using an approved testing device and approved procedure.

Earth Fault Loop Impedance (Zs): the total impedance presented to an earth fault current, comprising the impedance of the following parts of a system, illustrated in Appendix A5(g):

(a) the Circuit Earth Conductor;

(b) the Main Earth Terminal;

(c) the main Earth Conductors connecting to Earth Electrodes or the Distribution Company Earth;

(d) the path of earth fault current through the general mass of Earth, or through the conductors or Earth sheath or armouring of the Distribution Company cable;

(e) the neutral Earth connection(s) of the Distribution Company;

(f) the distribution transformer winding; and

(g) the phase conductor of the Circuit back to the point of fault.

Electric Vehicle (EV): Any vehicle propelled by an electric motor drawing current from a rechargeable storage battery or from other portable energy storage devices (rechargeable, using energy from a source off the vehicle such as a residential or public electricity services), which is manufactured primarily for use on public streets, roads or highways such as battery electric vehicles, hybrid vehicles, plug-in hybrid vehicles, and extended rang electrical vehicles.

Electric Vehicle Supply Equipment (EVSE): Conductors, including the phase, neutral and Circuit Earth Conductors, the EV couplers, attachment plugs, and all other accessories, devices, power outlets or apparatuses installed specifically for the purpose of delivering energy from the Premises wiring to the EV and allowing communication between them if required. Example: wall-box unit and charging pole.

Electricity Intake: a term used to describe the location or room housing the Main Distribution Board and/or the main cable and equipment owned by a Distribution Company to which the Electrical Installation of the Premises is connected via a defined Connection Point.

Electrical Installation: an Electrical Installation comprises any fixed or temporary cable, switchgear or other electrical equipment or apparatus within a Premises or other place where there is an electricity supply (including outdoor locations). Fixed or portable electrical Appliances are not considered part of the Electrical Installation, although these Regulations do include requirements for the connection of Appliances (e.g. plugs and socket-outlets).

Electrical Installation Certificate: a certificate in the format indicated in these Regulations which is issued by a Licensed Contractor after completion of work on an Electrical Installation and provided to the Customer or Owner of the Premises

Electricity Distribution Code: a code prepared and maintained by the Distribution

Companies detailing technical parameters and other requirements relating to the connection and the use of the distribution networks owned and operated by the Distribution Companies.

Exposed-Conductive-Part: a conductive part of an Electrical Installation or Appliance which can be touched by persons and which is not normally live but may become live due to a fault condition. Exposed-Conductive-Parts are required to be connected to Earth, see Regulation 6.6.

Extraneous-Conductive-Part: a conductive part, structure or any metalwork within a Premises which is not part of, and is unrelated to, the Electrical Installation and which is not designed to carry current, but which may become live due to a fault condition. Extraneous-Conductive-Parts are required to be connected to Earth for Electrical Installations or parts of Electrical Installations classified as Earthed Equipotential Bonded Systems, see Regulation 5.5.

Extra-Low Voltage (ELV): see Voltage.

Final Circuit: see Circuit

Functional Earth: an Earth or Earthing system which is provided for special functions (such as reduction of radio frequency interference, noise filtering for computers, etc.) and which is separate from other Earth Conductors in an Electrical Installation but is connected to the Main Earth Terminal.

High Voltage (HV): see Voltage.

In-Cable Control Box: A device incorporated in the charging cable assembly, which performs control functions and safety functions. Such functions include RCD, over-current, over-temperature, and protective Earth detection.

Indirect Contact: contact of a person with electricity through Exposed-Conductive-Parts of an Electrical Installation or Appliance, or through Extraneous-Conductive-Parts in a Premises which have become live during fault conditions, see Guidance note G4(b).

Law: means Law No (2) of 1998 and Law (11) of 2018 Concerning the Regulation of the Water, Wastewater and Electricity Sector in the Emirate of Abu Dhabi (as amended).

Licensed Contractor: a person, entity or company, which has been assessed by the Distribution Company as competent to work on Electrical Installations and issued a Competency Licence by that Distribution Company.

Low Voltage: see Voltage.

Luminaire: equipment which is designed to house one or more electric lamps and which may include diffusers, fixtures, transformers and auxiliary Circuits but is taken to exclude the lamps themselves. Outside of these Regulations, a Luminaire may commonly be referred to as a 'light fitting'.

Main Distribution Board: see Distribution Board.

Main Earth Terminal (MET): the main Connection Point at which the nominal value of Earth Resistance for an Electrical Installation is taken, and to which Earth Conductors from Earth

Electrodes or the Distribution Company Earth are connected. This will normally be at or close to the Connection Point.

Marina: a facility for the mooring of Leisure Crafts which has fixed wharves, jetties, piers or a pontoon arrangement capable of berthing one or more Leisure Craft. The following are related definitions:

Leisure Craft: a boat, vessel, yacht, motor launch, houseboat or other floating craft used exclusively for sport or leisure; and

Pedestal: an electrical service enclosure providing electricity connection to Leisure Crafts in Marinas.

Off-Board Charger: Charger connected to the Premises wiring of the AC supply network (mains) and designed to operate entirely off the vehicle. In this case, direct current electrical power is delivered to the vehicle (e.g. Mode 4).

On-Board Charger: Charger mounted on the vehicle and designed to operate only on the vehicle.

Owner: the legal owner of the Premises in which an Electrical Installation is installed

Premises: any occupied or unoccupied land, structure, building, enclosure or other place. Such locations include, but are not limited to, apartments, villas, offices, shops, warehouses, hotels, commercial complexes, leisure complexes, public buildings, parks and public realm, farms, temporary Electrical Installations, entertainment arenas, construction sites, tents, outbuildings, caravans, roadway lighting and traffic signs.

Prospective Fault Current: the value of current that would flow due to a short-circuit fault of negligible impedance between live phase conductors, or between phase conductors and Earth. The maximum Prospective Fault Current for an Electrical Installation is normally taken at the Connection Point.

Protective Device: a device installed at the start of a Circuit which will automatically disconnect the input of electricity in the event of a fault or overload occurring on that Circuit. Such devices include, but are not limited to, fuses, fuse links, miniature circuit breakers (MCB), moulded case circuit- breakers (MCCB) and Residual Current Devices (RCD).

PV: photovoltaic. The following are related definitions:

(a) AC side: part of a PV installation from the AC terminals of the PV Inverter to the point of connection of the PV supply cable to the Electrical Installation;

(b) Array: mechanically and electrically integrated assembly of PV Modules, and other necessary components, to form a DC power supply unit;

(c) Array Junction Box: enclosure where PV Strings of any PV Array are electrically connected and where devices can be located;

(d) DC side: part of a PV installation from a PV cell to the DC terminals of the PV Inverter;

(e) Inverter: device which converts DC voltage and DC current into AC voltage and AC current;

(f) **Module:** smallest completely environmental protected assembly of interconnected PV cells;

(g) **Open Circuit Voltage, Voc:** voltage under standard test conditions across unloaded (open) PV Module, PV String, PV generator, or on the DC side of the PV Inverter;

(h) **Short Circuit Current, Isc:** short circuit current of a PV Module, PV String, PV Array or PV generator under standard test conditions; and

(i) **String:** Circuit in which PV Modules are connected in series, in order for a PV Array to generate the required output voltage.

Radial Circuit: see Circuit.

Residual Current Device (RCD): a Protective Device which is installed to automatically isolate the supply to a Circuit or Distribution Board when the vector sum of currents in the phase and neutral conductors reaches a pre-set value (referred to as the residual operating current or residual current rating).

Ring Circuit: see Circuit.

Sub Main Distribution Board: see Distribution Board.

Touch Voltage: the Voltage that would appear during an earth fault condition between Exposed- Conductive-Parts and Extraneous-Conductive-Parts which are simultaneously accessible to persons.

*[**Note**: this term is used only in connection with protection against Indirect Contact and is not used to refer to Direct Contact with electricity. The seriousness of impact of Touch Voltage on a person will depend on the body resistance and the immediate surroundings, in particular the presence of water. See Guidance note G4(h) and G5(b).*

Vehicle Coupler: Means of enabling the manual connection of a flexible cable to an EV for the purpose of charging.

Vehicle Connector: Part of a Vehicle Coupler integral with, or intended to be attached to, the flexible cable connected to the AC supply network (mains).

Vehicle Inlet: Part of a Vehicle Coupler incorporated in, or fixed to, the EV or intended to be fixed to it.

Voltage:

(a) **High Voltage (HV):** an AC voltage greater than Low Voltage and less than 36kV between phases or 21kV between any phase and Earth (internationally referred to as Medium Voltage);

(b) **Low Voltage (LV):** an AC voltage below 1000V between phases, or below 600V between any phase and Earth or; a DC voltage below 1500V between conductors, or below 900V between any conductor and Earth;

(c) **Extra-Low Voltage (ELV):** a voltage not exceeding 50V AC or 120V DC whether between live conductors or between live conductors and Earth;

(d) Separated Extra-Low Voltage (SELV): an Extra- Low Voltage system which is electrically separated from Earth in such a way that a single fault cannot give rise to the risk of electric shock;

(e) Protective Extra-Low Voltage (PELV): a system which has the same features as SELV except that connection of Exposed-Conductive-Parts to Earth is allowed; and

(f) Reduced Low Voltage (RLV): a voltage which doesn't not exceed 55V AC between phase and Earth or 110V AC between phases.

3.

General principles and safety requirements

3. General principles and safety requirements

3.1 Technical standards, materials and workmanship

3.1.1 These Regulations provide guidelines and technical standards which are consistent with the principles contained in BS 7671:2018 (also known as the IET Wiring Regulations 18th Edition). Where any provision in these Regulations contradicts any provision in BS 7671, the requirements, standards or specifications under these Regulations shall apply.

*[**Note:** these Regulations are in some aspects more prescriptive than BS 7671, and take account of the physical environment of Abu Dhabi Emirate, as well as the typical skills and language diversity in the region.]*

3.1.2 Where a provision or technical requirement is not covered by these Regulations, BS 7671 may be used as a guideline or specification, with prior approval from the Distribution Company and the DoE.

3.1.3 All material used in Electrical Installations shall be of good quality and installed in a neat and orderly manner.

3.1.4 All materials and equipment used in electrical installations shall comply with relevant international standards which shall be mainly BS (British Standards) or IEC (International Electrotechnical Commission) standards, as referenced in these Regulations. Other international standards may be used, in particular where none are specified in these Regulations, with the prior approval of the Distribution Company and the DoE if required. A list of BS and IEC standards applying to the main types of equipment is given in Appendix A3.

3.1.5 The Distribution Company may issue specifications and requirements in relation to these Regulations, which will be endorsed or approved by the DoE, and provided to interested parties on request. The Distribution Company shall ensure that any such specifications or requirements are consistent with these Regulations, unless otherwise approved by the DoE.

3.1.6 Reference must be made, where relevant, to UAE or Gulf standards which may be issued from time to time by the Emirates Standardization and Metrology Authority (ESMA).

3.2 Approval of Electrical Installations

3.2.1 Any Owner requiring a new connection or alteration to an existing connection must make an application to the Distribution Company using the appropriate forms and procedures published by the Company.

3.2.2 The design of an Electrical Installation must be approved by the Distribution Company before commencement of construction. Details of the design must be submitted, together with appropriate calculations and wiring diagrams, using the standard symbols shown in Appendix A11.

*[**Note:** even though the relevant Distribution Company approves the design of Electrical Installations, this does not relieve the Owner and associated Licensed Contractor from the obligation to fully comply with these Regulations.]*

3.2.3 For large developments, the Owner may, with the prior approval of the DoE and the Distribution Company, enter into an undertaking with the Distribution Company to the effect that all parts of an Electrical Installation downstream from the Connection Point shall comply with these Regulations. Any such approval, including as to the form of undertaking, will be at the discretion of the DoE and the Distribution Company. If given, the Owner will not be required to submit details of the Electrical Installation design to the Distribution Company for prior approval. A decision by the DoE and the Distribution Company to allow the Owner to self-certify the design of an Electrical Installation shall not have any bearing on any inspection of the Electrical Installation by the Distribution Company, and the Owner shall rectify any non-compliance identified by the Distribution Company (either in the pre-energisation inspection or upon any other inspection) at its own cost and within the timeframes specified by the Distribution Company or set out in these Regulations.

3.2.4 Notwithstanding Clause 3.2.3, in all instances the Owner, designer and associated Licensed Contractor are responsible for ensuring that the design, construction and installation of Electrical Installations complies with these Regulations.

3.2.5 New Electrical Installations must be inspected and tested by the Distribution Company in accordance with the requirements of Chapter 8 of these Regulations, prior to and upon energisation.

3.2.6 The Distribution Company may, where appropriate, seek evidence of compliance against relevant standards of equipment and components used in the Electrical Installation.

3.2.7 The Owner must provide an estimate of the Connected Load at the Premises, including at each Distribution Board. In addition, the Diversified Load for the whole Premises and at each Distribution Board, must be calculated by the Owner's appointed Licensed Contractor (i.e. design engineer or other qualified person) and submitted in the format given in Appendix A20(e), see Guidance note G2.

3.3 Extensions, alterations and repairs

3.3.1 No extension or alteration to an Electrical Installation may be made without prior notification to the Distribution Company or without approval, testing and certification in accordance with Regulation 3.2.

3.3.2 All extensions or alterations to an existing Electrical Installation must comply with the requirements of these Regulations.

3.3.3 Notwithstanding Clause 3.3.1 and 3.3.2, repairs to existing Electrical Installations may be made using standards of equipment compliant with the original Electrical Installation, but limited to work of an essential nature on a like-for-like basis. Work on any part of the Electrical Installation other than Final Circuits, including any Distribution Board and any items at the Electricity Intake, must be notified to the Distribution Company.

3.3.4 Any proposed increase greater than 10% of the total Connected Load at a Premises, or greater than 10% of the Connected Load at any Distribution Board, must be approved by the Distribution Company.

3.4 Licensed Contractors

3.4.1 Work on Electrical Installations may only be carried out by Licensed Contractors who have been assessed and approved by the Distribution Company.

3.4.2 The process for approval of Licensed Contractors shall be published by the Distribution Company as amended from time to time subject to DoE approval.

3.4.3 A register of Licensed Contractors shall be kept up-to-date by the Distribution Company and provided on request to any person.

3.5 Requirements for safety

3.5.1 The provisions of these Regulations require that all Electrical Installations are designed and constructed so as to ensure the safety of all persons who may operate, maintain or otherwise use or be affected by any part of an Electrical Installation. In addition to the requirements detailed under the relevant sections of these Regulations, the following general safety principles shall apply.

*[**Note:** these Regulations do not include detailed requirements for the maintenance of Electrical Installations. However, the maintainability of Electrical Installations must be adequately catered for in their design and construction. In addition, the requirements for periodic inspection and testing, as detailed in Part 8, may give rise to the need for maintenance and repair work.]*

3.5.2 All parts of an Electrical Installation shall be designed and constructed so as to prevent Danger.

3.5.3 All parts of an Electrical Installation shall be sufficiently sized and rated to safely carry out the function for which they are required.

3.5.4 All parts of an Electrical Installation shall be insulated appropriately according to the function they serve and in consideration of the expected operating environment, so as to prevent Danger.

*[**Note:** for areas classified as explosive or flammable, the requirements of BS EN 60079 shall be satisfied.]*

3.5.5 All Exposed-Conductive-Parts of an Electrical Installation and of Appliances must be connected to Earth via appropriate Earth Conductors, so as to protect against electric shock, see Regulation 6.6.

3.5.6 Except in specified circumstances, all Electrical Installations shall be provided with Earth Leakage Protection at the source of supply, at all Final Circuits and at other appropriate points. In addition, Earth Equipotential Bonding shall be provided, see Clause 5.3.4.

3.5.7 All Electrical Installations must be protected against damage caused by excess current due to a fault or overload by suitable Protective Devices, see Regulation 5.2.

3.5.8 All Electrical Installations must be provided with a means of isolating the electricity supply at suitable sections, subsections and Circuits, and at points where Appliances are used, see Regulation 5.6.

3.5.9 All parts of an Electrical Installation must be suitably located so as to provide safe access for operation, maintenance and repair and must be protected against accidental or deliberate interference or damage.

3.5.10 Electrical Installations must be designed and constructed with particular consideration given to the risk of fire due to electrical faults and the propagation of fire through parts of the Electrical Installation. See Clauses 6.1.1(c), 7.2.4, 7.4.5, 7.4.15, 7.5.3, 7.5.4, 8.2.1(g) and 11.2.1.

3.5.11 All Electrical Installations must be inspected and tested at the time of first commissioning and at regular intervals thereafter to ensure ongoing safety, as detailed under Part 8 of these Regulations.

3.5.12 Inspection and testing of Electrical Installations must be carried out by suitably qualified and competent persons with due skill and care to avoid Danger to persons, property and installed equipment.

3.5.13 Additional requirements for safety in special locations are covered in Part 9.

3.6 Labelling and identification

3.6.1 Electrical Installations at the Electricity Intake room must be suitably labelled so as to give information on the electricity supply parameters, the source of supply, location in relation to other Electrical Installations, assets ownership, authorised personnel contact details and any special precautions to be taken. See example in Appendix A12(a).

*[**Note:** special precautions would include information on other sources of electricity such as local generation or interconnection with other Premises.]*

3.6.2 The means of isolation from all sources of electricity must be clearly labelled and accessible to authorised persons, see Regulation 5.6.

3.6.3 The provision of Earth Leakage Protection (as required under Clause 5.3.4) must be clearly indicated at appropriate isolation points, including a notice informing Owners of the need for regular testing of RCD devices, see Appendix A12(c).

3.6.4 Individual Circuits (including neutral and Earth Conductors) must be identified by numbering at the source end and where appropriate, at intervals along the route, see Guidance note G7(f).

3.6.5 For non-domestic Electrical Installations, all Accessories and fittings must be marked with Circuit identification numbers.

*[**Note:** Circuit identification numbers must indicate the Distribution Board from which an Accessory or fitting is supplied, and may be fixed externally or internally, i.e. either outside or inside cover plates.]*

3.6.6 Load distribution schedules, as shown in Appendix A20(e), must be provided at each Distribution Board. An overall wiring diagram showing the Connection Point(s), the location and interconnection of Distribution Boards must be provided at the Electricity Intake.

3.6.7 Where parts of an Electrical Installation are accessible or visible to the general public they must be labelled with a warning: "LIVE – 230/400 VOLTS – DANGER OF DEATH" or similar wording. This warning must be written in English and Arabic, see example in Appendix A12(a).

However, parts of Final Circuits and other points of normal use may be excluded from this requirement.

3.7 Environmental conditions

3.7.1 All parts of an Electrical Installation must be suitably designed, constructed and maintained so as to operate safely and carry out their designed function in the expected operating environment. The following environmental conditions may be used as a guide if no other special factors apply:

(a) maximum ground temperature (at 1m depth): 35˚C;

(b) soil resistivity: according to local conditions;

(c) weather: mainly sunny, occasional fog (causing condensation on outdoor equipment), and occasional sandstorms;

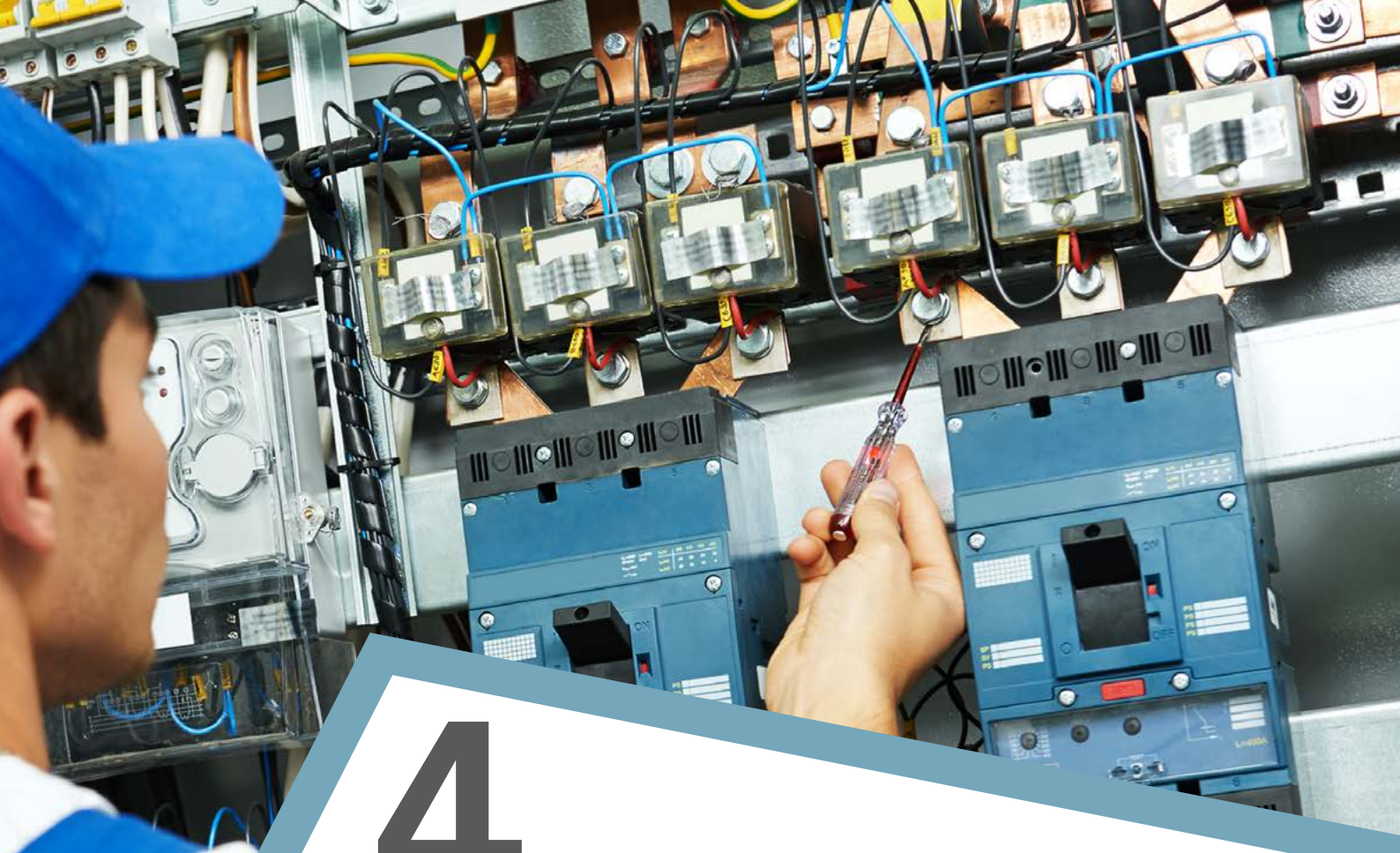
(d) air quality: frequently dusty, corrosive in coastal areas;

(e) maximum humidity: 100%; and

(f) maximum ambient (air) temperatures:

- outdoor (shaded): 50˚C
- outdoor (unshaded): temperature rise due to solar gain must be calculated for the relevant equipment or the maximum 'black bulb' temperature may be used (typically 10˚C above ambient temperature)
- indoor (not air conditioned): 40˚C
- indoor (air conditioned): 30˚C

*[**Note:** in some situations, the ambient temperature for indoor non-air-conditioned situations may reach the outdoor shaded temperature e.g. a small prefabricated building with little ventilation, or a garage which is open to the atmosphere.]*



4.

Electricity parameters and Electricity Intake

4. Electricity parameters and Electricity Intake

4.1 Electricity parameters

4.1.1 The parameters for electricity supplies provided in the Emirate of Abu Dhabi are defined in the Electricity Supply Regulations, issued by the DoE.

Voltage and frequency

4.1.2 The nominal Voltage at LV shall be 230V single-phase or 400V three-phase.

4.1.3 The permissible variation from the nominal Voltage shall be kept within + 10% and - 6%.

4.1.4 The nominal frequency shall be 50Hz.

Harmonics, voltage disturbances and power factor

4.1.5 Electrical Installations and the use of electrical equipment therein, must be designed to avoid the generation of disturbances in the electricity supply voltage. These may include voltage fluctuations, voltage dips, voltage unbalance and harmonics, which are of a magnitude that adversely affects the Customers of the Distribution Company.

4.1.6 The permitted limits of such disturbances are given in the Electricity Distribution Code, Annex

1. Owners will be required to install filters or other equipment to mitigate against such disturbances that are outside the permitted limits (as explained in the Electricity Distribution Code).

4.1.7 The power factor at the Connection Point between the Distribution Company and the Owner's Electrical Installation shall be maintained between 0.9 lagging and unity. Power factor correction equipment must be used where required to achieve this value, see Part 10.

Prospective Fault Current

4.1.8 The maximum three-phase Prospective Fault Current at LV shall be 46kA (1 Sec) at the LV busbar of the Distribution Company's HV/LV substation, or 30kA (1 Sec) at a LV feeder pillar, or 25kA (1 Sec) at a LV service turret or such lower value as otherwise agreed between the Distribution Company and the Owner.

4.2 Electricity Intake

4.2.1 The Electricity Intake must be positioned in a dedicated room or housing and would typically be made from concrete block, brick or similar construction.

*[**Note:** where prefabricated enclosures are used, the enclosures must be verified in accordance with the relevant international standards and be approved by the Distribution Company prior to installation.]*

4.2.2 Other than in exceptional circumstances, and with prior approval from the Distribution Company, there shall be only one Electricity Intake for any Premises.

4.2.3 The Electricity Intake must be positioned in an area which is readily accessible to Distribution Company staff and other authorised persons, particularly in an emergency, and must be at or close to the outside perimeter of a Premises.

4.2.4 The Electricity Intake must not be positioned in an area controlled by one of the tenants in a multi-occupancy building.

4.2.5 Equipment at the Electricity Intake must be located in a safe and accessible position, and kept clear of obstructions at all times.

4.2.6 The use of Electricity Intake rooms as storage rooms for any tools, equipment or other materials is prohibited.

4.2.7 The Electricity Intake must not be located on the reverse side of a bathroom or kitchen wall, or below a bathroom or kitchen. The Electricity Intake must not be located below any water services or pipes, such as mains water supply, drainage systems, storage tanks, air conditioning chillers, or other liquids or hazardous materials.

4.2.8 The Electricity Intake room must be well ventilated, preferably without the need for forced air circulation. Where air conditioning is required in the Electricity Intake room, the requirement for fresh air circulation must also be provided to avoid condensation.

*[**Note:** consideration must be given to the relevant UAE fire code requirements.]*

4.2.9 At least one emergency lighting unit must be fitted in all Electricity Intake rooms, which must be provided with a battery rated for minimum 3 hours' illumination, and subject to adequate routine maintenance.

4.2.10 Doors to Electricity Intake rooms must be arranged to open outwards, be kept free from obstructions, and be capable of being opened from the inside without the use of a key.

4.2.11 The need for delivery of heavy equipment to the Electricity Intake room during construction and for future repair or alterations must be taken into account in the location of the Electricity Intake room.

4.2.12 For Electricity Intake rooms greater than 6 m in length, more than one door shall be provided as a means of emergency access.

4.2.13 Electrical Installation layouts and minimum sizes of the Electricity Intake are given in Appendix A12(b) and A12(d).

4.2.14 For large Electrical Installations, the Electricity Intake may contain one or more LV switchboards, the requirements for which are given in Regulation 7.9.

4.2.15 Where a HV/LV substation is required within the Premises, the design and construction requirements for the substation will be specified by the Distribution Company.

4.3 The Connection Point

4.3.1 Equipment at the Connection Point must be locked or sealed by the Distribution Company to prevent deliberate or accidental interference. Such locks or seals will include those for metering equipment, etc.

4.3.2 The Owners' Main Distribution Board must always include a means of emergency isolation in the case of a fault or breakdown (e.g. main circuit breaker) which is readily accessible and clearly labelled so as to be easily operated by the Owner. Such means of emergency isolation must be left unlocked at all times, except when locked in the open position to allow access to the Electrical Installation (e.g. for maintenance).

4.4 Multiple occupancy Premises

4.4.1 Individual Customers within multiple occupancy Premises may be supplied by the Premises Owner's Electrical Installation consisting of rising and lateral mains (cabling or busbars). Rising and lateral mains will normally be owned and operated by the Premises Owner.

4.4.2 The electricity metering for individual Customers for a rising or lateral mains system will normally be at the point nearest to each Customer, remote from the main Electricity Intake.

4.5 Metering requirements

4.5.1 The requirements for Customer metering are contained in the Customer Metering Regulations, issued by the DoE. Additional detailed requirements and procedures will be provided by the Distribution Company where required.

5.

Protection

5. Protection

5.1 General principles

5.1.1 All Electrical Installations and individual Circuits therein must be designed, constructed and maintained to provide protection against the following:

(a) overload;

(b) short-circuits (phase to phase or phase to Earth); and

(c) electric shock (due to Direct or Indirect Contact with electricity).

5.1.2 Protection against conditions of overload and short-circuit will normally be provided by MCBs, MCCBs or similar devices, see Regulation 5.2 .

5.1.3 Protection of persons against electric shock due to Direct Contact or Indirect Contact must be provided by one of the methods detailed in Regulation 5.3.

*[**Note:** see Guidance note G4(a) and G4(b) for explanation of Direct and Indirect Contact.]*

5.2 Overload and short-circuit protection

5.2.1 All Electrical Installations and individual Circuits therein must be provided with devices that protect against thermal, electromagnetic and other detrimental effects caused by overload and short-circuits. Such devices must be located at suitable sections and Circuits so as to give effective automatic disconnection in such conditions.

5.2.2 The main circuit-breaker at the Connection Point must be of MCCB or ACB type and adequately rated for the maximum Prospective Fault Current.

5.2.3 All Circuits must be individually protected against overloads and short-circuits by suitable devices. Replaceable or re-wireable fuse links are not permitted for this purpose.

5.2.4 The time-current performance characteristics of Protective Devices must conform to the relevant reference standards listed in Appendix A3.

*[**Note:** the time-current performance curves for MCBs are shown in Appendix A6(a) – (d).]*

5.2.5 To ensure protection against overload, Circuit conductors must be sized taking into account the time-current characteristic of the Protective Device.

*[**Note:** see note 2 of Appendix A6(f).]*

5.2.6 Protective Devices at the Main Distribution Board must have a Prospective Fault Current withstand and interruption rating above the maximum Prospective Fault Current declared by the Distribution Company for the relevant Connection Point.

5.2.7 Protective Devices downstream of the Main Distribution Board may have a reduced Prospective Fault Current withstand and interruption rating, taking into account the 'energy let-through' characteristic (I2t) of the upstream Protective Device, see Appendix A6(e). Where appropriate, an allowance may also be made for the attenuation of Prospective Fault Current due to the Circuit impedance.

5.3 Electric shock protection

Direct Contact

5.3.1 Protection of persons against the risk of Direct Contact with electricity must be provided by either physically preventing contact or by an inherently safe systems of supply, using one or more of the following measures:

(a) insulated conductors, see Regulation 5.7;

(b) secure enclosures, barriers or covers on live parts;

(c) Separate Extra-Low Voltage (SELV) system; or

(d) Protective Extra-Low Voltage (PELV) system.

*[**Note:** SELV conductors at voltages of 12V AC or 30V DC may be un-insulated but must be provided with overload and short-circuit protection.]*

5.3.2 Residual Current Devices with a residual current rating of 30mA and complying with BS EN 61008 and BS IEC 1008 may be used as a means of supplementary protection against Direct Contact. However, RCDs may not be used as the sole means of protection against Direct Contact i.e. one of items (a) to (d) above must be used in addition to RCD protection.

*[**Note:** RCD devices with a residual current rating above 30mA are not considered to provide adequate protection against Direct Contact but may be used to provide protection against Indirect Contact – see Regulation 5.4. It should be noted that RCD devices do not protect against electric shock between phase conductors or between phase conductors and neutral.]*

Indirect Contact

5.3.3 Indirect Contact with electricity can occur when a Voltage appears on Earthed parts of an Electrical Installation or Appliance due to the passage of earth fault current and whilst a person is in contact with either:

(a) an Exposed-Conductive-Part and an Extraneous-Conductive-Part; or

(b) an Exposed-Conductive-Part and Earth; or

(c) an Extraneous-Conductive-Part and Earth.

5.3.4 Protection against the risk of electric shock in the above cases must be provided by:

(a) an Earth Leakage Protected System, where RCDs or similar devices are provided at Final Circuits and additional RCDs or other sensitive Earth Leakage Protection is provided at the Electricity Intake, see Regulation 5.4; and

(b) an Earthed Equipotential Bonded System, see Regulation 5.5.

*[**Note:** short-circuit Protection Devices provide the primary means of clearance of earth faults within 0.4 Sec, which will require the Earth Fault Loop Impedance to be sufficiently low for this to occur. ELP devices provide a secondary means of earth fault clearance.]*

5.4 Earth Leakage Protected Systems

5.4.1 An Earth Leakage Protected System (ELPS) is defined as one where protection against Indirect Contact is provided by the use of RCDs or other similar devices on all Final Circuits and ELP is provided at the Electricity Intake. Such a system is required to automatically disconnect the supply at a Final Circuit or at the Electricity Intake sufficiently quickly so as to prevent Danger.

5.4.2 For Final Circuits, ELP devices must be of the RCD type whereby the device will trip if the vector sum of currents carried by the phase and neutral conductors is above a pre-set value, see Guidance note G5(c). Voltage-operated earth leakage devices (ELCB) are not permitted.

5.4.3 RCD devices for Final Circuits must have a time-current performance characteristic complying with BS EN 61008 and BS IEC 1008. This requires that the device must operate within 200 milliseconds at its residual current rating and within 40 milliseconds at 5 times its residual current rating. It must not operate below 50% of its residual current rating, see Guidance note G5(a).

*[**Note:** Earth Leakage Protection Devices provide protection against electric shock by limiting the time that current may pass through the body of a person to Earth; they do not limit the magnitude of current, except by the feature of early cut-off for a rising current. In addition, ELP devices provide protection against 'high resistance' earth faults that may persist in an Electrical Installation if the fault current is too low to operate overcurrent devices such as MCBs. Such faults may cause overheating of Circuits or connections and lead to a fire.]*

5.4.4 For Final Circuits which are liable to carry pulsating or DC currents, RCD devices must be of type A (pulsating DC sensitivity) and for RCD devices requiring time-delayed operation, type S devices must be used, see Guidance note G5(d).

5.4.5 Earth Leakage Protection provided at the Electricity Intake must be set to discriminate with RCDs at Final Circuits (i.e. earth faults on Final Circuits must be automatically disconnected by the closest RCD). See Appendix A5(m) and Guidance note G4(e).

*[**Note:** such discrimination may be provided by time-delayed RCD's, earth fault relays or other suitable devices fitted at each incoming and outgoing Protective Device at the Electricity Intake.]*

5.4.6 The operating current setting for ELP devices at the Electricity Intake must take into account the nature of the Electrical Installation (e.g. commercial, industrial, etc.), the likelihood and magnitude of earth fault currents, and the requirement for protection against Indirect Contact, see Appendix A5(m) and Guidance note G4(f).

*[**Note:** where the Electricity Intake consists of a multi-panel LV switchboard, the incoming and each outgoing Protective Device of the LV switchboard should be fitted with ELP devices in order to limit the extent of power interruptions. These ELP devices should provide full discrimination between the upstream and downstream devices.]*

5.4.7 At each Distribution Board, or other point where a RCD is provided, a suitable label must be affixed to inform the Owner of the characteristics and mode of operation of the device and the need for routine testing, see Appendix A12(c).

5.4.8 For domestic Premises the residual current rating for RCDs must be no greater than 100mA for Final Circuits supplying fixed equipment (e.g. lighting and air conditioning) and no greater than 30mA for Final Circuits where Appliances may be used by persons (e.g. all socket- outlets, all kitchen Appliances, other Appliances accessible to persons), and no greater than 30mA for all Circuits in a bathroom, see Regulation 9.3. A full list of applications and residual current ratings is provided in Appendix A5(m).

5.4.9 Special Circuits within Premises, where there would be significant detriment or Danger from the tripping of the Earth Leakage Protection, may be excluded from the zone of Earth Leakage Protection. Such instances may include Circuits supplying data centres or fire protection equipment or safety alarms (not security alarms) or unoccupied sites (such as telecommunications stations, water pumping stations, etc.). All such cases must be declared in the Electrical Installation Certificate for the site and approved by the Distribution Company. In these cases, the requirements for an Earthed Equipotential Bonded System must be met for the relevant Circuits, see Regulation 5.5.

*[**Note:** Earth leakage alarm must be provided for Circuits which are excluded from the zone of Earth Leakage Protection (e.g. an alarm does not cause tripping of the Circuit but gives an audible and visible warning to appropriate persons in the Premises. This alarm should be transmitted back to the building management system where fitted.]*

5.4.10 Final Circuits with high Earth leakage currents (e.g. electronic equipment or industrial machinery) may be provided with ELP devices with higher residual current ratings, up to 500mA. These must be clearly stated on the Electrical Installation Certificate.

5.4.11 Notwithstanding Clauses 5.4.9 and 5.4.10, all Circuits from which portable Appliances may be used, or any outdoor equipment accessible to persons, must be provided with Earth Leakage Protection devices with a residual current rating no greater than 30mA.

5.5 Earthed Equipotential Bonded Systems

5.5.1 An Earthed Equipotential Bonded System (EEBS) is defined as one where protection against Indirect Contact is provided by the installation of Earthed Equipotential Bonding such that Voltage rises between Exposed-Conductive-Parts and Extraneous-Conductive-Parts are kept to a safe value for the duration of an earth fault (i.e. the time it takes for the relevant Protective Device to trip).

*[**Note:** an EEB system relies on the principle that all Exposed-Conductive-Parts and Extraneous-Conductive-Parts which are accessible to persons are connected to the Main Earth Terminal and therefore the prospective Touch Voltage between them is limited to a value which is safe when taking into account the operating time of the relevant Protective Device. In addition, it is assumed that a person cannot be in contact with Earth whilst touching any Conductive Part in a Premises – see Guidance notes G4(b) and G4(h).]*

5.5.2 For an EEB system, the operating characteristics of Protective Devices must limit the duration of any earth fault to less than 0.4 Sec for all Circuits supplying an Electrical Installation.

5.5.3 The most commonly used method for checking the prospective fault duration is by reference to data on the limiting values of earth fault loop impedance for the Protective Device concerned. For MCBs this is provided in Appendix A5(h), taken from BS 7671.

5.5.4 Main Equipotential Bonding Conductors must be installed from the Main Earth Terminal to connect metallic service pipes and other Extraneous-Conductive-Parts at points closest to the entry of such parts to a Premise. See Guidance notes G4(c).

5.5.5 In high risk areas, Supplementary Equipotential Bonding must be provided so that the Touch Voltage between Exposed-Conductive-Parts and Extraneous-Conductive- Parts is kept to safe limits for the duration of an earth fault.

***[Note:** high risk areas may include bathrooms, kitchens, laboratories, garages, confined spaces or other locations where the normal resistance of the body is reduced or the consequence of an electric shock may lead to another accident, such as fall from a height. For disconnection times greater than 0.4 Sec, safe Touch Voltage limits may be taken as 50V for dry conditions and 25V for wet conditions.]*

5.5.6 The method for calculation of Touch Voltage between Exposed-Conductive-Parts and Extraneous-Conductive- Parts is illustrated in Guidance note G4(h).

5.5.7 Items requiring Equipotential Bonding may include metallic pipes (particularly those connected to underground services such as water supply), steel beams, water tanks, baths, sinks and washbasins. An illustration of typical Equipotential Bonding arrangements is given in Guidance note G4(c).

5.5.8 It is not necessary to provide Equipotential Bonding for standalone metallic items which:

(a) do not pose any risk of providing a conductive path to Earth (are isolated from Earth);

(b) do not pose any risk of providing a conductive path to any other Earthed part of the Electrical Installation;

(c) do not pose any risk of becoming live as a result of an electrical fault in the Electrical Installation (i.e. are sufficiently remote from any Circuit or Appliance); or

(d) are out of reach of any person.

***[Note:** such items may include metal doors, window frames, handrails, inaccessible structural beams, small metallic fixings such as screws and brackets.]*

5.5.9 Where Circuit conductors are installed close to or within items of metalwork (such as mentioned in Clause 5.5.7) consideration must be given to provide additional protection or double insulation of such conductors.

***[Note:** examples include situations where cables pass through walls containing steel frames, metal door frames, metallic floor grids, suspended ceilings, etc.]*

5.5.10 The sizing of Equipotential Bonding Conductors is given in Appendix A5(j).

5.5.11 The point of connection of an Equipotential Bonding Conductor to any item must be labelled: SAFETY EARTH BONDING – DO NOT REMOVE, as illustrated in Appendix A5(d).

***[Note:** Clamps for Earthing and bonding shall be in accordance with BS 951.]*

5.6 Isolation and switching

5.6.1 All Electrical Installations must be provided with a means of safe isolation at the Electricity Intake, which must be lockable or otherwise provided with a means of preventing interference (e.g. by the removal of operating handles into the safe custody of a responsible person).

5.6.2 An Electrical Installation must be further sectionalised by means of isolation at the origin of each Circuit, in order to provide ease of access for safe working.

5.6.3 All mechanical equipment should be provided with a means of isolation close to the equipment which can be locked and kept under the control of the person performing maintenance. This isolation must be effective on all phases and neutral of the supply, must be clearly marked and must be located in an easily accessible position, see Guidance note G9.

5.6.4 Water heaters, air-conditioning units, fan-coil units, motors and other similar items must be provided with double pole isolation (or 4 pole isolation for 3-phase items) to ensure safe access for the purpose of maintenance and repair.

*[**Note:** double-pole isolation may be provided by a plug and socket-outlet arrangement.]*

5.6.5 All socket-outlets, flex outlets or other connection point to an Appliance or other electrical equipment must be provided with a switch as a means of isolation. Such switches must be provided with a neon indicator where it is desirable to have a visual indication of the presence or absence of power (e.g. fridge, gas or smoke alarm, and water heater).

5.6.6 In addition to the above, emergency switching (e.g. push-button switch) must be provided for moving machinery which may require immediate switch off from the supply in the case of an accident or other situation to avoid Danger. Such equipment may include large motors, ventilation equipment, industrial machinery, etc. Emergency push switches, must be clearly marked and must be located in an easily accessible position, see Guidance note G9.

5.6.7 Emergency switches must be designed so that their operation retains the switch in the off position until it is intentionally unlocked or reset. The release of the emergency switch must not automatically restart the related Appliance or machinery.

5.6.8 Functional switching devices required for control or operation of equipment and not for safety reasons need not comply with the requirements of Clauses 5.6.1 to 5.6.7.

5.6.9 Semiconductor devices cannot be used as a means of isolation for safety.

5.7 Insulation

5.7.1 All Electrical Installations must be sufficiently insulated to protect against electric shock from Direct Contact by any person (Clause 5.3.1). Such insulation must be capable of withstanding wear and tear during normal use of the equipment. Supplementary insulation or ‘double insulation’ may be used where additional robustness is required.

5.7.2 The application of paints, resins, varnishes and similar materials is not considered to satisfy the requirements of Clause 5.7.1 and additional insulation, barriers or obstacles are required to prevent Direct Contact by any person.

*[**Note:** an example may be a motor winding which is enamelled or resin coated and therefore must be guarded against Direct Contact by persons.]*

5.7.3 Live conductors are required to be inaccessible without the use of a special key or tool, available only to authorised persons and only for the purpose of testing, using special equipment and procedures.

5.7.4 Uninsulated equipment may be used at voltages not exceeding 12V AC or 30V DC and only where supplied by a SELV source, see Regulation 9.1.

5.7.5 The insulation resistance of Circuit conductors must be measured and recorded as part of the test procedures given in Part 8 and must be greater than the values given in Appendix A 19(f).

5.7.6 Where an Electrical Installation is supplied by underground cables, no special provisions are required for protection against over-voltages arising from atmospheric origin or from switching. Where an Electrical Installation is supplied by overhead lines, advice should be sought from the Distribution Company or the requirements of BS 7671 – Chapter 44 may be used.

6.

Earthing

6. Earthing

6.1 General principles

6.1.1 Earthing of Exposed-Conductive-Parts of an Electrical Installation and of Appliances in a Premises is required and must provide the following functions of safety:

(a) allow the passage of fault current in the event of a live conductor touching an Exposed- Conductive- Part;

(b) ensure that the magnitude of fault current is sufficient to operate Protective Devices within 0.4 Sec for all parts of an Electrical Installation; and

(c) ensure that, in association with Protective Devices, a 'high resistance' fault to Earth does not persist so as to cause overheating or fire.

6.1.2 The necessary requirements to achieve the above functions of safety are detailed in the following sections.

6.2 Systems of Earthing

6.2.1 The following types of system Earthing are considered in these Regulations:

(a) Locally Earthed System (TT): the Owner provides a Main Earth Terminal for the Electrical Installation, which is connected to a sufficient number of local Earth Electrodes to provide a maximum Earth Resistance measured at the Owner's Main Earth Terminal no greater than 10 Ohms (referred to in BS 7671 as a 'TT' system); and

(b) Distribution Company Earthed System (TN-S): the Distribution Company provides a connection to the Owner's Main Earth Terminal, using the distribution network Earthing system, normally via the armouring or metallic sheath of the incoming connection cable (referred to in BS 7671 as a TN-S system). The Distribution Company system is Earthed at the distribution transformer and separate Earth and neutral conductors are used throughout the distribution network.

*[**Note:** these types of Earthing systems are illustrated in Appendix A5(a) – A5(c). Earth Resistance values of less than 10 Ohms may be specified by the designer for purposes such as Functional Earthing or for specialist installations such as petrol stations, telecommunications sites, etc.]*

6.2.2 The Earthing system to be used in Abu Dhabi Emirate is a combination of both TN-S and TT. The use of any other system of Earthing must be approved by the Distribution Company. The type of Earthing system must be stated on the Electrical Installation Certificate and clearly labelled at the Main Distribution Board.

6.2.3 In all cases, the neutral and Earth Conductors must be kept separate and not connected together at the MET or at any other point downstream from the Owner's Connection Point.

6.3 Main Earth Terminal

6.3.1 The Owner's Electrical Installation must include a Main Earth Terminal located close to or within the Main Distribution Board and must be clearly labelled.

6.3.2 The Locally Earthed System (TT) and the Distribution Company Earthed System (TN-S) shall be connected to the MET.

6.3.3 A means of removing the connection to the Locally Earthed System (TT) and the connection to the Distribution Company's Earthed System (TN-S) (such as by a removable metal link) must be provided at the Main Earth Terminal to facilitate testing of the Earthing conductivity within the Electrical Installation and the Locally Earthed System (TT), see Appendix A5(e).

6.3.4 The Earth Resistance of the Locally Earthed System (TT) measured at the MET must be recorded on the Electrical Installation Certificate in accordance with the procedures described in Part 8. Methods of measuring Earth Resistance are shown in Appendix A 19(a).

6.4 Earth Electrodes

6.4.1 A Locally Earthed System (TT) must be provided at all Premises.

6.4.2 For Premises consisting of more than one building, a Locally Earthed System (TT) must be provided at each building that is at a distance of more than 30m from the Electricity Intake.

6.4.3 Earth Electrodes will normally comprise of 15mm diameter steel-cored copper rods driven to a minimum depth of 3m. The top of each Earth Electrode must be housed inside a 300mm x 300mm x 300mm inspection pit, which is clearly labelled and accessible for routine testing, see Appendix A5(d). Alternative types of Earth Electrodes may be used with prior approval of the Distribution Company (e.g. plate or wire mesh type, or structural steelwork in a building).

6.4.4 Where more than one Earth Electrode is required to achieve the required Earth 6.4.4 Resistance value, these must be separated at a distance greater than their mutual resistance zone

*[**Note:** a minimum separation of twice the Earth Electrode depth is considered to give adequate separation of the mutual resistance zones. See BS 7430 for further advice on spacing of Earth Electrodes.]*

6.4.5 The condition of the ground in which an Earth Electrode is placed must be taken into account to ensure its long-term performance. In particular, potential corrosion effects and ground moisture content is of critical importance. Proprietary chemical or salt materials may be used around the Earth Electrode to maintain moisture content but these must be stable and sustain their chemical properties over time.

*[**Note:** consideration to be given to the use of stainless steel rods in coastal regions.]*

6.4.6 For supplies of 500A rating and above, at least two independent Earth Electrodes must be provided, regardless of the Earth Resistance value achieved for each Earth Electrode, and connected to the same Main Earth Terminal, see Appendix A5(k).

6.4.7 Metallic service pipes (such as water, gas, etc.) must not be used as Earth Electrodes.

6.4.8 The use of structural foundations or piles as an Earth Electrode shall be in accordance with the requirement of BS 7430 and be subjected to all of the following conditions:

(a) adequate precautions against the possibility of electrolysis and consequential degradation of the metal (e.g. corrosion, continuous DC earth leakage current);

(b) electrical continuity between all metalwork forming part of the Earth Electrode is maintained (e.g. welding, clamping or bonding links across structural joints);

(c) provision for measuring and monitoring the Earth Resistance value at regular intervals;

(d) prior approval of the design by the Distribution Company;

(e) the consent of the Owner of the Premises; and

(f) the consent of the Premises structural engineer.

6.5 Earth Conductors

6.5.1 In these Regulations the following terminology is used to refer to Earth Conductors in an Electrical Installation, see illustration in Appendix A5(f):

(a) Main Earth Conductors (MEC): conductors connected between Earth Electrodes and Main Earth Terminals; and

(b) Circuit Earth Conductors (CEC): conductors connecting all Circuits emanating from Main Distribution Boards, Sub Main Distribution Boards, Final Distribution Boards including Circuits connecting to equipment and Appliances. Outside these Regulations, these may also be known as the Circuit Protective Conductor (CPC) or Earth Continuity Conductor (ECC).

6.5.2 All Earth Conductors must be covered with green/ yellow PVC insulation and be securely terminated with purpose- made lugs or fixings.

6.5.3 Where associated with Circuits, all Earth Conductors must be labelled at their termination points with Circuit identification numbers, see Guidance note G7(f).

6.5.4 The connection of Earth Conductors to Earth Electrodes must be made using corrosion resistant clamps.

6.5.5 Where Earth Conductors are buried below ground they must be mechanically protected (e.g. in metal duct or pipe) and, where necessary, with additional tiles or plates laid above the duct or pipe, see Appendix A5(d) and Guidance note G6.

6.5.6 The connection of Earth Conductors to the Main Earth Terminal must be made using purpose- made lugs or other fixings and the connection must be clearly labelled as shown in Appendix A5(d).

6.5.7 All Circuits must have a Circuit Earth Conductor sized in accordance with Appendix A5(j).

6.5.8 Circuit Earth Conductors must run alongside the associated phase and neutral conductors.

*[**Note:** this minimises the risk of a Circuit Earth Conductor being damaged or disconnected without any damage or fault indication being detected via the phase conductors.]*

6.5.9 For metal-sheathed or armoured cables, the sheath or armouring shall not be used as the Earth Conductor. However, the metal sheath or armouring shall be terminated by suitable cable glands with appropriate connection to an Earth Conductor providing a supplementary return path, see Guidance note G7(i).

6.5.10 The use of metal conduit, trunking, busbar trunking or switchgear metal enclosures as Earth Conductors is not permitted without the prior approval of the Distribution Company. In such cases, the provision of additional measures such as resistance measurements or supplementary Earth Conductors will normally be required.

*[**Note:** metal conduit, although not to be used as an Earth Conductor, must nevertheless be effectively connected to Earth since it comprises an Exposed-Conductive-Part. See Guidance note G7(j).]*

6.5.11 No switches, isolators or circuit breakers may be installed in the electrical path of any Earth Conductor. Removable links may be installed to allow testing at the Main Earth Terminal.

6.6 Exposed-Conductive-Parts

6.6.1 All Exposed-Conductive-Parts of an Electrical Installation, including Appliances, must be connected to Earth via Earth Conductors in accordance with the requirements of Regulation 6.5.

6.6.2 Exceptions to Clause 6.6.1 may include internal parts of equipment or Appliances, which cannot be accessed without first disconnecting the electricity supply.

6.6.3 Class I Appliances having Exposed-Conductive-Parts must be provided with a suitable connection point or plug and socket arrangement that includes connection to the Circuit Earth Conductor. Class II Appliances do not require an Earth connection; see illustrations in Appendix A18(a) and A18(b).

6.6.4 All connection points in an Electrical Installation must include an Earth Conductor for future use.

*[**Note:** an example would be a plastic light switch which does not require a Circuit Earth Conductor but one must be provided in any case for the protection of the Circuit and future use – see Guidance note G7(d).]*

6.6.5 Items within an Electrical Installation where it is mandatory for a connection to be made to an Earth Conductor are listed in Appendix A5(l).

6.7 Earth Faults Loop Impedance

6.7.1 The Earth Fault Loop Impedance (Zs) is defined as the total impedance presented to an earth fault current, comprising the impedance of the following parts of a system, illustrated in Appendix A5(g):

(a) the Circuit Earth Conductor (including the Appliance Earth Conductor);

(b) the Main Earth Terminal;

(c) the Main Earth Conductors connecting to local Earth Electrodes (TT system) and the Distribution Company Earth (TN-S system);

(d) the path of earth fault current through the general mass of Earth, and through the Earth sheath or armouring of the Distribution Company cable;

(e) in the case of a Locally Earthed System (TT system), the neutral Earth connection at the Distribution Company transformer;

(f) the distribution transformer winding; and

(g) the phase conductors of the Circuit back to the point of fault.

6.7.2 All Electrical Installations must be designed and tested such that the Earth Fault Loop Impedance at any point in the Electrical Installation is of a sufficient value to operate Protective Devices within 0.4 Sec.

*[**Note:** this requirement is important for parts of Electrical Installations where protection against Indirect Contact is provided by Earthed Equipotential Bonding, see Regulation 5.5.]*

6.7.3 The maximum Earth Fault Loop Impedance values required to meet the disconnection times in Clause 6.7.2 for MCB devices are given in Appendix A5(h).

6.7.4 The method for testing Earth Fault Loop Impedance (including the external Earth Fault Loop Impedance) is given in Appendix A19(b) and A19(c).

6.8 Lightning protection

6.8.1 Lightning protection systems must be designed, constructed and maintained in accordance with BS EN 62305.

6.8.2 Where practicable, a minimum distance of 7 m must be provided between lightning protection Earth Electrodes and the Electrical Installation Earth Electrodes.

6.8.3 Surge protective devices must be used at the Connection Point for Premises with a lightning protection system. These shall be installed typically at the Main Distribution Board. See Guidance note G10.

*[**Note:** a risk assessment evaluating the full requirements of lightning protection systems including the impact on electrical and electronic systems (e.g. surge protective devices) is to be carried out by the designer of the Electrical Installation.]*

6.8.4 The use of structural steel in place of, or in connection with, lightning down conductors is not permitted unless approved by the Distribution Company. Where such approval is given, provision must be made for regular testing of the structural Earth system from roof level to ground (e.g. via a separate test cable installed through the building). Structural foundations or piles may be used as lightning Earth Electrodes if sufficiently separated from the Main Earth Electrodes and where inspection/ testing points are provided for future maintenance. See Guidance note G10.

6.9 Functional Earthing and high leakage currents

6.9.1 Functional Earth Conductors may be required for purposes such as, but not limited to, radio frequency noise reduction, filters for computers and other equipment with high earth leakage currents.

6.9.2 Functional Earth Conductors must be separate from other parts of the Electrical Installation Earthing system, except at their connection to the Electrical Installation Earth via terminals at Main Distribution Board or Sub Main Distribution Board or Final Distribution Board where a suitable label must be provided, see Appendix A5(f).

6.9.3 Equipment which produces high earth leakage currents (above 10mA) may be provided with a Functional Earth and in any case must be provided with duplicate Circuit Earth Conductors to the Main Earth Terminal. Such equipment must remain connected to Earth at all times to avoid the risk of electric shock from Exposed-Conductive- Parts of the equipment.

*[**Note:** metallic conduit may be considered as one of the duplicate Earth Conductors required for high leakage equipment. Alternatively, Circuit Earth Conductors in a Ring Circuit are also accepted as providing a duplicate Earth path. This requirement safeguards against electric shock due to Indirect Contact if only one Circuit Earth was provided and was damaged or broken.]*

7.

Selection of components and installation requirements

7. Selection of components and installation requirements

7.1 Plugs, socket-outlets and flex outlets

7.1.1 For domestic Electrical Installations, all single-phase plugs and socket-outlets must comply with BS 1363 and be fitted with a switch. The use of any other type of single-phase plugs and sockets-outlets, such as BS 546 (3 round pins) is not permitted.

*[**Note:** BS 1363 requires plugs to have partly insulated live and neutral pins and include a fuse complying with BS 1362. Socket- outlets are required to have tamper-proof shutters on the live, neutral and Earth connections.]*

7.1.2 For single-phase applications in non-domestic Electrical Installations either BS 1363 or BS 546 type plugs and socket-outlets are permitted. However, BS 546 plugs and socket-outlets must be restricted to specialist applications such as high load Appliances (BS 546 15A plug) or where it is desirable not to intermix certain Appliances, see Appendix A17(a).

*[**Note:** examples of the use of BS 546 plugs include table lamps in hotel rooms which are switched from a dedicated lighting Circuit (3A or 5A) or self-contained air-conditioning units (15A). In the latter case, 15A BS 546 socket-outlets must be supplied from a dedicated Radial Circuit.]*

7.1.3 The use of 'Shuko' CEE7/7 2-pin type plugs is strictly prohibited. The use of 'Euro' CEE7/16 plugs is permitted only where used with an approved adaptor converting such plugs for use on BS 1363 type socket-outlets, see Appendix A17(a).

*[**Note:** adaptors must be certified by a recognised approvals authority.]*

7.1.4 An allowable exception to Clause 7.1.1 is the use of shaver supply units in bathrooms, complying with BS EN 61558-2-5. For these types of socket-outlet, which are supplied by a safety isolating transformer, 2-pin unearthed type plugs may be used. See Appendix A17(c).

7.1.5 No socket-outlets shall be installed in a bathroom except for a socket-outlet complying with BS EN 61558-2-5 (shaver socket-outlet including a safety isolating transformer).

7.1.6 Three-phase and industrial plugs and socket-outlets must comply with BS EN 60309, see Appendix A17(b). The rating of three-phase socket-outlets must be selected according to the load of the Appliance or equipment to be connected.

*[**Note:** BS EN 60309 plugs and socket-outlets are not fused and are not shuttered and therefore must not be used in any domestic application.]*

7.1.7 Socket-outlets for normal use must be positioned at a standard height of 300mm or 450mm above floor level or 100mm above work surfaces, see Appendix A16. Where required, low level or skirting height may be used (e.g. in offices) at a minimum of 100mm above the floor level, and where adequate precautions are taken against damage. Access for limited ability persons must be given due consideration in such cases (e.g. alternative socket-outlets provided).

7.1.8 Floor socket-outlets may be used where there is no undue risk of water ingress or flooding and which are designed to relevant international standards.

7.1.9 Socket-outlets in kitchens must be positioned at least 1m away from sources of water (e.g. sinks, basins, filter units, supply taps).

7.1.10 The minimum number of socket-outlets for domestic Electrical Installations is given in Appendix A15.

7.1.11 All socket-outlets in one room or service area shall be connected to the same phase.

7.1.12 The maximum number of single-phase socket-outlets on each Ring or Radial Circuit shall be determined according to the anticipated load and usage of Appliances. The assumed loads given in Guidance note G2 may be used in the absence of other loading information.

7.1.13 Three-phase socket-outlets must be connected on individual Radial Circuits.

7.1.14 For outdoor, damp or wet areas (e.g. water pump rooms, outdoor water coolers and drinking fountains) socket- outlets must be of the weather protected type (IP55) and incorporate a 30mA RCD, see Guidance note G7(c).

*[**Note:** where a number of outdoor socket-outlets are installed in close proximity, the above requirement may be met by one RCD device serving the group of outlets, provided that the RCD device is readily accessible and visible to persons using the socket- outlets and is clearly labelled.]*

7.1.15 Flex-outlets (with switch and fuse) complying with BS 1363 may be used in place of socket- outlets for fixed Appliances, see Guidance note G7(m).

7.2 Switches and isolators

7.2.1 All switches provided for local isolation of Appliances and equipment (including lighting) must comply with BS EN 60669. The rating of switches must be selected based on the expected load, taking into account any capacitive or inductive effects.

7.2.2 For outdoor locations, damp or wet areas, weather-protected switches must be used (BS EN 60669).

7.2.3 Wall-mounted switches must not be installed in bathrooms, shower rooms or other locations where normal body resistance is reduced due to the presence of water. In such locations, ceiling mounted cord-pull switches may be used or wall-mounted switches may be used outside the room. Wall-mounted switches may be used in kitchens but at least 2m from a sink or other source of water.

7.2.4 For areas with higher-than-normal risk of fire or explosion, gas-sealed switches must be used (BS EN 60079). For example, in gas storage areas, battery rooms, etc.

7.2.5 The normal mounting height for switches shall be 1.3m from floor level. Other mounting heights may be used where there is a specific need, such as, but not limited to, the prevention of access by children or the requirement for access by disabled persons.

7.2.6 Switches with neon indicators must be provided for Appliances such as water heaters, air conditioning units, cookers, fridges and freezers, where a visual indication of the presence of power is desirable.

7.2.7 Double-pole switches must be provided for water heaters, air-conditioning units and other fixed Appliances operating with or near water supplies.

7.2.8 Cooker control units (isolators) for domestic Electrical Installations must comply with BS 4177. The use of cooker control units with an integral 3-pin socket-outlet is prohibited except where the Final Circuit supplying the cooker control unit is protected by a RCD with a residual current rating of 30mA, in accordance with Clause 5.4.8.

*[**Note:** in addition to the above restriction, it is considered undesirable to use cooker control units with integral socket- outlets where there is a risk of Appliances or flexible cables supplied by the socket-outlet being damaged by heat from the cooker.]*

7.2.9 Flexible cables from switches or isolators to fixed Appliances (such as water heaters, cookers, etc.) must be adequately rated and securely fixed with a purpose-made flex outlet plate (which may be integral with or separate from the switch or isolator unit), see Guidance note G7(m).

7.3 Lighting

7.3.1 Lighting Circuits will normally be fed from 6A, 10A or 16A MCBs from a Final Distribution Board.

7.3.2 The rating of lighting Circuits shall be selected in accordance with the number of connection points to be supplied, the type and rating of Luminaires to be used and the Connected Load for the Circuit. A standard method of calculating Connected Load is given in Guidance note G2.

7.3.3 Lighting Circuits supplying small Edison screw (SES) or small bayonet cap (SBC) fittings must be supplied from Protective Devices of nominal current rating no greater than 6A.

*[**Note:** where these lamps are used in high numbers, e.g. in chandeliers, the Protective Device current rating may be greater than 6A.]*

7.3.4 Switching of Circuits containing discharge lighting or other lighting with high inductance may require special consideration due to high switching voltages that may occur. In order to accommodate the switching voltage in discharge lighting Circuits, the rating of the switch shall be suited to the conditions expected and shall not be less than twice the load current.

7.3.5 The design and construction of lighting signs used for publicity, decorative and general purposes (such as neon signs) must comply with BS 559. High voltage discharge lighting is to be provided with an emergency isolation switch which must be clearly marked and located in an easily accessible position.

*[**Note:** such switches may be marked "Fireman's Switch for Neon Sign" or similar wording.]*

7.3.6 The connection of mains-operated clocks to lighting Circuits other than through a clock connector unit is prohibited.

7.3.7 All Luminaires must be connected to Final Circuits using a ceiling rose or other purpose made connection point and not directly to such Circuits. Where cables are run within Luminaires, they shall be of the heat resistant type, or protected by heat resistant sleeving. See Guidance notes G7(b) and G8.

7.3.8 Lighting Circuits in false ceilings or voids must be installed in conduits or trunking in compliance with Clauses 7.5.12 and 7.5.13. However, short lengths (less than 3m) of flexible or insulated and sheathed cables may be provided between a lighting connection point or ceiling rose and a Luminaire, provided that provision is made for future access and maintenance. In addition, the use of purpose made plug and socket connection systems for Luminaires is not precluded, provided that approval is sought from the Distribution Company. See Guidance notes G7(h) and G8.

7.3.9 Luminaires and other light fittings must be installed with due consideration to the weight taken by fixings and supports, and the need for adequate ventilation and heat dissipation.

7.3.10 Heat resistant cables and flexible cords should be used for the connection of high temperature Luminaires. See Guidance notes G7(b) and G8.

7.3.11 Where light switch boxes contain more than one phase (for large groups of lighting), they must be labelled to indicate. The presence of a 400V supply, and suitable phase barriers should be provided inside the box.

7.3.12 Outdoor lighting should be of suitable weatherproof construction with appropriate connection points and fittings, see also Regulation 9 and Guidance notes G8.

7.3.13 Underwater lighting must be supplied by a Separated Extra-Low Voltage System (SELV) not exceeding 12V AC or 30V DC

7.3.14 Emergency light fittings must comply with BS 5266 and shall be provided with a battery of minimum 3 hours rating.

7.4 Conduit, trunking and Cable Trays

7.4.1 All plastic conduits and trunking must comply with BS 4607 and be suitable for the ambient conditions expected.

7.4.2 All metal conduits and trunking must comply with either BS 4568, BS EN 60423 or BS EN 61386-21. Cable Tray must comply with BS EN 61537.

7.4.3 Flexible conduits must be of metal construction, PVC covered and comply with BS EN 61386 -23. Flexible conduit may be of plastic construction only in indoor locations, where damage is unlikely.

7.4.4 Metal conduits, trunking or Cable Tray may not, on their own, be used as Circuit Earth Conductors; separate Circuit Earth Conductors must be run inside the conduits, trunking or Cable Tray, see also Clause 6.5.10. This does not obviate the requirement to comply with Clause 6.6.1 (i.e. metal conduits are required to be Earthed), see Guidance note G7(j).

7.4.5 Plastic conduits or trunking must not be used in situations subject to higher than normal temperatures or fire risk (e.g. near industrial machinery, generator rooms, workshops, petrol stations, plant rooms, etc.). Where a plastic conduit is installed outdoors, it should be suitable for exposure to solar radiation.

7.4.6 Where a plastic conduit is installed within a wall, floor or ceiling it must be at a minimum depth of 50mm from the surface. If it is installed at a shallower depth not less than 25mm from the surface, then a metal conduit must be used, and the Circuits contained in the conduit must be protected by a 30mA RCD. See Guidance note G7(e).

7.4.7 Conduits, trunking and Cable Tray must be installed so as to provide ease of access to cable Circuits throughout the route. Sufficient inspection plates and pulling points must be provided to enable inspection, repair and drawing out of cables throughout the life of the Electrical Installation.

7.4.8 The ends of conduits, trunking and Cable Tray shall be provided with bushes or other finished ends such that cables do not sustain damage during installation or throughout the life of the Electrical Installation, and must be suitably sealed against the ingress of water. Where such bushes or ends are not provided, any sharp angles, burrs or projections must be removed. All exposed steel edges and threads should be painted with zinc-rich paint, see Guidance note G7(g). Care must be taken not to leave sections of cable exposed at the ends of conduits or trunking. See Guidance note G7(a).

7.4.9 Plastic conduit boxes for Accessories shall be provided with copper or brass Earth terminals. See Guidance note G7(d).

7.4.10 Single-insulated cables may not be installed in slotted (perforated) trunking or Cable Trays.

7.4.11 The minimum internal radius of any bend or elbow fitting in a conduit shall be 2.5 times the diameter of the conduit.

7.4.12 Elbow fittings of trunking may be in a 90º formation only where the cover is removable so that cables may be installed without the need for pulling through.

7.4.13 Conduit shall be installed with a maximum of two 90º bends or three 120º bends between inspection or pulling points.

7.4.14 Cable Trunking and Cable Tray shall be run exposed or otherwise accessible after installation, throughout its length, for the purpose of removing or installing cables.

7.4.15 Where Cable Trunking or a Cable Tray passes through walls, floors or other barriers, it shall be provided with a continuous cover and an internal fire barrier where fire separation is specified for the Premises. See Guidance note G3(a).

7.4.16 Where trunking or Cable Tray is used for the combined provision of power, telecommunications and other Circuits, adequate segregation must be provided, together with suitably sealed service boxes and connection boxes.

7.4.17 Category 3 Circuits (fire and emergency lighting) may not be installed in the same conduit or trunking as Category 1 (mains supplied) Circuits or Category 2 (telecommunications) Circuits unless suitable segregation is provided.

7.4.18 Category 1 and Category 2 Circuits may only be installed in the same conduit or trunking if the latter is insulated to the level of Category 1 Circuits.

*[**Note:** trunking or conduit referred to in Clauses 7.4.17 and 7.4.18 may be metallic or non-metallic.]*

7.4.19 Under floor Cable Trunking shall be used only in areas which are not susceptible to water ingress or flooding. Suitable junction boxes, flush service boxes and inspection compartments shall be provided according to the design of the under-floor trunking system.

7.4.20 The maximum number of cables for typical sizes of conduits and trunking are given in Appendix A9.

*[**Note:** the use of different Final Circuits in a common conduit or switch drops in shared conduits are not permitted]*

7.4.21 Where a conduit or trunking is installed on the Distribution Company's side of the Connection Point, these must be provided with a means of locking or sealing against unauthorised interference.

7.5 Cables

7.5.1 For fixed wiring within Premises, PVC, rubber or XLPE insulated cables with stranded copper conductors must be used, complying with the reference standards given in Appendix A3. Solid- core copper or aluminium conductor cables are not permitted.

7.5.2 For locations subject to a higher than normal risk of interference or damage, armoured cables are recommended.

7.5.3 For locations with higher than normal fire risk, either cables must be installed in metal conduit or mineral-insulated- copper-clad (MICC) complying with BS EN 60702 or enhanced fire- resistance cables must be used. In addition, safety Circuits such as fire alarms, emergency lighting and control Circuits, which are required to remain operational in the event of a fire, must be installed in metal conduits or supplied by MICC cables.

*[**Note:** enhanced fire-resistance cables should meet the PH 120 classification when tested in accordance with BS EN 50200 and the 120 minutes survival time when tested in accordance with BS 8434-2.]*

7.5.4 The location and selection of cables must take into consideration any special requirements for the prevention of spread of fire. Fire barriers, low smoke insulation or other measures may be required (relevant building regulations should be referenced).

7.5.5 General-purpose flexible cables and cords for Appliances must be PVC insulated, with a PVC over sheath, stranded copper conductors, and comply with BS EN 50525.

7.5.6 Cables for high-temperature Appliances (e.g. electric heaters, irons, pendant lighting, connections within Luminaires) must be heat resistant rubber or PVC insulated, with over sheath, stranded copper conductors, and comply with BS EN 50525.

7.5.7 Cables under repetitive mechanical strain (e.g. lifts, heavy outdoor machinery, etc.) must comply with BS EN 50214.

7.5.8 Where cables are installed underground, they must be installed so as to protect against mechanical damage and enable future removal, see Guidance note G6.

7.5.9 Cables for meter tails (at 230V) shall be single-core, PVC insulated, with over sheath, and comply with BS EN 50525.

7.5.10 The cross-section of cables must be selected according to the expected load, voltage drop, ambient temperature and installation conditions using Appendix A7(a) - A7(h) including appropriate grouping factors. The maximum Voltage drop from the Connection Point to the remote end of any Final Circuit must not exceed 4%, except in special cases where equipment has been designed to operate under a greater voltage drop (such cases must be clearly stated in the Electrical Installation design and approved by the Distribution Company).

*[**Note:** the sizing of Final Circuits and Circuits feeding FDBs must be in accordance with the Connected Load. Other Circuits may be sized in accordance with the Diversified Load, with allowance made for future load growth where appropriate. See Clause 7.6.1, 7.7.7 and Guidance note G2.]*

7.5.11 The use of single-core armoured cables should be avoided due to the possibility of induced heating effects. However, such cables may be used where there is an exceptional need, with the written consent of the Distribution Company and where adequate precautions are taken to avoid induced heating effects. Such precautions must include the appropriate configuration of phases to balance induced currents, Earthing at one end only and the use of non- ferromagnetic armouring, cable glands, and switchgear gland plates, see Guidance note G7(l).

7.5.12 Other than as allowed under Clause 7.5.15, all cables that are not armoured or that do not have a metallic sheath or screen, must be installed in plastic or metal conduits or trunking throughout their entire length.

7.5.13 Cables running through inaccessible areas such as walls, floors and solid ceilings shall be installed, without exception, in conduits or trunking so as to be withdrawable in the future. In such cases, suitable inspection plates and pulling out points must be provided.

7.5.14 Non-sheathed cables must not be installed in concrete ducts.

7.5.15 Exceptions to Clause 7.5.12 may be allowed only for insulated and sheathed or flexible cables which will remain accessible but in locations free from undue risk of damage or interference (e.g. above-head height, or in unoccupied areas). Such cables must be securely supported by cable clips, Cable Tray or other fixings at suitable intervals.

*[**Note:** although flexible cords must not be used as fixed wiring, this Clause covers Appliance connection cables which should be limited to 3m in length where practicable. In addition, proprietary plug and fit connection systems may be installed from a suitable connection point in the fixed wiring system, provided they are suitably supported, mechanically protected, or otherwise located in areas where there is minimal risk of damage or interference. See Guidance note G7(h).]*

7.5.16 All cables must be installed between purpose-made termination points (switches, junction boxes, Distribution Boards) and be terminated with purpose-made lugs, crimps, screw or other connectors. Joints between such points are strictly prohibited. Termination points and junction boxes must remain accessible to facilitate future inspection, repair and alteration. See Guidance note G7(k).

*[**Note:** terminations for MICC cables must be suitably sealed against the ingress of moisture.]*

7.5.17 Where cables are terminated at high-temperature Appliances, their insulation must be suitable for the expected operating temperature or, where necessary, shall be protected by heat- resistant material. See Guidance notes G7(b) and G8.

7.5.18 Armoured cables must be terminated using suitable cable glands which incorporate a suitably rated Earth tag or other purpose-made connection to the armouring of the cable and to the metallic sheath if present. See Guidance note G7(i).

7.5.19 Cables must not be installed in lift shafts other than those serving lift functions.

*[**Note:** although a lift shaft may be a convenient means of providing a cable route through a building this creates unwarranted risk when accessing such Circuits for maintenance and also provides a vulnerable route for the propagation of fire.]*

7.5.20 The colour identification for cables is given in Appendix A8.

*[**Note:** although the identification colours for cables has recently been changed in European countries, a similar change is not currently proposed for Abu Dhabi Emirate. For fixed wiring in an Electrical Installation, the phase colours remain as red, yellow and blue whilst neutral remains as black. However, for flexible sheathed cables supplying single-phase Appliances, brown is used for Phase, blue is used for Neutral and green/yellow is used for Earth – see Appendix A8.]*

7.6 Final Circuits

7.6.1 The sizing of Final Circuits must be in accordance with the Connected Load on each Circuit (see Guidance note G2), whilst taking account of ambient temperature, grouping factors, power factor and voltage drop, see Appendices A7(a) - A7(h).

7.6.2 Radial Circuits should be provided to large Appliances, particularly those in continuous or near continuous operation, or those of importance for safety or other priority functions within a Premises. Examples include main water pumps, air conditioning units, water heaters, room heating, fire or intruder alarms, cookers and ovens.

7.6.3 Ring Circuits should be provided to areas within Premises, which can be most economically served by several Appliances sharing the same cable feed, arranged in a loop, from one circuit breaker on the Final Distribution Board. This is particularly suitable where Appliances are expected to operate at diverse times of the day. Ring Circuits would typically be installed in bedrooms, living rooms, kitchens (except major Appliances such as cookers), partitioned office areas, etc.

7.6.4 The number of Radial Circuits and Ring Circuits installed in Premises shall take into consideration future accessibility, maintainability, and safety of the system, whilst limiting the extent of power outage to serviced areas.

7.6.5 Circuits supplying a kitchen must not be used to supply any other area. However, ceiling lighting Circuits from a kitchen may be common to other areas.

7.6.6 For domestic Premises, all Circuits supplying one room must be on the same phase, other than for kitchens and for ceiling lighting.

7.6.7 Typical layout for small power and lighting Circuits for domestic Premises are shown in Appendix A14.

7.7 Busways, bus ducts and busbar risers

7.7.1 Busways, bus ducts, busbar risers or other similar systems may be used in Premises for the supply of large loads where they provide a more economical or practical option than cables.

7.7.2 Busways, bus ducts and busbar risers shall comply with the relevant reference standards given in Appendix A3.

7.7.3 Busways, bus ducts and busbar risers shall be totally enclosed (non-perforated) for protection against mechanical damage, moisture, dust and other environmental effects.

7.7.4 Busways, bus ducts and busbar risers shall not be located in areas prone to mechanical damage or where they may be exposed to hazardous materials, liquids or gases, unless special precautions are taken.

7.7.5 Busways, bus ducts and busbar risers shall be located so that they are accessible for future maintenance and repair throughout their length. They shall not be installed in habitable areas such as flats, offices, shops, etc. (a separate riser shaft or room must be provided).

7.7.6 Busways, bus ducts and busbar risers shall have neutral conductors of equal size to the phase conductors and shall have a dedicated Earth Conductor. The use of the metal casing as an Earth Conductor is permitted only with the prior approval of the Distribution Company.

*[**Note:** aluminium metal casings should be used in preference to steel due to the risk of corrosion and high resistance joints. In either case, the sizing of such conductors must meet the values equivalent to copper conductors given in Appendix A5(j).]*

7.7.7 The current rating of busways, bus ducts and busbar risers shall be based on the Diversified Load of the relevant part of the Electrical Installation being supplied, with allowance made for future load growth where appropriate. Diversity factors must be justified and submitted with the design for approval by the Distribution Company, see Regulation 3.2 and Guidance note G2.

7.7.8 Purpose made plug-in circuit breaker units may be used with busbar risers' systems where they are mechanically interlocked to prevent removal whilst energised. See Guidance note G3(a).

7.7.9 The number of busways, bus ducts or busbar risers required for a high-rise building and the number of floors served by each must be selected by taking due account of the future accessibility, maintainability and safety of the system, whilst limiting the extent of power outage to serviced areas.

*[**Note:** a typical arrangement may be to serve each 10 floors of a 30 storey building by a separate bus riser; however, other arrangements are not precluded.]*

7.8 Distribution Boards

7.8.1 All Distribution Boards must be factory assembled, type- tested and comply with BS EN 61439.

7.8.2 Distribution Boards must be of robust construction, capable of withstanding expected electrical, thermal, and environmental stresses in normal service and during faults.

*[**Note:** Final Distribution Boards, including the incoming cable, will normally be sized in accordance with the Connected Load of the Circuits supplied; other Distribution Boards and Distribution Circuits may be sized in accordance with the Diversified Load, using appropriate diversity factors, and with allowance made for future load growth where appropriate - see Guidance note G2.]*

7.8.3 Apparatus forming part of the assembly of Distribution Boards shall have electrical isolation clearances sufficient to withstand normal Voltages, surge Voltages and creepages as defined in BS EN 61439-1.

7.8.4 Each Distribution Board must have a neutral bar which is mounted on insulators and which has a sufficient number of terminal points of adequate size for the largest cable expected to be used.

7.8.5 Each Distribution Board must have an Earth bar which has a means of connection to the incoming Earth Conductor and cable gland of the incoming cable, see Appendices A5(e) and A12(c).

7.8.6 All Final Distribution Boards must be arranged so as to provide for at least two zones of Earth Leakage Protection (e.g. 100mA and 30mA or 30mA and 30mA) and to avoid complete disconnection of power to the area being served, in the event of an earth fault. This may be achieved by either of the following methods:

(a) two or more busbar sections, each protected by a RCD;

*[**Note:** it is recommended that no more than 9 single phase Circuits are protected by an individual RCD.]*

(b) one busbar section, with individual RCBOs fitted on all Final Circuits (the incomer device may be a time-delayed RCD or an isolator switch where adequate fault protection is provided by an upstream Protective Device); or

(c) two or more FDBs installed together to serve an area, each having one busbar section protected by a RCD of appropriate rating (e.g. one DB with an incomer 100mA or 30mA RCD for lighting and another DB with incomer 30mA RCD for power Circuits).

*[**Note:** either solid busbar or removable ('comb') busbar DB's are acceptable (horizontal or vertical type) if factory assembled and where the manufacturer's type tests are provided. Single phase DBs up to 12 ways, serving a limited area, may be provided with one busbar section, and one incomer RCD of appropriate rating, e.g. hotel rooms, pump room, central air-conditioning room, etc.]*

7.8.7 Other than for small 2-storey buildings, each floor of a Premises shall be provided with at least one Final Distribution Board installed in an easily accessible location.

7.8.8 The number of Final Distribution Boards and Sub Distribution Boards provided in Premises shall take into account the future accessibility, maintainability and safety of the system, whilst limiting the extent of possible power outages to serviced areas.

[Note: to meet the above requirement Final Distribution Boards should be limited to a maximum capacity of 14 ways 3-phase (or 42 ways single phase) and Sub Main Distribution Boards should be limited to 18 ways 3-phase.]

7.8.9 Single-phase Distribution Boards may be permitted in Premises where adequate provision is made for balancing the total load at the Electricity Intake between the three phases.

[Note: single-phase Distribution Boards would normally be used for small load applications such as hotel rooms, garages or small out buildings.]

7.8.10 The phase and neutral busbars in all Distribution Boards shall be identified by the colours given in Appendix A8.

7.8.11 The phase and neutral conductors in all Distribution Boards shall be of the same cross sectional area.

7.8.12 Neon indicators, voltmeters and ammeters must be provided for Distribution Boards rated at 400A and above and, where reasonably practicable, for other Distribution Boards.

[Note: where practicable, maximum demand meters and power factor meters should also be provided. This can also be achieved by the use of a multifunctional meter. Consideration should be given to the provision of sub-metering facilities that allow the energy performance of building to be recorded and monitored in accordance with the relevant UAE energy efficiency requirements.]

7.8.13 All outgoing Circuits of Distribution Boards must be provided with only circuit breakers (such as CBs, MCBs, MCCBs, ACBs, RCDs, RCBOs) and shall not contain fuses of any kind, except for capacitor banks. See Regulation 10.2.

[Note: the incoming device of a DB may be an isolator switch, where adequate fault protection is provided by an upstream Protective Device.]

7.8.14 All Distribution Boards must be installed in locations easily accessible for inspection, operation and maintenance, preferably at the entrance to the area they serve. Such locations must be secured from unauthorised interference.

7.8.15 Distribution Boards of rating 200A and above shall be installed in a dedicated room Distribution Boards of rating below 200A may be installed in a cupboard or other suitable enclosure, complying with Clause 7.8.14 and Clause 3.5.9.

[Note 1: Main Distribution Boards of rating 200A and above must be located in an Electricity Intake room, see Appendix A12(b).]

[Note 2: At residential villas, Main Distribution Boards of rating 400A and above must be located in an Electricity Intake room and Sub Main Distribution Boards of rating 400A and above must be located in a dedicated room, see Appendix A12(b). Main Distribution Boards or Sub Main Distribution Boards of rating below 400A may NOT need to be installed in a dedicated room i.e. outdoor wall mounted, complying with Clause 7.8.14 and Clause 3.5.9 and in accordance with the approved installation procedures of the Distribution Company]

7.8.16 Distribution Boards shall not be installed in locations where water is used (e.g. kitchens, bathrooms, pump rooms), within 2m of any pipe or other source of water, or in difficult-to- access positions (such as stairways).

7.8.17 Distribution Boards and all electrical equipment installed outdoors must be corrosion resistant and give protection against mechanical damage and a minimum ingress protection of IP55 unless otherwise specified in these Regulations.

*[**Note:** At residential villas, outdoor wall mounted Main Distribution Boards or Sub Main Distribution Boards of rating below 400A must be corrosion and dust resistant and give protection against mechanical damage and a minimum ingress protection of IP65 unless otherwise specified by the distribution company]*

7.8.18 Distribution Boards must be provided with sufficient numbers of Protective Devices so as to enable every outgoing Circuit to be connected to an individual Protective Device and shall include not less than 10% spare Protective Devices or blank positions.

7.9 LV switchboards

7.9.1 Where prefabricated Distribution Boards of sufficient rating are not available, LV switchboards, consisting of cubicle panel switchgear, may be provided. LV switchboards must consist of type- tested assemblies, which satisfy the requirements of BS EN 61439.

7.9.2 Switchboards must be located in a dedicated room to provide for safe access and egress at all times, including during maintenance, repair and replacement work.

7.9.3 LV switch rooms must meet the requirements of Electricity Intake rooms listed in Regulation 4.2 typical layouts and minimum space requirements for LV switch rooms are given in Appendix A12(d) and A12(b).

7.9.4 Switchboards rated above 400A must be provided with instruments for Voltage, current, maximum demand and power factor measurement, as well as phase indicating lamps.

7.9.5 Where more than one incoming supply cable is provided at the Electricity Intake, these must be connected to separate switchboards (or separate sections of the same switchboard) which have the facility for interconnection through a bus coupler circuit-breaker or switch. In order to prevent parallel connection of the incoming supply cables, the bus coupler circuit breaker or switch must be interlocked to prevent its closure when both incoming supply cables are live. Bus switches and circuit breakers must be capable of closure onto a fault unless interlocked so as to only be operated whilst dead.

7.9.6 All busbars in switchboards must be tinned copper and rigidly supported throughout their length. The neutral and Earth busbars must run throughout the length of the switchboard. The neutral busbar must be of the same cross- sectional area as the phase busbars.

7.9.7 The main incoming circuit breaker must be clearly marked and left unlocked to allow immediate operation in an emergency, see Clause 4.3.2.

8.

Inspection, site testing and certification

8. Inspection, site testing and certification

8.1 Inspection and testing by the Licensed Contractor

8.1.1 Every new Electrical Installation shall, during installation and on completion before being energised, be inspected and tested by a Licensed Contractor who shall duly complete the relevant test reports and submit these to the Distribution Company (with the exception of tests that can only be carried out upon energising).

8.1.2 Inspection and testing shall be recorded on the standard forms shown in Appendices A20(b) – A20(d) and shall include the following tests:

(a) continuity of Ring and Final Circuit conductors;

(b) continuity of Earth Conductors including Equipotential Bonding Conductors;

(c) insulation resistance;

(d) protection against Direct Contact;

(e) protection against Indirect Contact;

(f) polarity of Circuits;

(g) Earth Fault Loop Impedance and Prospective Fault Current measurements;

(h) Earth Electrode Resistance; and

(i) operation of Earth Leakage Protection devices.

[Note: *see Appendices A 19(a) to A 19(g) for relevant test procedures.]*

8.1.3 The continuity test shall be carried out with an instrument having a no-load voltage between 4V and 24V DC or AC and a short-circuit current not less than 200mA, in accordance with the procedure in Appendix A 19(d).

8.1.4 The insulation resistance tests between live conductors and between each live conductor and Earth shall be measured with a test voltage of 500V DC, in accordance with the procedure in Appendix A 19(f).

8.1.5 Every Electrical Installation shall be inspected and tested on a periodic basis. The responsibility for periodic inspection and testing of Electrical Installations lies with the Owner of the Premises who shall request the services of a Licensed Contractor at the intervals shown in table 8.1.5. The Owner must also ensure that any necessary rectification work is carried out.

Table 8.1.5

	Internal Electrical Installation	External Electrical Installation
Domestic	3 years	3 years
Non-domestic (commercial, industrial, farms, etc.)	2 years	1 years
Premises used by the public (schools, hospitals, hotels, malls, parks, tents, mosques)	1 years	1 years
Special locations (construction sites, swimming pools and fountains, roadway lighting)	1 years	1 years

Note:

(a) see Clause 8.1.2 for the required tests.

(b) Table 8.1.5 above suggests the recommended periodic frequency to be followed, another periodic frequency in line with best practices can be adopted based on the premises type.

8.1.6 Electrical Installations which were constructed before Commencement Date of these Regulations shall be inspected and tested within the time indicated above, from the Commencement Date.

8.2 Inspection and testing by the Distribution Company

8.2.1 The Distribution Company shall verify on site the test results for Earth Resistance at the Main Earth Terminal and inspect or test other items as deemed appropriate, including as a minimum:

(a) connection of conductors;

(b) identification of conductors and labelling of equipment;

(c) routing of cables and their protection against mechanical damage;

(d) cross-sectional area of conductors for current- carrying capacity and Voltage drop;

(e) connection of single-pole devices for protection or switching in phase conductors only;

(f) correct positioning and connection of Accessories and equipment;

(g) presence of fire barriers and protection against thermal effects;

(h) methods of protection against electric shock, both Direct and Indirect Contact;

(i) inspection of integrity of Main Earth Conductors and Earth Electrodes;

(j) presence and correct location of devices for isolation; and

(k) measurement of Earth Fault Loop Impedance.

8.2.2 The Distribution Company may carry out intermediate inspection(s) prior to the final inspection mentioned in Clause 8.2.1. This is to verify compliance of concealed parts of the Electrical Installation (e.g. conduits, buried cables and Earth Conductors).

8.2.3 Internal checks and inspection shall be carried out on a minimum of 10% sample of the Electrical Installation, relevant to the items listed under Clause 8.2.1.

8.3 Electrical Installation Certificates

8.3.1 In order to verify compliance with these Regulations:

(a) the Licensed Contractor and the designer of the Electrical Installation shall complete and sign an Electrical Installation Certificate in the format shown in Appendix A20(a); and

(b) the Licensed Contractor shall complete and sign the inspection report, and installation testing report in the format shown in Appendices A20(b), A20(c), and A20(d) respectively.

8.3.2 Two original copies of the Electrical Installation Certificate and associated test results shall be provided; one to the Owner of the Premises and one to the Distribution Company. An additional copy must be affixed at the Main Distribution Board or Electricity Intake position, see Appendix A12(d).

8.3.3 After any extension or alteration to an Electrical Installation, a Licensed Contractor is required to issue an amended Electrical Installation Certificate, together with a copy of the original certificate and stating the details of the work carried out; in addition to an amended inspection report and installation testing report, see Regulations 3.2 and 3.3.

9.

Special locations and systems

9. Special locations and systems

9.1 Separated Extra-Low Voltage

9.1.1 Separated Extra-Low Voltage (SELV) systems are used where an inherently safe system of supply is required such that a breakdown of primary insulation will not lead to the risk of electric shock. This is achieved by electrical separation of the Final Circuit from the source of energy, typically using a safety isolating transformer, see illustration in Appendix A18(c).

9.1.2 For a SELV system, the Final Circuit Voltage shall not exceed “Extra-Low Voltage” i.e. 50V AC or 120V DC between conductors or to Earth.

9.1.3 The source of SELV power shall be provided by either:

(a) a safety isolating transformer complying with BS EN 61558, in which there is no connection between the output winding and the body or with the Circuit Earth Conductor, if any; or

(b) a battery source.

9.1.4 All components of a SELV system (including conductors, switches, relays, etc.) shall be physically separated from those of any other live system.

9.1.5 No Exposed-Conductive-Part of a SELV system shall be connected to any of the following:

(a) Earth;

(b) any Earthed conductive part of another system or Extraneous-Conductive-Part; or

(c) an Earth Conductor of any system.

9.1.6 Insulation against Direct Contact of the conductive parts of a SELV system is required if the operating Voltage exceeds 12V AC or 30V DC Insulation is not required if the operating voltage is at or below these values.

9.2 Protective Extra-Low Voltage

9.2.1 A Protective Extra-Low Voltage (PELV) system is one where the same provision for electrical separation is provided as for SELV, i.e. between the source of energy and the Final Circuit. However, in a PELV system the connection to Earth of Exposed-Conductive-Parts is permitted. See Appendix A18(d).

9.3 Bathrooms and similar locations

9.3.1 Special provisions are required for the protection against electric shock of persons in locations containing a bath or shower. Such provisions, as listed in the following Clauses, must also be applied in other similar situations where persons are likely to be partly clothed and in contact with water, with or without footwear.

*[**Note:** similar locations would include washrooms, toilets, wudu areas in mosques, etc. The requirements for swimming pools are listed in Regulation 9.4.]*

9.3.2 The following principal requirements must be met for bathrooms and similar locations:

(a) all Final Circuits (including lighting, water heater, extract fan, etc.) must be protected by a RCD of residual current rating 30mA and complying with BS EN 61008. Such protection may be grouped across several Circuits at the Final Distribution Board. However, fan-coil units mounted in a ceiling void in a bathroom may be provided with 100mA RCD protection.

(b) no socket-outlets are permitted except those supplied by an isolating transformer and complying with BS EN 61558-2-5 (e.g. 'shaver' socket-outlet);

(c) all Appliances, Luminaires and other Accessories must have a minimum level of moisture ingress protection of IPX5;

(d) Appliances, Luminaires or other Accessories may not be installed within Arm's Reach of a bath, shower or similar facility. However, such items are permitted within the room containing a bath or shower at a distance greater than Arm's Reach from the bath, provided that the requirements of Clauses 9.3.2(a) to 9.3.2(c) above are complied with. In addition, all switches associated with such equipment must be installed outside the bathroom or provided with a cord-pull switch; and

(e) Appliances, Luminaires or Accessories which are within Arm's Reach of a bath, shower or similar facility must be supplied by SELV or PELV and have a minimum level of ingress protection of IPX5. Underwater lighting must be supplied by SELV at a maximum Voltage of 12 V AC or 30V DC and with ingress protection IPX8.

*[**Note:** items which are within a distance of Arm's Reach but are inaccessible to persons need not comply with Clause 9.3.2(e). For example, water pumps installed under a bath which are not accessible without removal of covers requiring a tool.]*

9.3.3 The requirement for Earth Leakage Protection on Final Circuits must be met, along with the requirements for Earthed Equipotential Bonding and Supplementary Equipotential Bonding. See Guidance note G4(c).

9.4 Swimming pools

9.4.1 The requirements for protection against electric shock for swimming pools are similar to those of bathrooms, with some exceptions, as follows:

(a) all Final Circuits must be protected by a RCD of residual current rating 30mA and complying with BS EN 61008. Such protection may be grouped across several Circuits at the Final Distribution Board. Exceptions may be allowed for high leakage current applications where RCD protection of 100mA residual current rating may be allowed, but only where such equipment is out of reach of persons;

*[**Note:** an example of Circuits where 30mA RCD protection may not be practical is floodlighting or large water pumps. Such items must be out of reach of any person using the swimming pool or any associated washing areas.]*

(b) no socket-outlets are permitted within Arm's Reach of a swimming pool. Socket-outlets may be provided outside this distance for purposes such as cleaning of the pool, which must have a minimum ingress protection of IPX6 and must have an integral RCD of residual current rating 30mA, see Guidance note G7(c);

(c) all Appliances, Luminaries and other Accessories must have a minimum level of moisture ingress protection of IPX5;

(d) no Appliances, Luminaires or other Accessories may be installed within Arm's Reach of a swimming pool. However, such items are permitted within the swimming pool area (but not shower room area) at a distance greater than Arm's Reach from the pool, provided that the requirements of Clauses 9.4.1(a) to 9.4.1(c) above are complied with; and

(e) Appliances, Luminaires or Accessories which are within Arm's Reach of a swimming pool must be supplied by SELV or PELV and have a minimum level of ingress protection of IPX7. Underwater lighting must be supplied by SELV at a maximum Voltage of 12V AC or 30V DC and with ingress protection IPX8.

9.4.2 The requirement for Earth Leakage Protection on Final Circuits must be met, along with the requirements for EEB and Supplementary Equipotential Bonding.

9.5 Water fountains

9.5.1 The requirements for protection against electric shock for water fountains are similar to those required for swimming pools, with some exceptions, as follows:

*[**Note:** it is assumed that persons may enter a water fountain for the purpose of maintenance, or other reason, and the exposure to electric shock is therefore similar to that of swimming pools.]*

(a) all Final Circuits must be protected by a RCD of residual current rating 30mA and complying with BS EN 61008. Such protection may be grouped across several Circuits at the Final Distribution Board. Exceptions may be allowed for high leakage current applications where RCD protection of 100mA residual current rating may be allowed, but only where such equipment is out of reach of any person;

*[**Note:** an example of Circuits where 30mA RCD protection may not be practical is floodlighting or large water pumps. Such items must be out of reach of persons whilst standing within the water fountain.]*

(b) no socket-outlets are permitted within Arm's Reach of a water fountain. Socket-outlets may be provided outside this distance for purposes such as cleaning of the water fountain, which must have a minimum ingress protection of IPX6 and must have an integral RCD of residual current rating 30mA, see Guidance note G7(c);

(c) all Appliances, Luminaires and other Accessories must have a minimum level of moisture ingress protection of IPX5;

(d) no Appliances, Luminaires or other Accessories may be installed within Arm's Reach of a water fountain. However, such items are permitted at a distance greater than Arm's Reach from the water fountain, provided that the requirements of Clauses 9.5.1(a) to 9.5.1(c) above are complied with; and

(e) Appliances, Luminaires or Accessories which are within Arm's Reach of a water fountain must be supplied by SELV or PELV and have a minimum level of ingress protection of IPX7. Underwater lighting must be supplied by SELV at a maximum voltage of 12V AC or 30V DC and with ingress protection IPX8.

9.5.2 The requirement for Earth Leakage Protection on Final Circuits must be met, along with the requirements for EEB and Supplementary Equipotential Bonding.

9.6 Temporary Electrical Installations

9.6.1 This Regulation applies to temporary Electrical Installations (e.g. construction sites, work sites, exhibitions, tents, amusement parks, circuses) which are fixed or movable.

9.6.2 Due to the additional risks of damage and interference to temporary Electrical Installations, the following precautions should be catered for in the design and construction of such systems:

(a) all cables which are not installed in conduits or trunking must be armoured and adequately protected against accidental or deliberate interference by persons, and against the effects of weather;

*[**Note:** type HO7 RN-F braided or armoured cables complying with BS EN 50525 are recommended.]*

(b) outdoor temporary Electrical Installations must have a minimum ingress protection level of IP55 and switchgear assemblies must comply with BS 4363 and BS EN 61439-4;

(c) specification for distribution assemblies for RLV electricity supplies for construction and building sites shall comply with BS 4363;

(d) cables passing on or over walkways and access roads must be adequately enclosed to avoid Danger. Buried cables must be installed so as to afford adequate protection against damage, see Guidance note G6;

(e) particular attention should be given to the location, signing and protection of equipment where the public may have access, in particular children;

(f) equipment should be located and adequate notices displayed so that emergency disconnection of the electricity supply can be effected without delay. Locking arrangements should be such that these can be removed in an emergency (e.g. panic bar or keys available in break-out box);

*[**Note:** typically, an emergency power off facility should be provided.]*

(g) regular inspection and testing appropriate for the nature and use of the Electrical Installation and sufficient to ensure compliance with these Regulations at all times shall be carried out;

(h) an Earth Leakage Protected System and an Equipotential Bonded System must be provided in line with Regulations 5.4 and 5.5; and

(i) outdoor socket-outlets must be provided with integral RCD protection with a residual operating current of 30mA or less, and must have a minimum ingress protection level of IP55.

*[**Note:** water coolers and drinking fountains must be provided with individual RCD protection, in addition to that provided at the Final Distribution Board.]*

9.6.3 Reduced voltage supply (RLV) should be used where there is a high exposure to potential damage, and where persons are involved in working in confined spaces or other hazardous circumstances. See Appendix A18(e).

*[**Note:** RLV is recommended on construction sites compared with supply by ELPS to avoid nuisance tripping and the potential failure of RCDs in harsh outdoor environments.]*

9.7 Roadway lighting

9.7.1 This Regulation applies to Electrical installations associated with roadway lighting installed outdoors to produce quick, accurate, safe and comfortable visibility at night or when visibility is low at streets, avenues, boulevards and highways.

*[**Note:** the proper use of roadway lighting as an operative tool provides economic and social benefits to the public as used in the Abu Dhabi Lighting Manual.]*

9.7.2 Protection against electric shock for roadway lighting shall be provided by an Earth Leakage Protected System (Regulation 5.4) and by an Earthed Equipotential Bonded System (Regulation 5.5). In the latter case, the roadway lighting pole or other structure shall be connected to a means of Earthing, which will normally be from the Distribution Company supply cable.

9.7.3 Temporary supplies taken from street lights, such as for decorative lighting or signboards, must be provided with Earth Leakage Protection using RCDs of residual current rating no greater than 30mA where within reach of persons, or 100mA where not within reach of persons. Time delayed devices may be used to avoid nuisance tripping. Alternatively, such supplies may be provided by SELV or RLV.

*[**Note:** Clauses 9.8.3, 9.8.4, 9.8.5 and 9.8.6 of these regulations shall apply to Roadway lighting installations]*

9.8 External lighting

9.8.1 This Regulation applies to Electrical Installations associated with external lighting installed outdoors on Premises (e.g. decorative and landscape lighting etc.).

*[**Note:** the scope does not include specialist high-mast lighting systems, e.g. football stadiums, where used, the relevant approval shall be sought from the Distribution Company.]*

9.8.2 External lighting Luminaires mounted on poles shall be supplied from a suitably rated single phase RCBO.

*[**Note:** the RCBO would typically be mounted at a lower level within the pole and be accessible via an opening in the pole normally closed by a secure cover.]*

9.8.3 The connecting cable between the Luminaire and the cut- out shall be a 3 core (L-N-E) Double Insulated heat resistant flexible cable in accordance with BS EN 50525

9.8.4 The cut-out shall include suitably sized shrouded terminals to accommodate for the looping in and looping out of 3 core (L-N-E) steel wire armoured cables and the connections to the single phase RCBO

9.8.5 Earth bonding connections to the steel wire armour of the cable, the metal enclosure of the cut- out or gland plate and the metal pole, shall be made within the cut-out.

9.8.6 The cut-out shall be metal enclosed or thermoplastic polymer with minimum ingress protection of IP55.

9.8.7 Temporary supplies taken from external lighting cut- outs, such as for decorative lighting or signboards, must be provided with Earth Leakage Protection using RCBOs of residual current rating preferably 10mA but no greater than 30mA Alternatively, such temporary supplies shall be SELV or RLV.

9.8.8 All Circuits supplying external lighting shall be single phase and protected by an Earth Leakage Protected System (Regulation 5.4) and by an Earthed Equipotential Bonded System (Regulation 5.5).

*[**Note:** the use of three phase supply arrangements must be approved by the Distribution Company.]*

9.8.9 Looping of external lighting Circuits shall be via purpose- made junction boxes or cut-outs in compliance with Clause 7.5.16.

9.9 Marinas and similar locations

9.9.1 This Regulation applies to Electrical Installations in Marinas and similar locations.

9.9.2 Electrical Installation in a Marina environment shall be designed to minimise the following:

(a) risk of electric shock due to the wet environment and proximity to water;

(b) deterioration of the condition of electrical equipment due to the presence of salt and water;

(c) damage to supply cables and flexible cord connections; and

(d) risk of fire and explosion.

*[**Note:** for Electrical Installations on Leisure Crafts, refer to BS EN 60092-507]*

9.9.3 Inspection, testing and certification of Electrical Installations in Marinas shall satisfy the requirements set out in Part 8 of these Regulations.

Cables

9.9.4 Cables shall be selected and installed so that mechanical damage due to tidal and other movement of craft and other floating structures is prevented.

9.9.5 Where cable management systems are used, they shall be installed to allow the discharge of water by drainage holes and/or installation of the equipment on an incline.

9.9.6 Where flexible cables are used, they shall be in accordance with BS EN 50525.

Distribution Boards and Pedestals

9.9.7 Distribution Boards and Pedestals and all equipment mounted thereon and installed outdoors must be corrosion resistant and give protection against mechanical damage and ingress of dust and sand. A minimum ingress protection of IP55 is required.

*[**Note:** Selection of IP code must take into account the particular location of the Electrical Installation]*

9.9.8 Pedestals must be located in the immediate vicinity of the berths.

9.9.9 In order to minimise the Pedestal exposure to water, any water outlet within the Marina shall be suitably sited away from the Pedestal.

9.9.10 Pedestals shall include means of local isolation that disconnects phase(s) and neutral

9.9.11 Circuits supplying Pedestals must be individually protected against short-circuit, overload, and earth leakage. The Earth Leakage Protection shall be effective for leakage currents of 30mA.

*[**Note:** refer to Appendix A21 for general arrangement for the connection of Pedestals]*

Socket-Outlets and lighting

9.9.12 Socket-outlets and lights shall be placed at a height of not less than 1m above the highest water level.

9.9.13 Socket-outlets shall comply with BS EN 60309, refer to Appendix A17(b).

9.9.14 A maximum of four socket-outlets shall be allowed on a single Pedestal.

9.9.15 All single phase socket-outlets and lighting on a common Pedestal shall be connected on the same phase.

9.9.16 Socket-outlet(s) and lighting in a Pedestal shall be individually protected against short-circuit, overload, and earth leakage. The Earth Leakage Protection shall be effective for leakage currents of no greater than 30mA.

9.9.17 There shall be at least one single-phase socket-outlet with a rated current of 16A on each Pedestal.

*[**Note:** person(s) operating a Leisure Craft must ensure that the Leisure Craft plug is suitable for the Pedestal socket-outlet rating.]*

9.9.18 One socket-outlet shall supply only one Leisure Craft.

9.9.19 All socket-outlets shall be provided with an interlock to prevent the insertion and removal of plugs under loads.

9.9.20 Single-phase socket-outlets shall be blue in colour, and three-phase socket-outlets shall be red in colour.

9.9.21 Where a three phase socket-outlet(s) is used, a warning sign of the existence of 400V shall be provided on the Pedestal refer to Appendix A12(a).

9.10 Solar photovoltaic systems

General principles

9.10.1 This Regulation applies to Electrical Installations associated with solar photovoltaic (PV) systems.

*[**Note:** solar PV system intended for standalone operations (not connected in parallel with the Low Voltage distribution system) are not covered in these Regulations.]*

9.10.2 The design of solar PV systems shall be submitted to the relevant Distribution Company for approval.

*[**Note:** the solar PV system shall be inspected and tested by the Distribution Company prior to energising the solar PV system.]*

9.10.3 Solar PV system components and switchgear assemblies shall comply with the relevant equipment standards listed in Appendix (A3).

9.10.4 The designer of a solar PV system shall consider the potential risks during the installation, operation and maintenance of such systems. The design should consider the assessment of the installation constraints including wind and structural loading.

9.10.5 Precautions shall be made to ensure that live parts are either not accessible or cannot be touched during installation, operation and maintenance.

*[**Note:** PV Modules cannot be switched off. A String of solar PV Modules can produce a voltage in excess of 1000 V DC]*

9.10.6 The design and installation of solar PV system shall enable maintenance and service work to be carried out safely

Protection

9.10.7 Solar PV system components shall be selected and erected so as to minimise the risk of overloads, and short-circuits.

9.10.8 The wiring of solar PV systems shall withstand external influences such as wind, temperature and solar radiation.

9.10.9 Equipment on the DC side of the solar PV system shall be suitably rated in consideration of the highest DC voltage and highest DC current.

9.10.10 The current carrying capacity for solar PV system DC cables shall be at least 1.25 times Short Circuit Current (Isc) under standard test conditions at any location.

9.10.11 All PV DC cables shall be Double Insulated and black in colour.

*[**Note:** to minimise Voltages induced by lightning, the area of all wiring loops shall be as small as possible.]*

9.10.12 PV Modules may be connected in series up to the maximum allowed operating voltage of the PV Module and the PV Inverter, whichever is lower.

9.10.13 The DC side of the solar PV system shall be protected by the use of Class II Equipment.

9.10.14 For Inverters that are able to feed DC fault currents to the AC side of the Electrical Installation, a type B RCD, in accordance with IEC 62423, shall be provided for the automatic disconnection of the supply.

9.10.15 Where the DC side of the Electrical Installation is constructed to meet the requirements of an installation using double or reinforced insulation, no connection to Earth between the PV Modules or frame and main Earthing terminal is required.

9.10.16 Where blocking diodes are used, they shall be connected in series with the PV String, and their reverse Voltage shall be rated for 2 times Open Circuit Voltage (Voc) under standard test condition of the PV String.

9.10.17 The solar PV system shall automatically disconnect from the public grid supply in the event of loss of grid or deviation of the electricity parameters at the supply terminals.

9.10.18 Single phase Inverters must be interlocked and configured to behave as an integrated multiphase Inverter providing a reasonably balanced output to all connected phases at all times whilst connected to the distribution system and taking into account of the permitted disturbance limits under Clause 4.1.6.

*[**Note:** this can be achieved by the internal controls of the Inverters. If the Inverter is not capable of this functionality, then protection by the use of a phase balance relay which shall disconnect all Inverters simultaneously in the absence of reasonable balance is required].*

9.10.19 All AC Circuits connected to solar PV system Inverters shall be protected against fault current by suitably rated overcurrent Protective Devices

9.10.20 A switch disconnector shall be provided on the DC side of the Inverter with the following requirements:

(a) the switch disconnector must isolate all live conductors;

(b) the switch disconnector must be in a prominent position;

(c) the switch disconnector must be rated for DC operation at the system Voltage maxima as calculated;

(d) the switch disconnector must be rated for DC operation at the system current maxima as calculated;

(e) the switch disconnector must be clearly labelled as shown in Appendix A12(a); and

(f) the switch disconnector must clearly show the “On” and “Off” position.

9.10.21 A switch disconnector shall be provided on the AC side of the Inverter with the following requirements:

(a) the switch disconnector must be located adjacent to the Inverter;

(b) the switch disconnector must switch all live conductors including the neutral;

(c) the switch disconnector must be clearly labelled as shown in Appendix A12(a):

(d) the switch disconnector must clearly show the “On” and “Off” position; and

(e) the switch disconnector must be lockable in the off position only.

9.10.22 Solar PV systems shall be connected via a dedicated Circuit from a switch disconnector located adjacent to the MDB. The switch disconnector shall be connected via a dedicated Circuit from the MDB. The switch disconnector shall be a standalone wall mounted unit, clearly labelled, easily accessed, and lockable. It is also preferable that the switch disconnector function be incorporated within a suitable enclosure together with the loss of mains protection and metering devices where required. Refer to Appendix A22.

***[Note:** the switch disconnector provides isolation of the PV system from the public grid supply.]*

9.10.23 All labels must be clear, easily visible, constructed and affixed to remain legible for as long as the enclosure is in use and written both in English and Arabic. PVC engraved labels shall be used, see Appendix A12(a).

9.10.24 Labelling along PV DC cables shall indicate the polarity and associated Dangers as shown in Appendix A12(a). The labels shall be fixed every 5 to 10m.

Inspection and site testing

9.10.25 Inspection and site testing of the completed solar PV system shall be carried out and documented by a Licensed Contractor under the supervision of a solar PV system

designer, refer to Appendix A20(f) and Appendix A20(g) for a sample Solar PV test and inspection reports.

9.10.26 The inspection and testing of AC Circuits is covered in Part 8 of these Regulations.

9.10.27 The inspection and testing of the DC side of the Solar PV system shall be in accordance with the requirements of BS EN 62446. The tests required as a minimum shall include the following:

(a) connection of conductors;

(b) continuity test of protective Earthing and/or equipotential bonding conductors (where used);

(c) polarity test;

(d) string Open Circuit Voltage test;

(e) string Short Circuit Current test;

(f) functional tests; and

(g) insulation resistance of the DC Circuits.

10.

Power factor correction

10. Power factor correction

10.1 General requirements

10.1.1 The power factor at any Connection Point between the Distribution Company and an Owner's Electrical Installation shall be maintained between 0.9 lagging and unity.

10.1.2 Air-conditioning units, motors, large electrical machines, fluorescent or discharge lighting, etc., shall be provided with power factor correction. Where the requirements in Clause in 10.1.1 still cannot be achieved, the use of capacitor banks shall be permitted.

*[**Note:** Power factor correction may be provided by a selection of equipment including variable speed drives, integral capacitors, or other suitable methods. The design must account for restrictions of disturbances under Clause 4.1.6.]*

10.1.3 The use of capacitor banks in residential villas shall be determined by the distribution company on a case by case basis and hence permitted in accordance with the relevant regulations and shall be installed in the main intake room.

10.1.4 All power factor correction capacitors shall normally be of dry or oil-filled, metal encapsulated, sealed type. The use of oil containing PCB (poly-chlorinated biphenyls) is strictly prohibited.

10.1.5 Power factor correction capacitors shall be provided with a means of prompt discharge on disconnection of the supply Voltage. The discharge circuit shall be permanently or automatically connected to the capacitor. Manual means of switching or connecting the discharge circuit is not permitted.

10.1.6 Automatically regulated capacitor banks, when used, shall provide, as far as reasonably practicable, a smoothed power factor throughout the range of operation.

10.1.7 Capacitor banks and associated components shall be suitably designed and selected to ensure reliable and continuous operation at a maximum system Voltage of 440V and at a maximum ambient temperature of 50˚C.

*[**Note:** the design of capacitor banks must be verified by the appropriate type test.]*

10.1.8 For induction motors with a permanently connected capacitor unit, the capacitor unit rating must not exceed 90% of the no-load reactive power of the motor.

*[**Note:** this is required in order to avoid the occurrence of self-excitation on run-down condition of the motor.]*

10.1.9 The occurrence of harmonics while employing variable speed drives, welding machines or similar devices in Circuits can lead to disturbances in the system and may cause capacitor failure. To minimise this risk, harmonic filter reactors must be employed in series with capacitors.

10.2 Specifications for capacitors

10.2.1 The Voltage rating of capacitor units shall be 480V as a minimum.

10.2.2 Capacitor units shall be temperature class D.

10.2.3 Capacitor units shall be metal encapsulated.

10.2.4 Capacitor units shall be capable of continuous operation in accordance with the over-voltage and overcurrent requirements of IEC 60831.

10.2.5 Built-in discharge resistors for capacitors shall be sized to ensure safe discharge of the capacitor to less than 50V in one minute after a switch off.

*[**Note:** capacitors should not restart until a minimum 3 minutes after the restoration of the supply.]*

10.2.6 Each capacitor shall be provided with a permanent nameplate, which includes the following information:

(a) name of the manufacturer;

(b) serial number;

(c) year of manufacture;

(d) rated reactive power;

(e) rated Voltage (rms);

(f) number of phases;

(g) rated frequency;

(h) statement of discharge device;

(i) short-circuit current; and

(j) statement of liquid fill (if any)

10.2.7 Capacitors shall have provision for effective Earth connection of the case to the capacitor mounting frame and to the Circuit Earth Conductor.

10.2.8 Capacitors and related components such as regulators, indicating instruments, contactors, etc., shall be capable of withstanding local environmental conditions.

10.2.9 Contactors shall be suitably rated and designed for capacitive back to back switching with pre insertion resistors and be able to withstand switching surges. Contactors shall isolate all three phases on switch off of the capacitor bank or on loss of supply voltage.

10.2.10 Each capacitor step shall be protected against conditions of overload and short-circuit by means of suitably rated rated overcurrent relays and suitably rated HRC fuses (current limiting type) respectively.

10.2.11 The capacitor panel must be provided with a suitably rated main incomer isolating switch. This shall be a three-pole isolator or MCCB. The handle of the incomer isolator or MCCB shall be interlocked with the door to ensure that the capacitor bank is de-energised when the door is open.

10.2.12 A capacitor bank shall not be a part of the motor control centre, main LV panel or sub-main panel, but it shall be accommodated in a separate cubicle, see Appendix A12(d).

10.2.13 Capacitor banks shall conform to the latest relevant international standards, including the following:

Relevant international standards for capacitors

Relevant international standards for capacitors	
LV switchboard	IEC 61439-1
Degree of protection	IEC 60529
LV circuit-breaker and disconnector	IEC 60947 (1-5)
Power factor correction capacitors	IEC 60831 (1-2)
Power factor regulator	IEC 60664 and IEC 1010-1
Capacitor switching contactors	IEC 60871 and IEC 60831
Detuning reactors	IEC 60076-6 and IEC 60076
Low-voltage power factor correction banks	IEC 61921

11.

Electric motors and starters

11. Electric motors and starters

11.1 General requirements

11.1.1 When motors are starting and running up to full speed, a current higher than the normal full load amps (FLA) is drawn. This starting current results in a Voltage drop. The permissible Voltage drop levels are as stated in the Electricity Distribution Code. The motor starting current and resulting Voltage drop is reduced when motor starters employing current limiting starting equipment are used.

11.1.2 All single-phase motors above 1 HP and three-phase motors above 3 HP shall be provided with current limiting starting equipment to effectively keep the starting current within the following limits:

Rating of motor	Maximum permissible starting current
1 HP to 5 HP	5 x full-load current
Above 5 HP and up to 50 HP	2 x full-load current
Above 50 HP and up to 150 HP	1.5 x full-load current

*[**Note:** it is preferred that modern practice is followed by the provision of variable frequency drives, where appropriate, to limit the starting current but also to afford further control and reduce the energy usage. Other starting techniques such as star-delta, primary resistance starter, auto transformer or electronic soft starter may also be considered depending on the application.]*

11.1.3 Where motor ratings and starting currents exceed those above, then the relevant diagrams, operation information, protection arrangements, starter details, system Voltage drop calculations etc. must be provided to the Distribution Company to gain approval for connection.

11.1.4 All electric motors shall be provided with internal proprietary terminal block to facilitate connection

11.1.5 Wiring and control diagrams must be permanently fixed, adjacent to motors.

11.2 Protection and isolation

11.2.1 All electric motors shall be adequately protected against overload, short-circuit, loss of one or more phases and Voltage dips, etc. as appropriate for each application. Emergency fire fighting motors or pumps are excluded from this Clause as they may be required to operate to failure without the provision of Protective Devices.

*[**Note:** motor control and protection equipment must be arranged so that re-starting is not automatic after automatic tripping due to a fault or other disturbance mentioned in Clause 11.2.1 above. It is recommended that air-conditioning units above 3kW be provided with under-Voltage tripping relays operating at 75% of the nominal supply Voltage and with an auto-reset timer set at between 5 and 10 minutes.]*

11.2.2 All electric motors above 5 HP must be provided with protection against mechanical overload.

11.2.3 Emergency switching (e.g. push-button switch) shall be provided for moving machinery which may require immediate manual disconnection from the supply in case of an accident or other situation to avoid Danger.

11.2.4 All mechanical equipment shall be provided with a means of isolation close to the equipment which can be locked and kept under the control of the person performing maintenance, see Guidance note G9.

12.

Standby generators

12. Standby generators

12.1 General requirements

12.1.1 Installation and connection of standby generators in any Electrical Installation, for the purpose of maintaining power in the case of a failure of the incoming supply, shall be permitted only with the prior approval of the Distribution Company.

12.1.2 The changeover circuit-breaker shall have 4 poles for a three-phase generator and 2 poles for a single-phase generator, to ensure that all live and neutral conductors are disconnected at the same time.

12.1.3 The installation and changeover arrangements must ensure that there is no possibility of paralleling the generator and incoming mains supply. If paralleling arrangements are required, these must be mechanically and electrically interlocked and be specifically assessed and approved by the Distribution Company.

12.1.4 The requirements for generator connections and Earthing arrangements are provided in the Electricity Distribution Code.

13.

Electrical Vehicle (EV) Charging Systems

13. Electrical Vehicle (EV) Charging Systems

13.1 General Principles

13.1.1 This Part applies to the installation of both AC and DC dedicated conductive charging equipment for charging of battery powered Electric Vehicles.

*[**Note:** see Installation of Electric Vehicle Supply Equipment (EVSE) Guidance Document Jan 2017]*

13.1.2 This Part does not cover inductive charging equipment and Electrical Installations meant for scooters or similar vehicles of 10A and less.

13.1.3 The technical requirements set out in this Part applies to all locations where such equipment may be required, such locations include but are not limited to domestic installations, on-street installations, public and private car parks, malls, offices, and single-level or multi-story car parks.

13.1.4 The Electrical Vehicle charging equipment, also known as the Electrical Vehicle Supply Equipment (EVSE), are fixed Electrical Installations which are connected to the mains electrical supply and provide electrical energy to recharge the traction batteries of electrically propelled road vehicles.

13.1.5 EVSE shall be designed, installed, maintained and tested in accordance with the listed technical requirements of this Part as well as all relevant requirements of the Electricity Wiring Regulations.

13.1.6 The design of EVSE shall be submitted to the relevant Distribution Company for review and approval.

*[**Note:** EVSE shall be inspected and tested by the Distribution Company prior to energisation.]*

13.1.7 The designer of EVSE shall consider the potential risks during the installation, operation and maintenance of such Equipment and systems.

13.1.8 The design should consider protection against vehicle impact, EVSE shall be installed in a position to minimise the likelihood of vehicle impact damage.

*[**Note:** Where the likelihood of vehicle impact damage cannot be minimised, the use of additional protection barriers shall be installed. A typical protection against mechanical stress impact for EVSE installed outdoors is IK10 in accordance with IEC 62262]*

13.1.9 EVSE shall be installed in a position to avoid obstruction to public or private footpaths and it shall not be installed in such a position that causes unnecessary trip hazard.

*[**Note:** Electrical wiring shall be routed to avoid creating potential trip hazard, and suitably clipped or enclosed in a containment system.]*

13.1.10 EVSE shall be installed so as to minimise the distance between the Vehicle Inlet and the charging equipment.

13.1.11 EVSE shall not be installed in locations where potentially explosive atmosphere exists such as petrol stations. Where it is required to have EVSE equipment in such locations it must be installed outside the hazardous zone.

13.1.12 Precautions shall be made to ensure that live parts are either not accessible or cannot be touched during installation, operation and maintenance.

13.1.13 The design and installation of EVSE shall enable maintenance and service work to be carried out safely.

13.1.14 Means of preventing unauthorized usage of the charging facilities such as housing the socket outlet in a padlocked box or using an access card for energising charging facility etc. may be provided as necessary especially for outdoor installations.

13.1.15 EVSE shall be installed with sufficient space around it to allow for adequate ventilation and cooling of the equipment (e.g. DC charging equipment incorporating rectifiers).

*[**Note:** It is strongly recommended that the designer and installer of the EV charging equipment electrical installation refer to the manufacturer's installation and operational instructions supplied with the equipment for details.]*

13.1.16 EVSE and all associated equipment shall have an IP rating suitable for the installation location; for indoor locations a minimum ingress protection of IP44 shall be used; for outdoor locations a minimum ingress protection of IP55 shall be used.

13.1.17 For domestic usage (i.e. home charging), Mode-2 charging is recommended, however installation of the In-cable control and protection devices (IC-CPD) for mode 2 charging of electric road vehicles shall be in accordance with IEC 62752. The use of Mode-3 charging in homes may be allowed with a maximum rating of 32A and with the prior approval from the Distribution Company. For areas accessed by the public only Mode-3 and Mode-4 can be used.

13.1.18 EVSE components shall comply with the relevant reference standards provided in the table below and any other relevant standards in Appendix A3.

Components	BS	IEC
Electric Vehicle (EV) and Electric Vehicle Supply Equipment (EVSE)		
EV conductive charging system	61851-1* 61851-21* 61851-23* 61851-24*	61851-1 61851-21 61851-23 61851-24
Plugs, socket-outlets, Vehicle Connectors and Vehicle Inlets. Conductive charging of electric, vehicles, In-cable	62196-1* 62196-2* 62196-3* 62752*	62196-1 62196-2 62196-3 62752
Degrees of protection provided by enclosures, IP code	60529*	60529
External mechanical impact protection	62262*	62262

*[**Note:** British Standards marked with an asterix * are also issued as European Standards under the same number (labelled as BS EN).]*

13.2 Final Circuit

13.2.1 EVSE shall be supplied by a separate and a dedicated Radial Circuit that supplies no other loads except ventilation equipment intended for use with the EVSE where required. However, more than one EVSE can be fed from the same supply Circuit, provided that the combined current demand of the equipment does not exceed the rating of the supply Circuit.

*[**Note:** For the purpose of these Regulations, EV charging loads are considered to be continuous. It shall be considered that in normal use, each single charging point is used at its rated current.]*

13.2.2 Cables supplying EVSE shall be mechanically protected by means of metal sheath/ armour, or installed inside a rigid steel conduit, plastic or PVC conduit, refer to Clause 7.5.2 and 7.5.8.

13.2.3 Each Final Circuit shall be sized to carry the rated current of the EVSE and with limited voltage drop as required by the Electricity Wiring Regulations, and the instructions of the EV charging equipment manufacturer, refer to Clause 7.5.10.

13.2.4 Where the final circuit supplies more than one EVSE charging point no diversity shall be allowed. The use of a diversity factor may be allowed for a dedicated distribution circuit supplying multiple EVSE charging points if load control is available.

13.2.5 Cable Extension unit must not be used with the EV charging cable assembly.

13.3 Sockets and Connectors

13.3.1 One socket-outlet or Vehicle Connector shall be used to charge only one EV.

13.3.2 For residential villas, a minimum of one EV charging point located in a suitable location is recommended.

13.3.3 EVSE shall be installed such that the main operating controls and any socket-outlet are between 0.75m and 1.2m above ground.

*[**Note:** Mounting height may be varied for special circumstances such as access for disabled persons or physical condition at the site.]*

13.3.4 The use of Mode-1 charging is not permitted under these Regulations due to the lack of safety measures associated with this mode of charging.

13.3.5 For Mode 2 charging, each AC charging point shall incorporate an interlocked socket-outlet complying with BS EN 60309. The rating of the socket-outlet shall not exceed 32A.

*[**Note:** Mode 2 charging cables must have an In-Cable Control Box typically provided by the EV manufacturer.]*

13.3.6 For Mode 3 charging, each AC charging point shall incorporate a Vehicle Connector or a type-2 socket-outlet complying with BS EN 62196-2.

13.3.7 For Mode 4 charging, a connector complying with IEC 62196 type 4 is to be used with the use of a tethered cable.

13.3.8 For Mode 3 and Mode 4 mechanical or electrical locking system shall be provided to prevent unintentional plugging or unplugging of the Vehicle Connector unless switched off from the supply.

13.3.9 EV manufacturers' instructions should be followed when determining the type of socket- outlet to be installed.

13.3.10 If different modes are combined on a single Vehicle Connector, IEC 62196-3 type 2 'Combo 2' connector shall be used

13.4 Isolation and switching

13.4.1 A means of isolating the supply to the EVSE circuit shall be provided, in accordance with Regulation 5.6. This isolating device shall be capable of being locked in the open position and also located in a position that is readily accessible for maintenance purposes and shall be suitably identified by marking and/or labelling.

13.4.2 Where an emergency switch is provided it shall be located in a position that is readily accessible and shall be suitably identified by marking and/or labelling and shall disconnect all live conductors including the neutral.

13.5 Protection

13.5.1 EVSE and all associated equipment shall be selected and erected so as to minimise the risk of overloads, and short-circuits.

13.5.2 Each Final Circuit shall be individually protected against fault current by a suitably rated overcurrent Protective Devices.

13.5.3 Basic protection against electrical shock shall be provided by automatic disconnection of supply or electrical separation. Refer to Regulation 5.3.

13.5.4 Every charging point shall be individually protected by a 30mA RCD. The RCD shall disconnect all live conductors, including the neutral.

[Note: Either an RCBO or RCD with characteristics of type A is acceptable. If it is known that the DC component of the residual current exceeds 6mA then a Type B RCD complying with IEC 62423 shall be used.]

13.5.5 The requirements of Earth Leakage Protection on Final Circuits must be met, along with the requirements for Earthed Equipotential Bonding and Supplementary Equipotential Bonding. Refer to Regulations 5.4 and 5.5.

[Note: *There should be discrimination between any RCD installed at the connecting point or incorporated in the charging equipment and the protection at the origin of the Circuit (e.g. Type S RCD used at the origin.]*

13.6 Labelling requirements

13.6.1 All labelling and identifications requirements listed in Regulation 3.6 are applicable to this Part.

13.6.2 All labels must be clear, easily visible, constructed and affixed to remain legible for as long as the enclosure is in use and written both in English and Arabic.

13.6.3 An operation instruction for the charging facility including essential information of the rated voltage (V), frequency (Hz), current (A), and number of phase shall be displayed at a prominent location at each of the parking space with EVSE.

13.6.4 Directional signage inside and outside car park is recommended to direct EV drivers to designated parking spaces with EVSE.

13.7 Inspection and site testing

13.7.1 Upon completing the installation of the EVSE and before energisation, the installation shall be inspected and tested by a Licensed Contractor to verify that the installation complies with the manufacturer's instructions, all applicable standards as well as these Regulations.

13.7.2 Periodic inspections and testing shall be carried out in accordance with these Regulations, and the manufacturer recommendations.

13.7.3 Refer to Part 8 of the Regulations for the required inspection, site testing and certification.

13.8 Provision of information

13.8.1 Owners and operators of EVSE are required to provide such information to the DoE concerning the activities and services relevant to their EVSE as the DoE may request.

13.8.2 Owners and operators of EVSE accessed by the public are required to submit to the DoE, where requested to do so, complete information on the service charge rate and the payment mechanism they levy on their customers if any (i.e. EV drivers).

14.

Review of DoE decision

14. Review of DoE decision

14.1 Application for review

14.1.1 Any application for enquiry, clarification, dispute, relaxation relevant to these Regulations must be in the first instance made in writing to the Distribution Company with supporting documents who in turn shall provide a resolution.

14.1.2 The Distribution Company may seek further clarifications and/or more documents from the applicant to assist with resolving the case in question.

14.1.3 The Distribution Company may seek support from the DoE to assist with providing a resolution to the case.

14.1.4 In the event the distribution company fails to provide a satisfactory resolution or should the applicant wish to appeal the decision of the Distribution Company, an application must be made in writing to the DoE and submitted with supporting documents.

14.2 Timescale for application for review

14.2.1 The time scale for application to be reviewed by DoE is 30 calendar days.

14.3 Extension of time for application for review

14.3.1 Licensee/Applicant will be informed in case of any extension of time required for application review.

14.4 DoE request for information

14.4.1 DoE may request from an Entity making an application for a decision, any information or documentation it considers reasonable and necessary in the circumstances and the Entity must provide such information within the period specified by the DoE.

14.5 DoE decision

14.5.1 DoE shall notify the Entity which made the application of its final decision

14.5.2 DoE may:

(a) Make any decision it sees fit in the circumstances; and/or

(b) Issue directions as it sees fit to the Entity which made the application for review and to any third party. Any decisions or directions issued by DoE are binding on the Entity which made the application for review and any third party stated in these decisions or directions.

(c) Failure to comply with decisions or directions issued by DoE under this Part shall be considered as a failure to comply with these Regulations.

15.

Failure to comply with Regulations

15. Failure to comply with Regulations

15.1 Reporting failures

15.1.1 Any failure to comply with these Regulations or any act that may be considered as a failure to comply with these Regulations must be reported to the DoE.

15.2 Enforcement procedures

15.2.1 In case of failure to comply with these Regulations, the DoE may issue a written warning notice to the non-complying Entity.

15.2.2 The warning notice shall include:

(a) The name of the Entity;

(b) The regulation which has been violated;

(c) A tolerance period to comply;

(d) The enforcement procedures to be taken against the Entity in case it does not comply with the Regulations within the tolerance period.

15.2.3 Without prejudice to any other stricter punishment provided in any other legislation, an administrative fine of not more than (AED 10,000,000) ten million dirhams shall be imposed on anyone who contravenes the provisions of these Regulations and the rules, policies, decisions, circulars, codes issued thereunder pursuant to Article (10) Law No (11) of 2018.

15.2.4 After Executive Council's approval, the DoE Chairman shall issue the table of offenses and fines for violating any of these Regulations and the rules, policies, decisions, circulars, and codes issued thereunder.

15.2.5 The DoE shall remove any violation of these Regulations at the expense of the violator if the latter does not remove it as specified by DoE.

15.2.6 The DoE reserves the right to take further administrative sanctions against violators in accordance with Article (11) of Law No (11) of 2018

15.2.7 Failure to comply with these Regulations (or any party herein) may be also deemed as a breach of a license condition where applicable.

16.

Governing Law

16. Governing Law

16.1 Governing Law

16.1.1 These Regulations and the rights and duties of any parties hereunder shall be governed by the laws of the Emirate of Abu Dhabi and the federal laws of the UAE as applied by the courts of the Emirate of Abu Dhabi.

17.
Appendices

17. Appendices

A1. Glossary of terms and abbreviations

A	Amps or Amperes
ACB	Air Circuit Breaker
AC	alternating current
a/c	air-conditioning
BS	British Standard
BS EN	British Standard which has been published under the European Normalisation procedure
BSI	British Standards Institute
CB	Circuit Breaker
CP	Connection Point (see definitions)
CEC	Circuit Earth Conductor (see definitions)
CPC	Circuit Protective Conductor (see definition for CEC)
DC	direct current
ECC	Earth Continuity Conductor (see definition for CEC)
EEB	Earthed Equipotential Bonding (see definitions)
EEBS	Earthed Equipotential Bonded System (see definitions)
E/F	Earth Fault (protective device)
ELCB	Earth Leakage Circuit-Breaker
ELP	Earth Leakage Protection (see definitions)
ELPS	Earth Leakage Protected System (see definitions)
ELV	Extra-Low Voltage (see definitions)
EN	European Normalisation standard document
ESMA	Emirates Standardization & Metrology Authority
FCU	Fan Coil Unit
ESMA	Emirates Standardization & Metrology Authority
FCU	Fan Coil Unit
FDB	Final Distribution Board (see definitions)
HP	Horse-Power (= 0.746kW)
HRC	High Rupture Capacity (fuse)
HV	High Voltage (see definitions)
IEC	International Electrotechnical Commission
In	Nominal current rating or current setting of a Protective Device

A1. Continued...

kA	kilo-Amps
kV	kilo-Volts
LV	Low Voltage (see definitions)
m	Metres
MCB	Miniature Circuit-Breaker
MCCB	Moulded Case Circuit-Breaker
MDB	Main Distribution Board (see definitions)
MEC	Main Earth Conductor (see definitions)
MET	Main Earth Terminal (see definitions)
MICC	Mineral Insulated Copper-Clad (type of cable)
ms	milli-seconds
˚C	degrees Celsius
PELV	Protective Extra-Low Voltage (see definitions)
PV	Photovoltaic
PVC	Poly-vinyl Chloride (insulation for LV cables)
r.m.s	root-mean-square (value of voltage, current etc.)
RCBO	Residual Current Breaker (with) Overcurrent Protection
RCCB	Residual Current Circuit-Breaker
RCD	Residual Current Device (see definitions)
RLV	Reduced Low Voltage (see definitions)
Sec	Seconds
S	cross-sectional area (of conductors, mm^2)
SMDB	Sub Main Distribution Board (see definitions)
SELV	Separated Extra-Low Voltage (see definitions)
TN-S	a Distribution Company Earthed System (see definitions)
TT	a Locally Earthed System (see definitions)
Uo	nominal phase Voltage
WED	Water and Electricity Department (Abu Dhabi)
Ze	External Earth Fault Loop Impedance at Intake
Zs	Total Earth Fault Loop Impedance (see definitions)

Z_{R1+R2} Internal Loop Impedance (R1 = resistance of Circuit conductor, R2 = resistance of Earth Conductor)

A2. Recommended Books and references

Books:

(1) Requirements for Electrical Installations (BS 7671: 2018) The Institution of Engineering and Technology (formerly the Institution of Electrical Engineers)

(2) IEE Guidance Note 8 - Earthing & Bonding The Institution of Engineering and Technology

(3) IEE Guidance Note 7 – Special Locations

The Institution of Engineering and Technology

(4) IEE Guidance Note 5 – Protection Against Electric Shock The Institution of Engineering and Technology

(5) Exam Success – The IEE Wiring Regulations 2381

The Institution of Engineering and Technology, City & Guilds

(6) The IEE On-site Guide to BS 7671:2008 (2011)

The Institution of Engineering and Technology

(7) The IEE Electrical Installation Design Guide The Institution of Engineering and Technology

(8) The Electricians Guide – 3rd Edition John Whitfield, EPA Press

(9) Testing Electrical Installations

A Hinsley, Castleknight Publications

(10) Advanced Testing Techniques

A Hinsley, Castleknight Publications

(11) Inspection, Testing and Certification The Electrical Safety Council (NICEIC)

(12) Snags and Solutions Part 1 – Earthing & Bonding

The National Inspection Council for Electrical Installation Contracting (NICEIC)

(13) Domestic Electrical Installation Guide

The National Inspection Council for Electrical Installation Contracting (NICEIC)

Regulations:

(14) Abu Dhabi Emirate Environment Health and Safety Management System (ADEHSMS) COP15 - Electrical Safety

(15) Former ADWEA Wiring Rules and Regulations for LV Installations 2003, Abu Dhabi Water and Electricity Authority

(16) Regulations for Electrical Installation Works 1980 Water and Electricity Department (WED) of Abu Dhabi

(17) The Earth Leakage Protection Regulations 2001 The former Regulation and Supervision Bureau

A2. Continued...

(18) Regulations for Electrical Installations 1997 Dubai Electricity Authority

(19) Rules and Regulations of Electrical Connections Sharjah Electricity and Water Authority

(20) The Australian & New Zealand Wiring Rules AS/NZS 3000:2000 Standards Australia/ Standards New Zealand

(21) The Electricity Safety (Installations) Regulations 1999 Government of Victoria (Australia)

(22) The Electricity Safety (Network Assets) Regulations 1999 Government of Victoria (Australia)

(23) Industry Standard for Electrical Installations on Construction Sites Office of the Chief Electrical Inspector, Victoria (Australia)

(24) New Zealand Code of Practice for Homeowner / Occupier's Electrical Wiring Work,

Energy Safety Service, Wellington, New Zealand

(25) Code of Practice for Safe Electrical Work

Office of the Chief Electrical Inspector, Victoria (Australia)

(26) The Electricity Safety, Quality and Continuity Regulations 2002 Her Majesty's Stationary Office, UK

(27) The Plugs and Sockets etc. (Safety) Regulations 1994 Her Majesty's Stationary Office, UK

(28) The Low Voltage Electrical Equipment (Safety) Regulations 1989 (Adoption of the Low Voltage Directive No. 73/23/ EEC) Her Majesty's Stationary Office, UK

(29) The Electrical Equipment (Safety) Regulations 1994 Her Majesty's Stationary Office, UK

Reference Papers:

(30) Cahier Technique no. 172 – Earthing Systems in LV B Lacroix, R Calvas, Schneider Electric

(31) Cahier Technique no. 173 – Earthing Systems Worldwide B Lacroix, R Calvas, Schneider Electric

(32) Neutral Earthing in LV Networks

A Robert, J Hoeffelman, CIRED Conference June 2001

(33) Plugs and Sockets Around the World Conrad H. McGregor, World Standards

(34) The Distribution Code – Annex 1 – E/R 1 – Limits for Harmonics in the Electricity Supply System Approved by the former Regulation and Supervision Bureau

(35) The Distribution Code – Annex 1 – E/R 7 – Limits for Voltage Fluctuations in the Electricity Supply System Approved by the former Regulation and Supervision Bureau

(36) The Distribution Code – Annex 1 – E/R 10 – Limits for Voltage Unbalance in the Electricity Supply System Approved by the former Regulation and Supervision Bureau

(37) Designing for Low Resistance Grounding Lightning Eliminators & Consultants, Inc

(38) Guide to the Installation of Photovoltaic Systems Microgeneration Certification Scheme ('MCS')

A3. Reference standards

Components	BS	IEC
Cables		
Power & lighting (70˚C PVC,	6004	6004
Power and lighting (90˚C rubber, thermosetting)	50525-1:2011*, 50525-2-41:2011*, 50525-2-42:2011*, 7889	
Mineral insulated (copper-clad)	60702-3:2016* 60702-1*	702
Flexible cables & cords (domestic)	50525-1:2011*, 50525-2-11:2011*, 50525-2-12:2011*, 50525-2-21:2011*, 50525-2-71:2011*	245
Low smoke (90˚C rubber, thermosetting)	7846, 7211, 6724, 7629	
Armoured cables (90˚C rubber, thermosetting)	5467	
Switchgear and control wiring	6231	
Flexible cables for lifts	50214*	
Cable glands	6121	

A3. Continued...

Components	BS	IEC
Cables		
Crimp connectors	61238*	
Cable cleats	61914*	
Conduits & trunking		
Steel	4568, 60423*, 61386-21, 61386*,61386*, 80000*	423, 614
PVC	4607	
Flexible steel	61386-23	
Cable tray	61537*	
Trunking	4678*	

The standards listed below are for typical components used in an Electrical Installation. However, this list is not exhaustive and the latest relevant BS or IEC standards should be used.

Components	BS	IEC
Electrical Accessories		
General	5733	
Ceiling roses	67	
Cooker Control Units	4177	
Household Appliances	60335*	
Plugs & socket-outlets (domestic)	546, 1363, 4573	
Plugs & socket-outlets (industrial)	60309*	
Switches (domestic)	60669*	

A3. Continued...

Components	BS	IEC
Electrical Accessories		
Lighting	60598*	
Emergency lighting	5266	
Signs and discharge lighting	559	
Isolating (safety) transformers	61558*	
LV switchgear & assemblies		
General	61439*	61439
Contactors & motor starters	60947*	947
Circuit-Breakers (MCB, MCCB)	60898*	898
Circuit-Breakers (RCD, RCBO)	61008*, 61009*	1008, 755
Fuses	88, 60269*	269
Busbar trunking systems	61439-6*	61439-6
General		
Fire / combustibility test	60695- 4*	60695
Degrees of protection & ingress	60529*	60529
Assemblies for construction sites	4363	364-7-704
Hazardous areas	60079*	60079
Lightning protection	62305*	62305
Earthing	7430, 951, 4444	364-5-54
Wiring diagram symbols		60617
Identification and marking of the man-machine interface	60445*	
RCD socket-outlets	7288	

A3. Continued...

Components	BS	IEC
Electrical Accessories		
Thin-film terrestrial photovoltaic PV modules	61215*	61215
Crystalline silicon terrestrial PV modules	61215*	61215
Solar PV modules safety qualification	61730-1*	61730-1,
Solar PV inverters degree of protection	61730-2*	61730-2
Solar PV inverters protection class	60529*	60529
Solar PV inverters characteristics of the utility interface	60664-1*	60664-1
Solar PV inverters EMC Conformance	61727*	61727
Solar PV inverters Harmonics Conformance	61000*	61000-3-2, 61000-3-3, 61000-3-11, 61000-3-12
Solar PV inverters power converting equipment safety	62109*	62109
Solar PV DC cable	See Note 4	See Note 4
Solar PV DC connectors	62852*	62852
RCD Type B	62423*	62423

Note 1: *British Standards marked with an asterix * are also issued as European Standards under the same number (labelled as BS EN).*

Note 2: *for compliance requirements under the Regulations see Clause 3.1.2 and 3.1.4.*

Note 3: *reference standards for capacitors are given under Regulation 10.2.*

Note 4: *for solar DC cables the following standards may be referenced UL 4703, TUV 2 PfG 1169/08.2007, VDE E PV 01:2008-02 and BS EN 50618.*

British Standards are issued by the British Standards Institute (BSI), a UK National Standards body. The UK Wiring Regulations (BS 7671) are published jointly by BSI and the IET (formerly known as the IEE). The BSI represents UK international standards work through the British Electrotechnical Committee (BEC) which is a member of the International Electrotechnical Commission (IEC) and also a member of the European Committee for Electrotechnical Standardisation (CENELEC). There are 24 member countries of CENLEC (formed in 1973) whose role is to prepare standards for the European market. CENELEC issues 'EN' standards which are adopted by the member countries, and 'HD' standards which are adopted in their general technical content by member countries. The IEC (formed in 1906) has 48 member countries and IEC standards may be adopted voluntarily by any country.

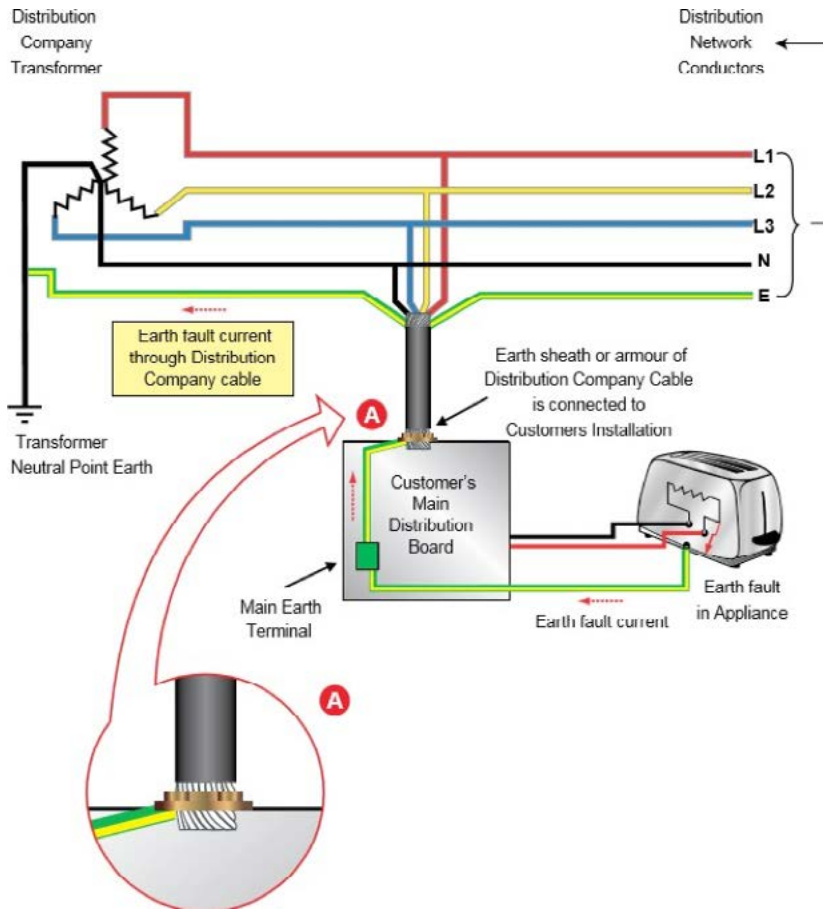
A4. List of regulations and clauses which do not apply to existing electrical installations

The Electricity Wiring Regulations are effective from 1 January 2008. For any Electrical Installations which were constructed prior to this date, the following Regulations do not apply.

Clause or Regulation	Reason	Application
Clause 3.1.4	Installation components to meet international standards	Does not apply (see also Clause 3.3.3 referring to repairs to existing installations)
Clause 3.5.6 Clause 5.3.4 Clause 5.5.1	Requirement for Earth Leakage Protection (ELP) and Earthed Equipotential Bonding (EEB)	Does not apply
Clause 4.2.9	Emergency lighting in Electricity Intake rooms	Does not apply
Clause 7.1.1	Prohibition of BS 546 plugs and socket-outlets in domestic premised	Does not apply but it is recommended to replace BS 546 socket-outlets with BS 1363 type
Clause 7.8.6	All Final Distribution Boards must, be arranged so as to provide for at least two zones of ELP	Does not apply if a single RCD of residual operating current 30mA is fitted to cover the whole DB, or a RCD of residual operating current of 100mA is fitted to cover the whole DB and 30mA RCBOs fitted in the DB for all bathrooms and socket-outlet circuits. Otherwise this Regulation shall apply after 1 January 2015, or the date of the next inspection or re- certification, whichever is the earlier

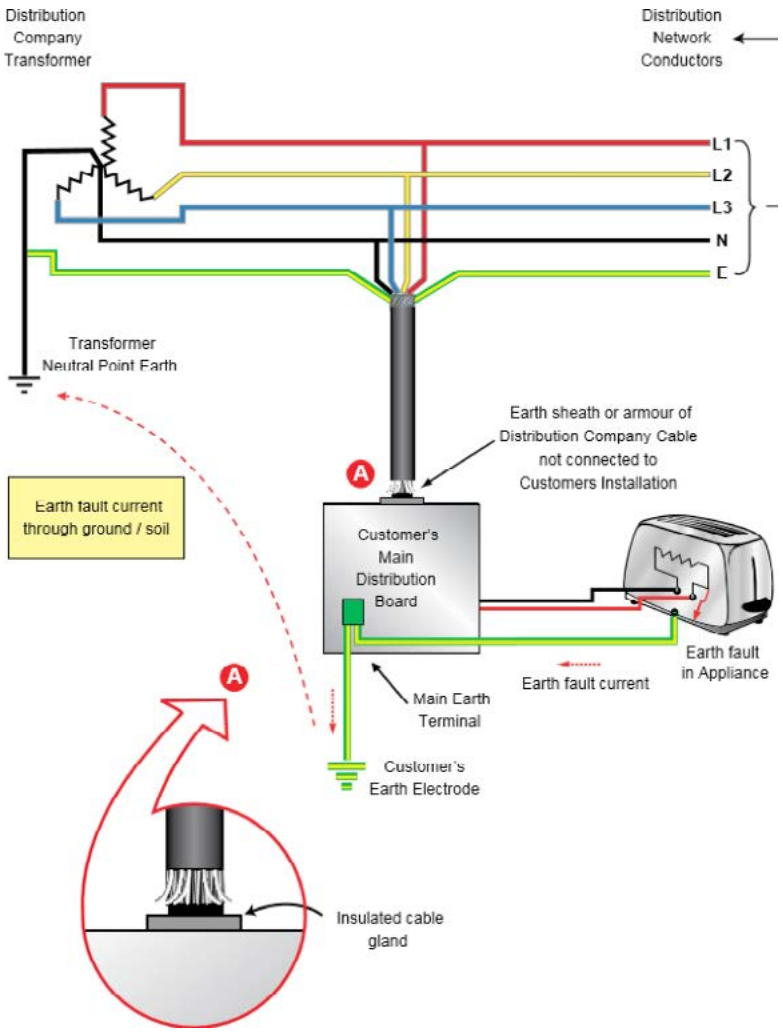
Note: *for the avoidance of doubt, for any Electrical Installations constructed before 1 January 2008, Clause 7.8.6 (Regulation 7.8) shall apply on the date of the next inspection or re-certification, unless the conditions in the above table are satisfied.*

A5.(a) Distribution Company Earthed System (TN-S)



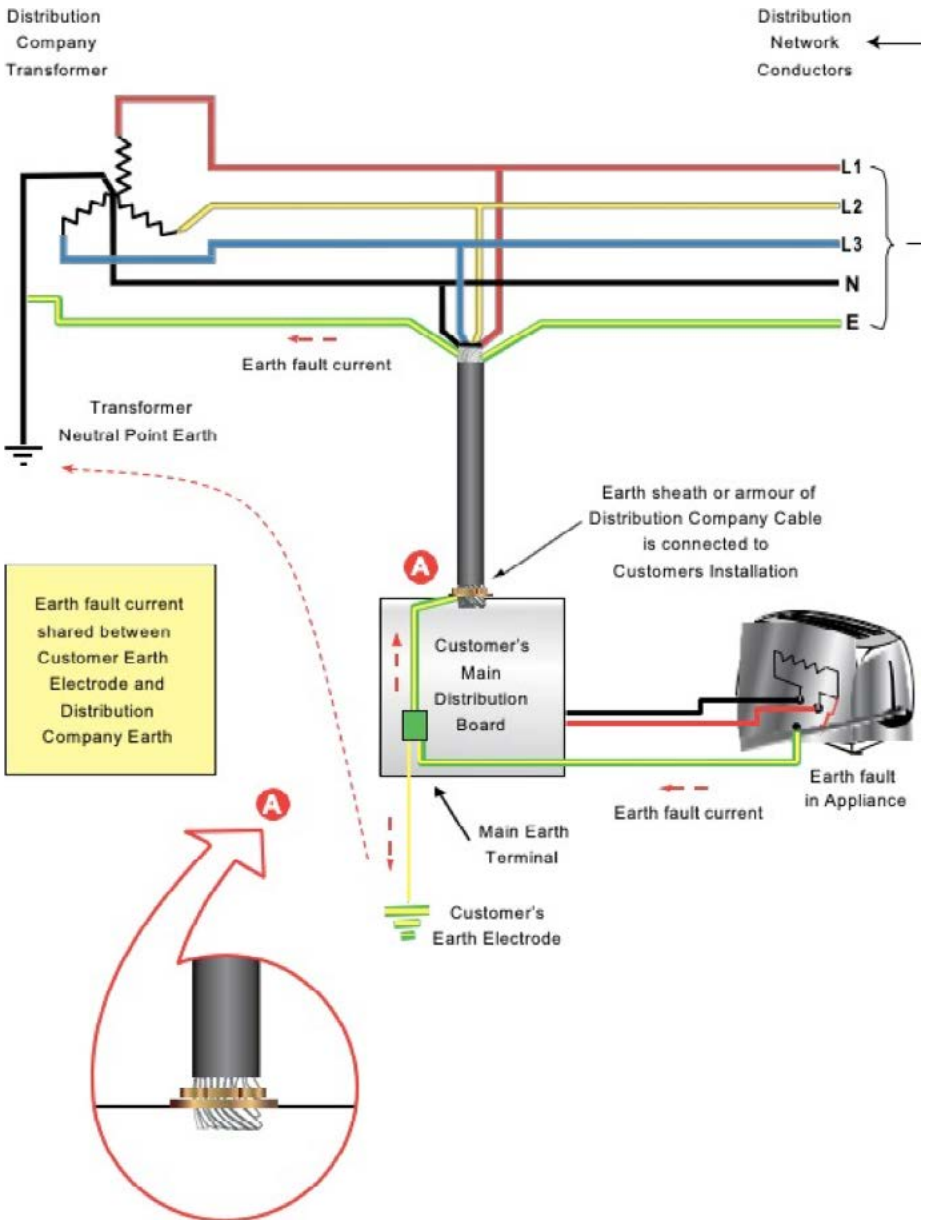
[see Regulation 6.2]

A5.(b) Locally Earthed System (TT)



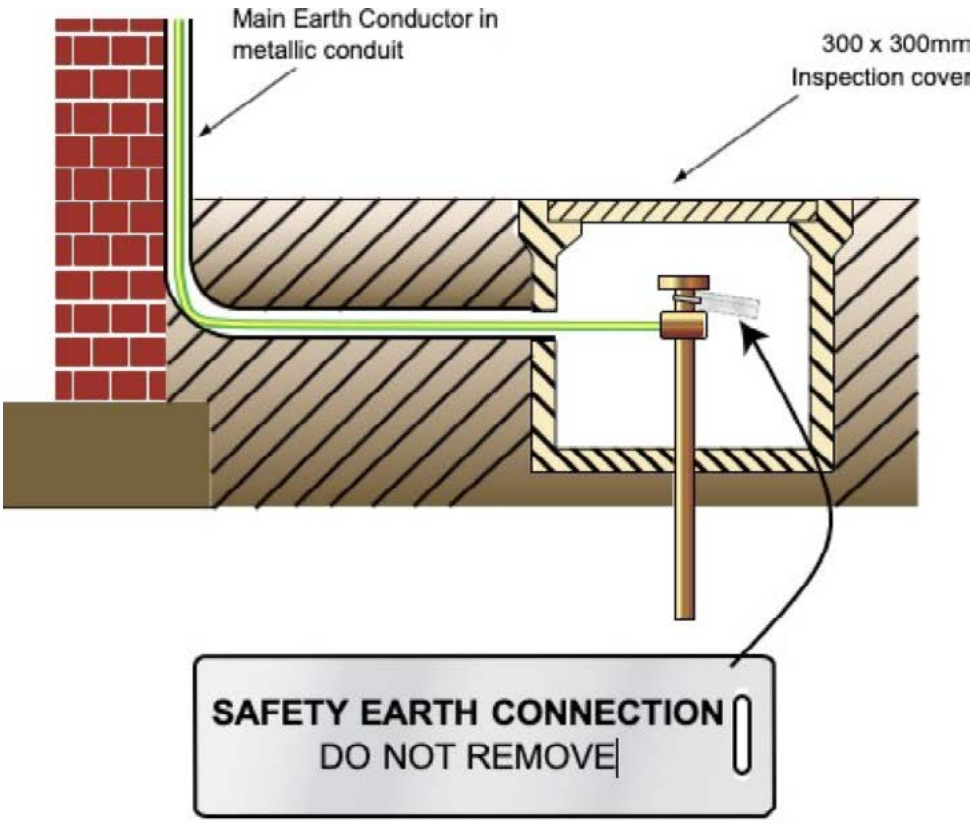
[see Regulation 6.2]

A5.(c) Distribution Company Earthed System with Locally Earthed System (TN-S and TT)



[see Regulation 6.2]

A5.(d) Earthed Electrode pit and standard labels

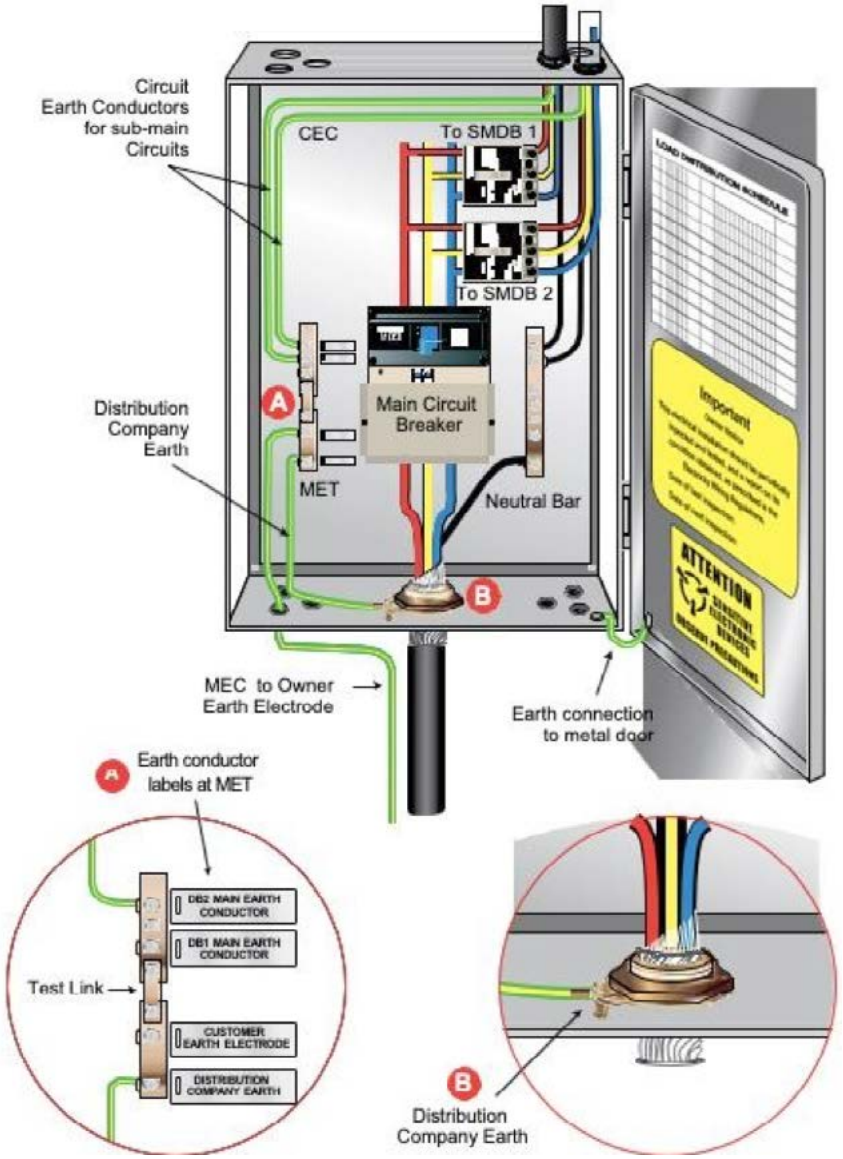


Standard safety label for Main Earth Connections

Standard safety label for main and supplementary bonding connections

[see Clauses 5.5.11, 6.4.3 and 6.5.6]

A5.(e) Main Earth Terminal (MET) at Main Distribution Board (MDB)



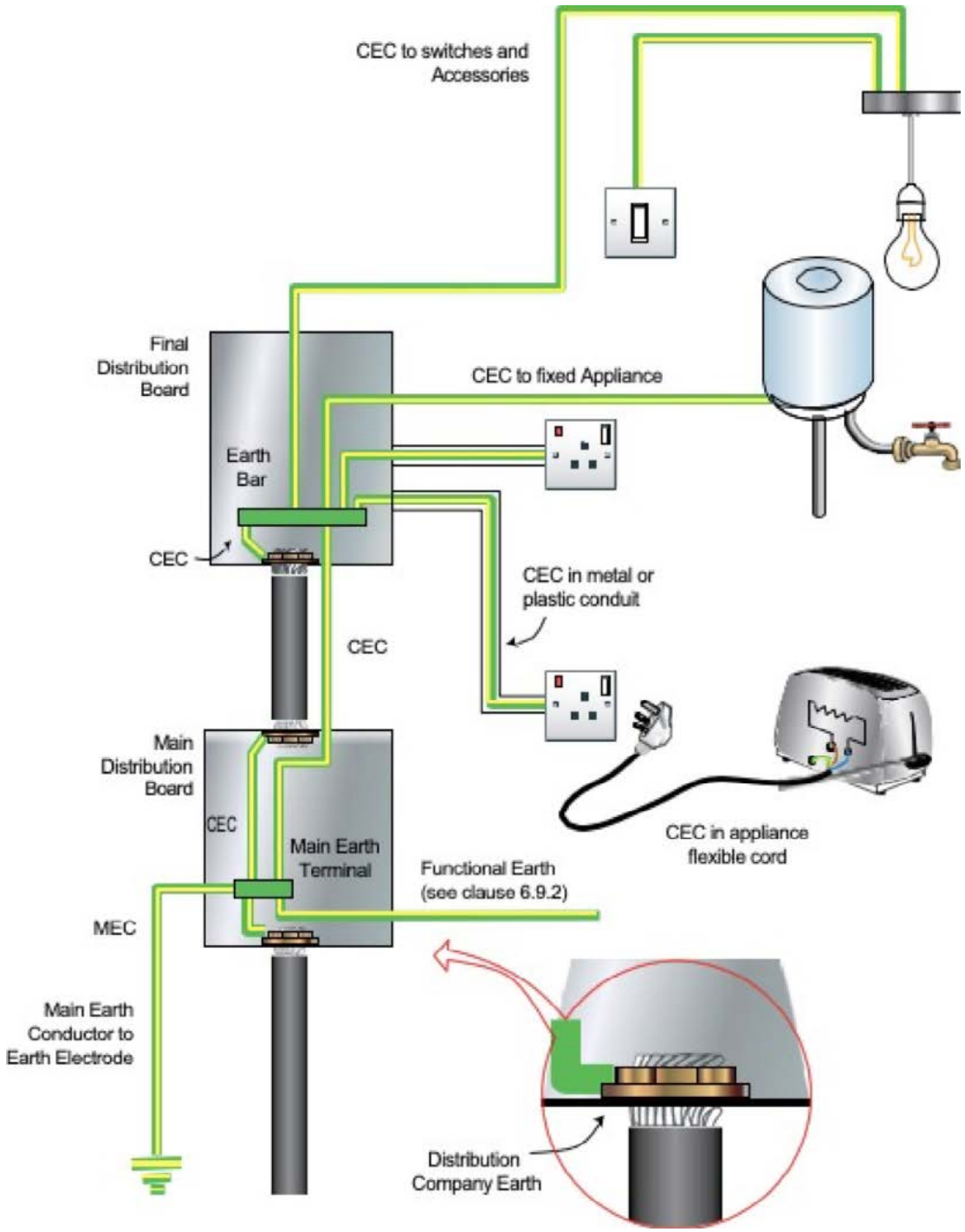
[see Regulation 6.2 and 6.3]

Note 1: *illustration shows a Distribution Company Earthed System with a Locally Earthed System (TN-S and TT).*

Note 2: *for sizing of Earth Conductors refer to Appendix A5(j) (S for cables up to 16mm^2, 16mm^2 for cables up to 35mm^2 and $\frac{S}{2}$ above this).*

Note 3: *this arrangement shows single core cables for SMDBs, other arrangement may be used (e.g. cables with SWA with separate Earth Conductor).*

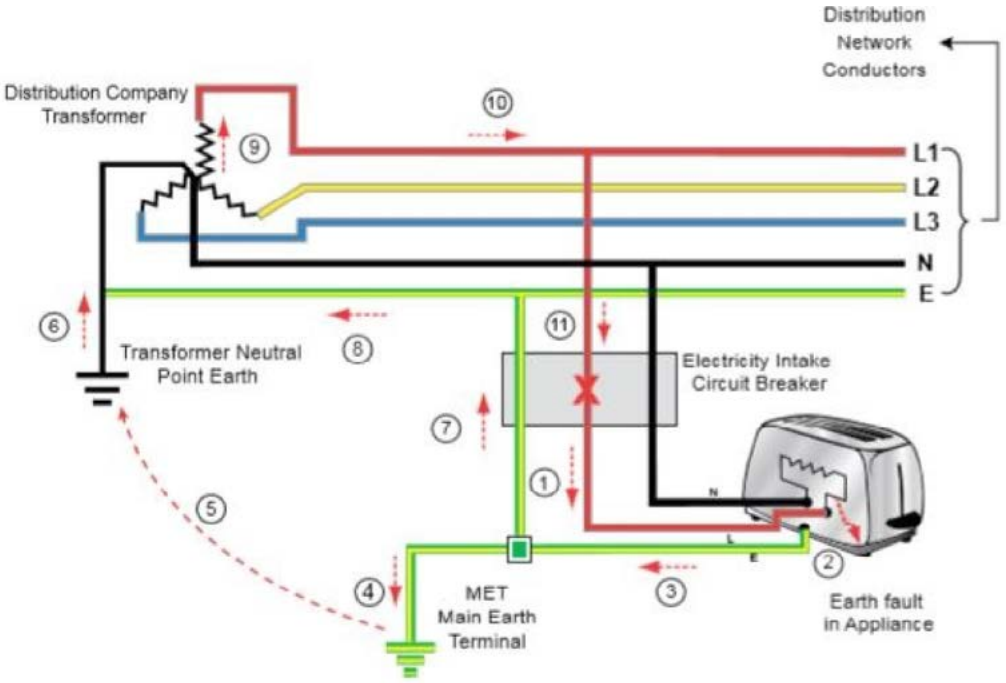
A5.(f) Main Earth Conductor (MEC) and Circuit Earth Conductor (CEC)



Note 1: *common terminology (outside these Regulations) includes CPC (Circuit Protective Conductor) and ECC (Earth Continuity Conductor) in place of CEC illustrated above. [see Regulation 6.2]*

Note 2: *for sizing of Earth Conductors refer to Appendix A5(j) (S for cables up to 16mm^2, 16mm^2 for cables up to 35mm^2 and $\frac{S}{2}$ above this).*

A5.(g) Components of Earth Fault Loop Impedance



Internal Earth Loop Impedance

1. Impedance of Circuit phase conductor
2. Resistance of fault
3. Impedance of Circuit Earth Conductor (CEC)

4. Impedance of Local Earth Electrode and Main Earth Conductor
5. Impedance of fault path through Earth

Source Earth Loop Impedance, Ze

6. Impedance of transformer Earth Electrode and Earth Conductor to the transformer star point
7. Impedance of supply cable Earth Conductor / armouring
8. Impedance of network cable Earth Conductor / armouring
9. Distribution Company transformer winding
10. Live conductor of distribution network cable
11. Live conductor of supply cable

[see Regulation 6.7]

A5.(h) Earth Fault Loop Impedance values required for MCBs (at 230V)

Device rating (A)	MCB type B	MCB type C	MCB type D
3	14.57	-	-
6	7.28	3.64	1.82
10	4.37	2.19	1.09
16	2.73	1.37	0.68
20	2.19	1.09	0.55
25	1.75	0.87	0.44
32	1.37	0.68	0.34
40	1.09	0.55	0.27
50	0.87	0.44	0.22
63	0.69	0.35	0.17

[from table 41.3 of BS 7671]

Note 1: *the above values are given for conductor temperatures of 70˚C. As measurements are normally taken at room temperature the measured values must be approximately 20% less than tabulated above.*

Note 2: *the above values are used as an alternative to calculating the disconnection time for each specific situation, i.e. MCBs will operate in the instantaneous mode if the Earth Fault Loop Impedance value is kept below the above, levels. For impedance values higher than shown above, it is still possible to comply with the requirement of 0.4s disconnection for all Circuits in an Electrical Installation if a check is made against the manufacturer's time- current performance chart.*

A5.(i) Resistance per metre of copper conductors

Conductor cross-sectional area (mm^2)	Resistance per metre (milli- ohms)
1.0	18.1
1.5	12.1
2.5	7.41
4.0	4.61
6.0	3.08
10.0	1.83
16.0	1.15
25.0	0.73

[above values at 20°C]

Note: *to allow for the increase in resistance with increased temperature under fault conditions these values must be multiplied by 1.2 for PVC insulated cables.*

A5.(j) Sizing of Earth Conductors and Equipotential Bonding Conductors

Cross sectional area of phase and neutral conductors (S) (mm^2)	Minimum cross- sectional area of Earth conductors [see note 1] (mm^2)	Minimum cross- sectional area of equipotential bonding conductors (mm^2)
S ≤ 16	S (not less than 1.5 see note 2)	$S/2$ (not less than 4 or 6, see note 3)
16 < S ≤ 35	16	10
S > 35	$S/2$	$S/4$ (but not exceeding 25)

[from table 54.7 of BS 7671]

Note 1: *for Main Earth Conductors between Earth Electrodes and the Main Earth Terminal of an Electrical Installation, S should be taken as the cross- sectional area of the conductors of the incoming supply cable. For Circuit Earth Conductors S should be taken as the cross-sectional area of the Circuit phase conductors.*

Note 2: *Earth Conductors must always be insulated and a cross-sectional area of less than 1.5mm2 must not be used unless they are an integral part of a sheathed cable (e.g. an Appliance flexible cord).*

Note 3: *Main Equipotential Bonding Conductors should be sized according to the live conductors of the incoming supply, but should not be less than 6mm2. Supplementary Bonding Conductors should be sized according to the live conductors of the circuit to which they are connected but should not be less than 4mm2.*

Note 4: *as an alternative to using the above selection table, the sizing of Earth Conductors and Equipotential Bonding Conductors may be calculated using the adiabatic equation provided in the IET Wiring Regulations BS 7671:2018 paragraph 543.1.3. This normally allows smaller sizes of Earth Conductor to be used.*

For example: $4mm^2$ earth for $6mm^2$ circuit conductor

$2.5mm^2$ earth for $4mm^2$ circuit conductor

$1.5mm^2$ earth for $2.5mm^2$ circuit conductor

A5.(k) Minimum number of Earth Electrodes

The number of Earth Electrodes required at a Premises will be determined primarily by the value of Earth Resistance that can be achieved from each. However, the minimum number in any case shall be as shown below:

Main incoming circuit- breaker rating (Amps)	Minimum number of Earth Electrodes	Minimum size of main Earth Conductor (mm2)
60/100	1	16
200	1	50
300	1	50
400	1	70
500	2	70
600	2	70
800	2	70
1000	2	70
1600	2	70
2000	2	150
2500	2	150

Note 1: *standard Earth Electrode diameters are 9mm, 12.5mm or 15mm for copper-clad steel, or 16mm for stainless steel. Standard lengths are 1.2m or 1.5m (see also BS 7430).*

Note 2: *structural foundations of large buildings may be used as Earth Electrodes, see Clause 6.4.8 and 6.8.4.*

A5.(I) Mandatory connections to Earth Conductors

The following items must be connected to the Circuit Earth Conductor, which should be provided separately for each Final Circuit, insulated with green/yellow PVC sheath, be of the appropriate size (Appendix A5(j)) and be installed in the same conduits or routes as the phase and neutral conductors.

Items where connections must be made to the Circuit Earth Conductor	
Distribution Boards:	Exposed-Conductive-Parts (frame, door etc.)
Metal conduits, trunking, Cable Trays and ladders:	at start and end of runs, at pulling points intersections and inspection boxes
Switchgear:	Exposed-Conductive-Parts (frame, door etc.)
Luminaires:	Exposed-Conductive-Parts
Switches:	Exposed-Conductive-Parts (mounting boxes, cover plates)
Socket-outlets:	Exposed-Conductive-Parts (mounting boxes, cover plates)
Fixed appliances and machinery:	Exposed-Conductive-Parts (metal casing etc.)

Note 1: *the Earthing of cover plates should not rely solely on the connection of fixing screws to an Earthed mounting box (due to the possibility of poor connections, corrosion etc.); a short flexible Earth Conductor should be connected between the mounting box and the plate. See Guidance Note G7(d).*

Note 2: *the Circuit Earth Conductor should be terminated in the connection box for a Luminaire even if it is plastic (to provide for future use and protection of the Circuit itself). See Guidance note G7(d).*

A5.(m) Residual Operating current settings for RCDs and ELP devices

Equipment	Maximum Residual operating current settings (mA)
13 A switched-socket outlets	30
Water heaters	30
Kitchen fixed Appliances (e.g. washing machine)	30
Domestic water pumps	30
Swimming pool pumps, or jacuzzi	30
Underwater lighting	SELV only
General fixed lighting (except in bathrooms and swimming pools)	100
Floodlighting	100 - 300
Window or split type air-conditioning	100
Air handling, a/c fan coils etc	100
Central or package a/c units	100 - 300
Irrigation pump	100
Electric Cooker	30
Industrial machines etc	100 - 300
Elevators, escalators, lifts	300 - 500
Neon signs	300
School areas (e.g. laboratory for children)	10
LV main circuit breakers or switchboards (Electricity Intake)	See Note 4

Note 1: *where two values are indicated, the higher value is allowed only where the equipment is not normally accessible to any person.*

Note 2: *all Final Circuits in a bathroom (including lighting, but excluding FCUs in a ceiling void) must be provided with 30mA RCD protection. See Clause 9.3.2(a).*

A5.(m) Continued...

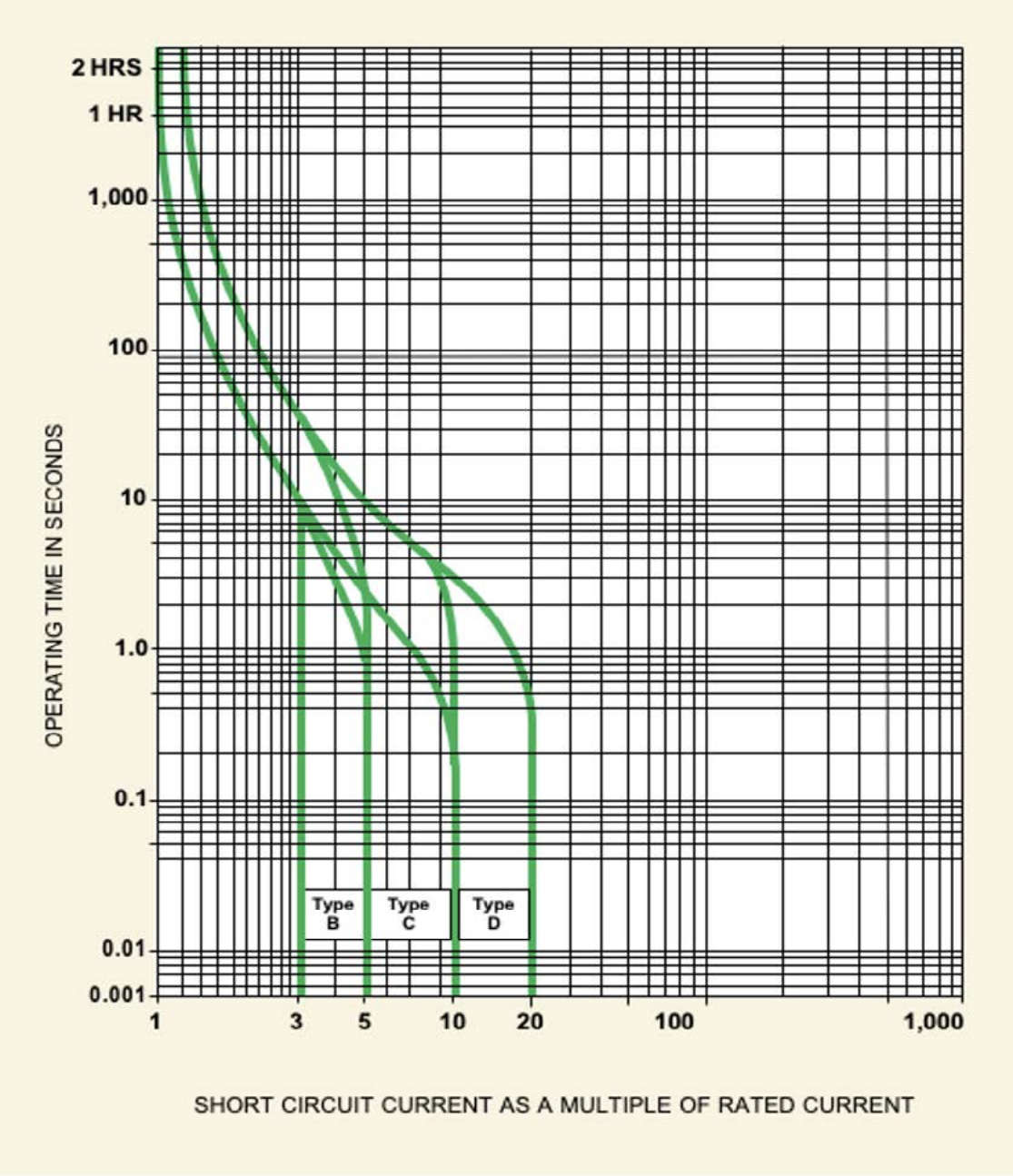
Note 3: where a Circuit supplies more than one type of equipment, the lower value must be used for RCD protection (e.g. a Circuit supplying bedroom lighting and bathroom lighting must be protected by a 30mA RCD).

Note 4: the selection of ELP devices at main switchboards must take into account the requirement for discrimination with downstream Protective Devices (Clause 5.4.5 and 5.4.6). For small supplies (200A or less), a 300mA RCD device may be used, with time delay of 200ms. For larger supplies (above 200A), Earth Leakage Protection relays may be used in conjunction with MCCBs or ACBs incorporating a trip unit (e.g. 1A, 3A, 5A with a suitable time delay to ensure proper discrimination with downstream Protective Devices). Irrespective of the Earth Leakage Protection provided at the main switchboard, the incomer MCCB or ACB shall have short-circuit protection to ensure tripping within 400ms taking into account the Earth Fault Loop Impedance.

The table opposite shows the required residual operating current values for RCDs and other Earth Leakage Protection devices. These are intended to provide supplementary protection of electric shock as well as protection against high resistance earth faults which may not operate overcurrent devices and pose a risk of overheating or fire, see Regulation 5.4.

All Final Circuits where Appliances may be used by any person must be provided with Earth Leakage Protection. Earth Leakage Protection must also be provided at the main Electricity Intake and subsequent Distribution Boards where necessary, see Regulation 5.4.

A6.(a) Time-current characteristic of MCBs as multiple of rated current



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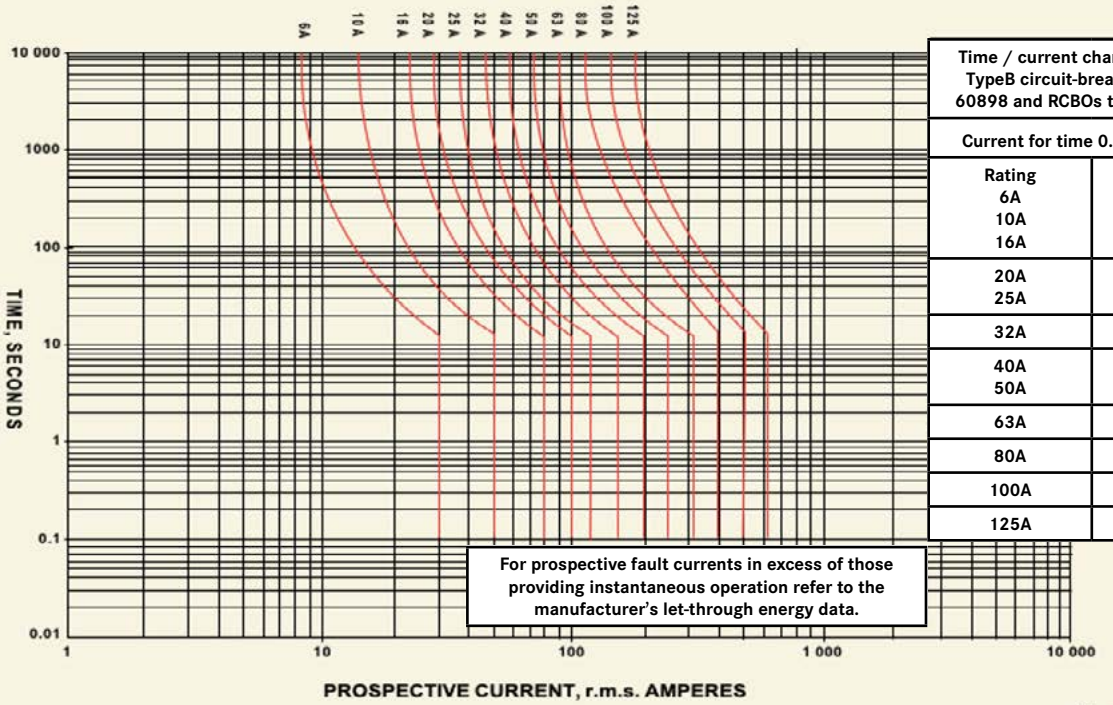
[see notes to A6(f)]

A6.(b) Time-current characteristic of Type B MCBs

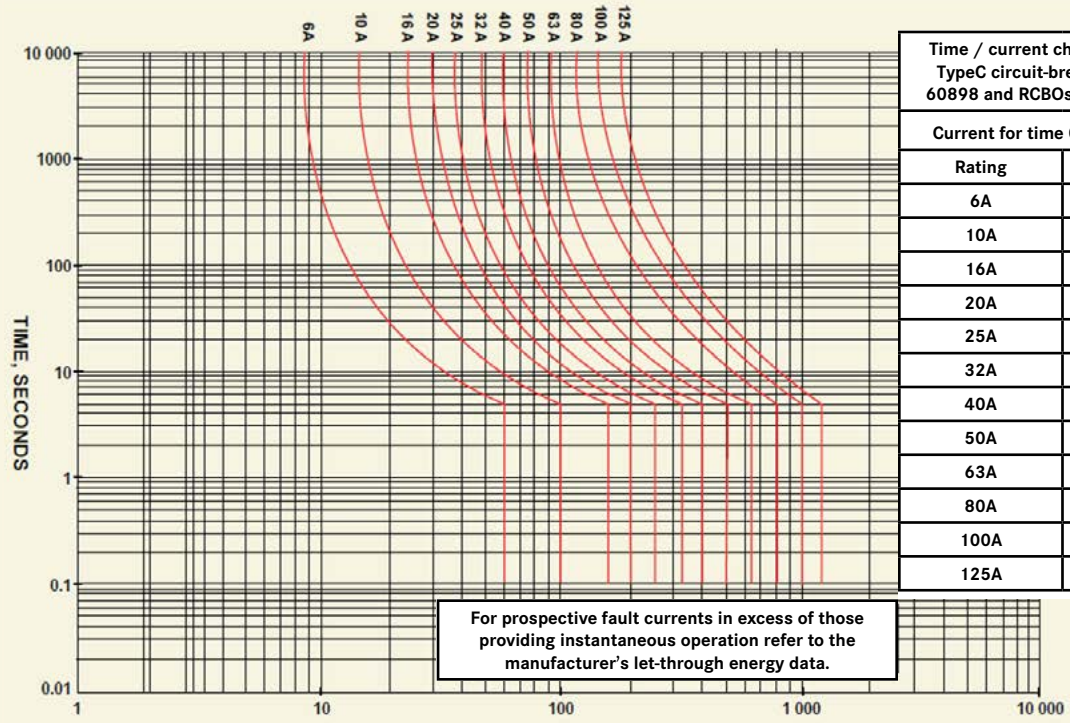


Time / current characteristics for TypeB circuit-breakers to BS EN 60898 and RCBOs to BS EN 61009	
Current for time 0.1 sec to 5 secs	
Rating	Current
6A 10A 16A	30A 50A 80A
20A 25A	100A 125
32A	160A
40A 50A	200A 250A
63A	315A
80A	400A
100A	500A
125A	625A

For prospective fault currents in excess of those providing instantaneous operation refer to the manufacturer's let-through energy data.

[from fig. 3A4 of BS 7671]

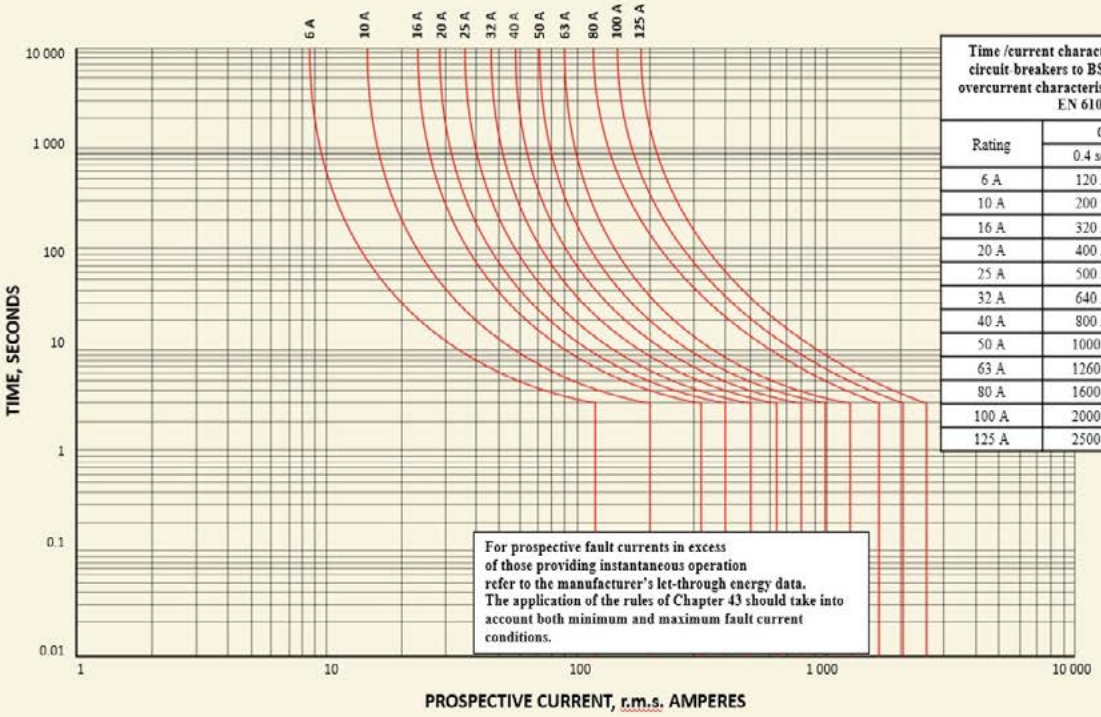
A6.(c) Time-current characteristic of Type C MCBs



Time / current characteristics for TypeC circuit-breakers to BS EN 60898 and RCBOs to BS EN 61009	
Current for time 0.1 sec to 5 secs	
Rating	Current
6A	60A
10A	100A
16A	160A
20A	200A
25A	250A
32A	320A
40A	400A
50A	500A
63A	630A
80A	800A
100A	1000A
125A	1250A

[from fig. 3A5 of BS 7671]

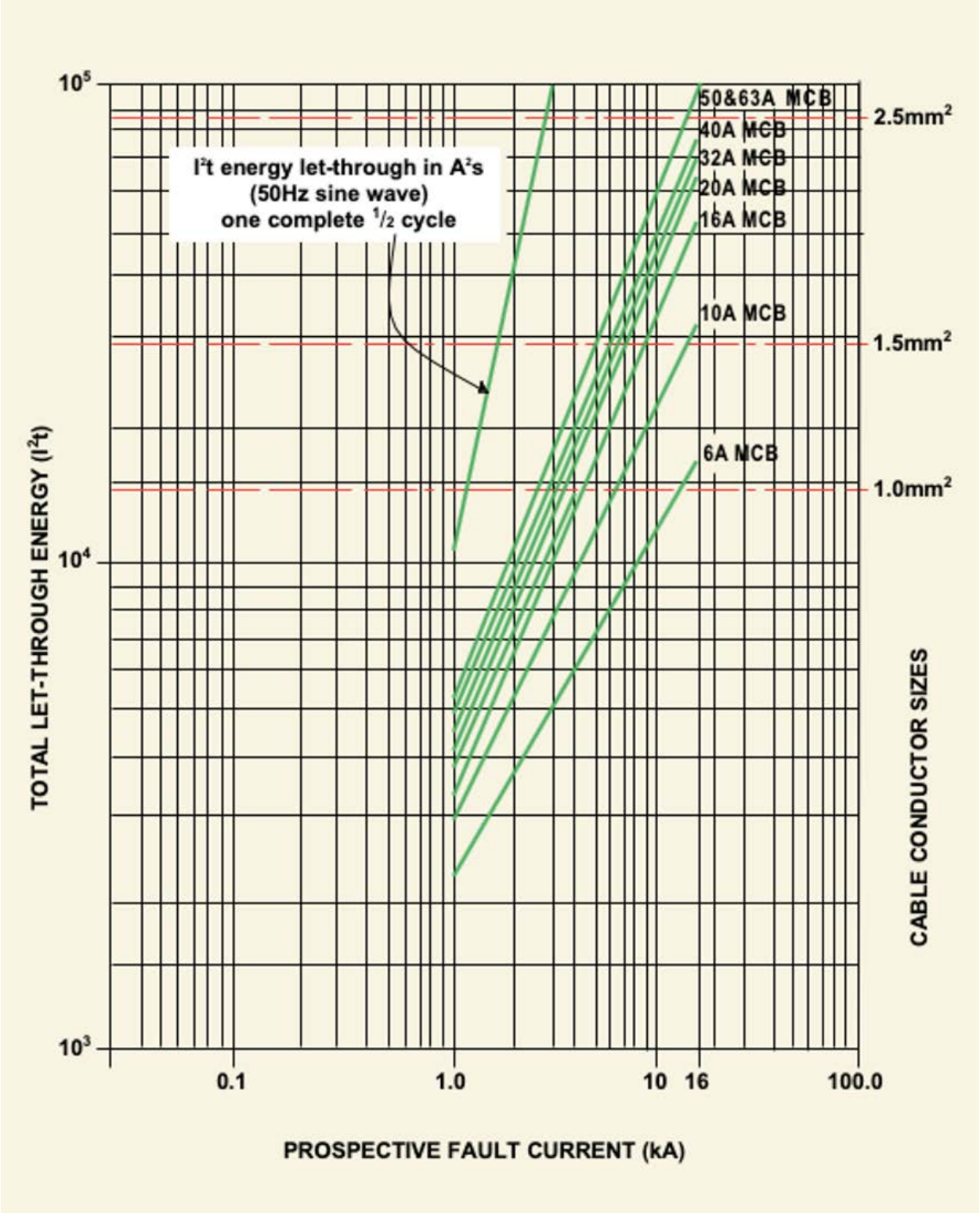
A6.(d) Time current characteristic of Type D MCBs



Time /current characteristics for Type D circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1

Rating	Current for time	
	0.4 sec	5 sec
6 A	120 A	60 A
10 A	200 A	100 A
16 A	320 A	160 A
20 A	400 A	200 A
25 A	500 A	250 A
32 A	640 A	320 A
40 A	800 A	400 A
50 A	1000 A	500 A
63 A	1260 A	630 A
80 A	1600 A	800 A
100 A	2000 A	1000 A
125 A	2500 A	1250 A

A6.(e) Typical energy let-through characteristics of MCBs



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A6.(f) MCBs selection criteria

Operating characteristics of MCB types and the required Earth Fault Loop Impedance values are given in Appendix A6(a) to A6(d) and Appendix A5(h). MCBs for common cable sizes and Circuits are shown in the following table:

MCB nominal rating Amps	Cable size mm2	Cable rating at 30˚C, PVC Amps, (kW)	Cable rating at 40˚C, PVC Amps, (kW)	Typical Circuit application
6	1.5	17.5 (3.4)	15.2 (3.0)	Lighting (light load)
10	2.5	24.0 (4.7)	20.9 (4.1)	Lighting (heavy load)
16	2.5	24.0 (4.7)	20.9 (4.1)	Radial Circuit to socket- outlets
20	4.0	32.0 (6.3)	27.8 (5.4)	Radial Circuit to fixed appliance
32	2x4.0	48 (9.3)	41.7 (8.1)	Ring Circuit to socket-outlets
32	6.0	41.0 (8.0)	35.7 (7.0)	Radial Circuit to large Appliance (e.g. cooker)
40	10.0	57.0 (11.1)	49.6 (9.7)	Radial Circuit to machinery (e.g. chiller unit)

Note 1: *cable ratings are taken from Appendix A7(a), assuming one circuit in conduit, with temperature correction factors applied from Appendix A7(g). Power factor of 0.85 is assumed to calculate kW ratings at 230V.*

Note 2: *selection of MCBs for overload protection of cables must take account of the device characteristics given in Appendix A6(b) to A6(d). These are based on minimum MCB operating currents of 1.45 times the MCB nominal rating (In) and a maximum 'non-tripping' current of 1.15 times In. Hence, cables must be selected with ratings at least 1.15 times the MCB nominal rating (see IEE Guidance Note 6 - section 2).*

The classification of Types B, C or D is based on the fault current rating at which magnetic operation occurs and their ability to handle surge currents without tripping. See Appendix A6(a).

- Type B devices are designed to trip at fault currents of 3-5 times rated current (In). For example, a 10A device will trip at 30-50A
- Type C devices are designed to trip at 5-10 times In
- Type D devices are designed to trip at 10-20 times In

A6.(f) Continued...

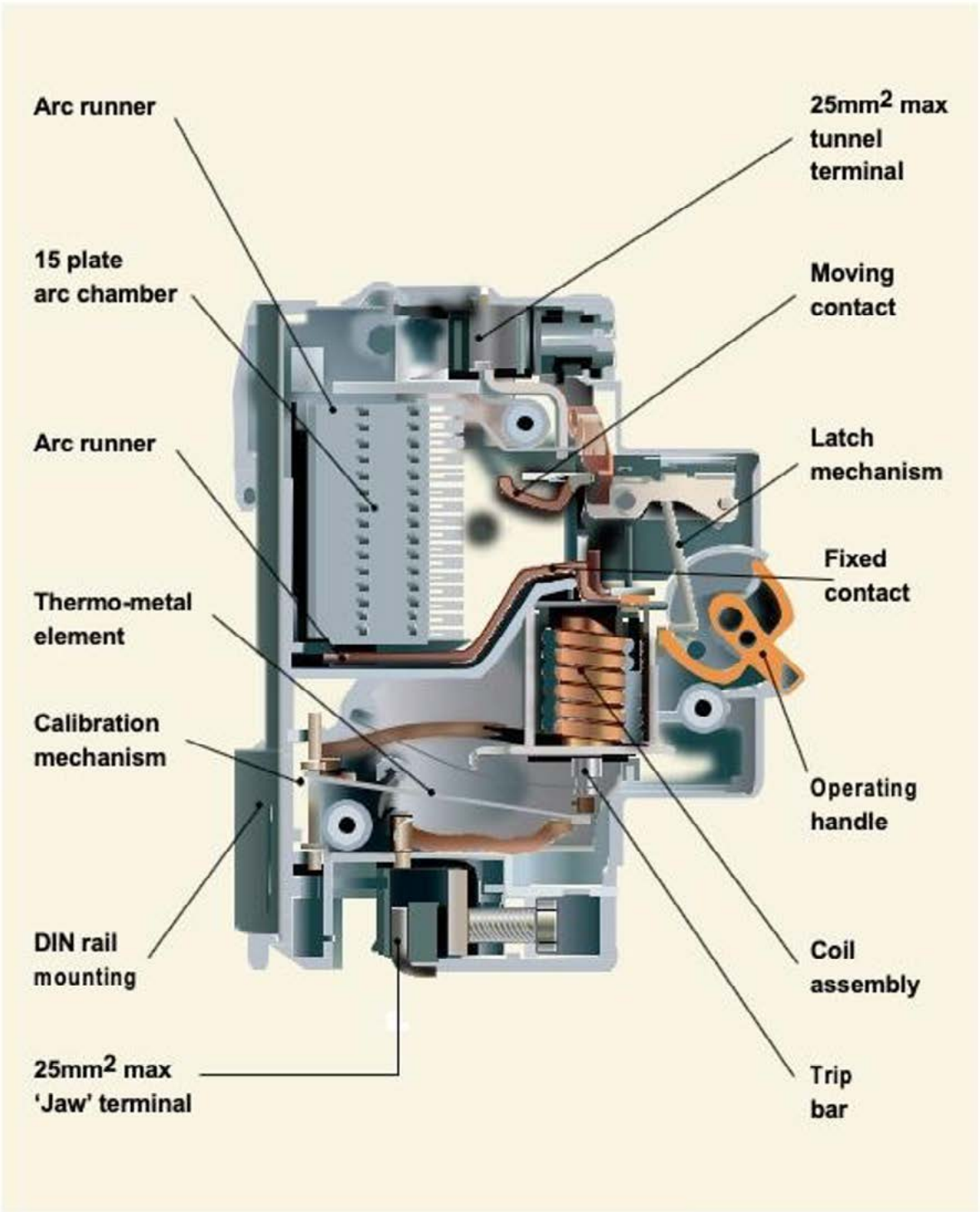
Type B devices are generally suitable for domestic applications. Type C devices are the normal choice for commercial and industrial applications where large groups of fluorescent lighting, motors, etc. are used.

Type D devices have more limited applications, where high inrush currents may be expected. For example, large battery systems, motors, transformers, etc.

Sometimes failure of tungsten filament lamps can trip Type B circuit- breakers in domestic and retail environments. This is caused by high arcing currents occurring at the time of failure and is generally associated with inferior quality lamps. A Type C device may be substituted for a Type B device where unwanted tripping persists, especially in commercial applications. A change from Type C to Type D devices should only be taken after careful consideration of the installation conditions, in particular the operating times required by Regulation 5.5.

(Referenced from www.voltimum.co.uk)

A6.(g) Internal construction of MCB



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A7.(a) Circuit rating and Voltage drop for PVC single core cables (non- armoured)

Standard cable ratings and Voltage drop for single core, PVC (70˚C thermoplastic), non-armoured, stranded copper conductor (BS 6004), with or without sheath, installed in buried or surface conduit or trunking.

Cross sectional area (mm²)	In conduit in thermal insulation (A)		In conduit on wall or in concrete (A)		Voltage drop (mV/A/m)	
	2 cables single phase AC or DC	3 or 4 cables three phase AC	2 cables single phase AC or DC	3 or 4 cables three phase AC	2 cables single phase AC or DC	3 or 4 cables three phase AC
1.0	11	10.5	13.5	12	44	38
1.5	14.5	13.5	17.5	15.5	29	25
2.5	20	18	24	21	18	15
4.0	26	24	32	28	11	9.5
6.0	34	31	41	36	7.3	6.4
10	46	42	57	50	4.4	3.8
16	61	56	76	68	2.8	2.4
25	80	73	101	89	-	-
35	99	89	125	110	-	-
50	119	108	151	134	-	-
70	151	136	192	171	-	-

At 30°C ambient temperature [see Appendix A7(g) for grouping factors]

Note 1: *data from table 4D1A and 4D1B of BS 7671.*

Note 2: *for Voltage drop for cables above 25mm2 refer to BS 7671.*

A7.(b) Circuit rating and Voltage drop for PVC multi-core cables (non- armoured)

Standard cable ratings and Voltage drop for PVC (70˚C thermoplastic) multi-core cables (sheathe non-armoured, stranded copper conductor (BS 6004), installed in buried or surface mounted cond or trunking, or on exposed, perforated cable tray.

Cross sectional area (mm^2)	In conduit on wall or in concrete (A)		Clipped direct to a wall (A)		On perforated Cable Tray or in free air (A)	
	2 core single phase AC or DC	3 or 4 cables three phase AC	2 core single phase AC or DC	3 or 4 cables three phase AC	2 core single phase AC or DC	3 or 4 cables three phase AC
1.0	11	10	13	11.5	15	13.5
1.5	14	13	16.5	15	19.5	17.5
2.5	18.5	17.5	23	20	27	24
4	25	23	30	27	36	32
6	32	29	38	34	46	41
10	43	39	52	46	63	57
16	57	52	69	62	85	76
25	75	68	90	80	112	96
35	92	83	111	99	138	119
50	110	99	133	118	168	144
70	139	125	168	149	213	184
95	167	150	201	179	258	223
120	192	172	232	206	299	259
150	219	196	258	225	344	299

At 30˚C ambient temperature [see Apenddix A7(g) for grouping factors]

Note 1: *data taken from table 4D2A and 4D2B of BS 7671.*

Note 2: *2-core refers to single-phase Circuits; 3 or 4-core refers to three-phase Circuits*

A7.(b) Continued...

Standard cable ratings and Voltage drop for PVC (70˚C thermoplastic) multi-core cables (sheathed), non-armoured, stranded copper conductor (BS 6004), installed in buried or surface mounted conduit or trunking, or on exposed, perforated cable tray.

	Cable size (mm^2)						
Voltage drop (mV/A/m)	1.0	1.5	2.5	4	6	10	16
2 core single phase AC or DC	44	29	18	11	7.3	4.4	2.8
3 or 4 core three phase AC	38	25	15	9.5	6.4	3.8	2.4

Note: *for Voltage drop for cables above 16mm^2 refer to BS 7671.*

A7.(c) Circuit rating and Voltage drop for PVC multi-core cables (armoured)

Standard cable ratings and Voltage drop for PVC (70˚C thermoplastic) multi-core cables (sheathed), non-armoured, stranded copper conductor (BS 6004), installed in buried or surface mounted conduit or trunking, or on exposed, perforated cable tray.

Cross sectional area (mm^2)	Clipped direct to a wall (A)		On perforated Cable Tray (A)		Voltage drop (mV/A/m)	
	2 core single phase AC or DC	3 or 4 core three phase AC	2 core single phase AC or DC	3 or 4 core three phase AC	2 core single phase AC or DC	3 or 4 core three phase AC
1.5	21	18	22	19	29	25
2.5	28	25	31	26	18	15
4	38	33	41	35	11	9.5
6	49	42	53	45	7.3	6.4
10	67	58	72	62	4.4	3.8
16	89	77	97	83	2.8	2.4
25	118	102	128	110	-	-
35	145	125	157	135	-	-
50	175	151	190	163	-	-
70	222	192	241	207	-	-
95	269	231	291	251	-	-
120	310	267	336	290	-	-
150	356	306	386	332	-	-
185	405	348	439	378	-	-
240	476	409	516	445	-	-
300	547	469	592	510	-	-

At 30˚C ambient temperature [see Appendix A7(g) for grouping factors]

Note 1: *data taken from table 4D4A and 4D4B of BS 7671.*

Note 2: *2 core refers to single-phase Circuits; 3 or 4 core refers to three-phase Circuits.*

Note 3: *for Voltage drop for cables above 16mm² refer to BS 7671.*

A7.(d) Circuit rating and Voltage drop for thermo-setting (XLPE) multi-core cables (armoured)

Standard cable ratings and Voltage drop for PVC (70˚C thermoplastic) multi-core cables (sheathed), non-armoured, stranded copper conductor (BS 6004), installed in buried or surface mounted conduit or trunking, or on exposed, perforated cable tray.

Cross sectional area (mm^2)	Clipped direct to a wall (A)		On perforated Cable Tray (A)		Voltage drop (mV/A/m)	
	2 core single phase AC or DC	3 or 4 core three phase AC	2 core single phase AC or DC	3 or 4 core three phase AC	2 core single phase AC or DC	3 or 4 core three phase AC
1.5	27	23	29	25	31	27
2.5	36	31	39	33	19	16
4	49	42	52	44	12	10
6	62	53	66	56	7.9	6.8
10	85	73	90	78	4.7	4.0
16	110	94	115	99	2.9	2.5
25	146	124	152	131	-	-
35	180	154	188	162	-	-
50	219	187	228	197	-	-
70	279	238	291	251	-	-
95	338	289	354	304	-	-
120	392	335	410	353	-	-
150	451	386	472	406	-	-
185	515	441	539	463	-	-
240	607	520	636	546	-	-
300	698	599	732	628	-	-

At 30˚C ambient temperature [see Appendix A7(g) for grouping factors]

Note 1: *from table 4E4A and 4E4B of BS 7671 [2 core refers to single-phase Circuits, 3 or 4 core refers to three-phase Circuits].*

Note 2: *for Voltage drop for cables above 16mm² refer to BS 7671 table 4E4B.*

A7.(e) Circuit rating for MICC cable

Standard cable ratings and Voltage drop for mineral insulated copper- clad cables installed on a wall (clipped direct). PVC sheathed cable assumes 70˚C sheath temperature, bare copper-clad cable assumes 105˚C sheath temperature.

	Cross-sectional area	PVC sheath (70˚C) 2 x single or twin core cable AC or DC	PVC sheath (70˚C) 3 core	Bare sheath 105˚C 2 x single or 1 two core cable, single phase AC or DC	Bare sheath 105˚C 3 x single or 1 three core, or four core cable
	(mm²)	(A)	(A)	(A)	(A)
Light duty 500 V	1.0	18.5	15	22	19
	1.5	23	19	28	24
	2.5	31	26	38	33
	4	40	35	51	44
Heavy duty 750 V	1	19.5	16	24	20
	1.5	25	21	31	26
	2.5	34	28	42	35
	4	45	37	55	47
	6	57	48	70	59
	10	77	65	96	81
	16	102	86	127	107
	25	133	112	166	140
	35	163	137	203	171
	50	202	169	251	212

At 30˚C ambient temperature [see Apenddix A7(g) for grouping factors]

Note 1: *for MICC cable installed in perforated Cable Tray, the current rating is approximately 5-10% greater than shown above, see BS 7671 table 4G1A and 4G2A.*

Note 2: *where the sheath temperature may be above 70˚C, care should be taken that the cable is not within reach of any person or in contact with combustible materials*

A7.(f) Circuit Rating and Voltage drop for flexible cords

Standard current ratings and Voltage drop for flexible cords, 60˚C conductor temperature (PVC or rubber insulated), stranded copper conductors to BS 50525 (domestic applications).

Cross sectional area	Single phase	Three phase	Voltage drop (single phase)	Voltage drop (three phase)	Mass supportable by twin flexible cord
(mm^2)	(A)	(A)	(mV/A/m)	(mV/A/m)	(kg)
0.5	3	3	93	80	2
0.75	6	6	62	54	3
1.0	10	10	46	40	5
1.25	13	-	37	-	5
1.5	16	16	32	27	5
2.5	25	20	19	16	5
4.0	32	25	12	10	5

At 30˚C ambient temperature [from table 4F3A and 4F3B of BS 7671:2018]

For ambient temperatures above 30˚C, the following correction factors may be applied for flexible cords:

Ambient temperature (°C)	35	40	45	50	55
Correction factor	0.91	0.82	0.71	0.58	0.41

A7.(g) Rating factors with respect to ambient (air) temperature

Ambient temperature correction factors (relative to 30°C) for cable ratings shown in Appendices A7 (a) to A7 (e).

	Type of cable insulation			
Ambient temperature (°C)	70°C PVC thermo-plastic	90°C Rubber or XLPE thermosetting	mineral insulated (70°C sheath)	mineral insulated (105°C sheath)
25	1.03	1.02	1.07	1.04
30	1.00	1.00	1.00	1.00
35	0.94	0.96	0.93	0.96
40	0.87	0.91	0.85	0.92
45	0.79	0.87	0.78	0.88
50	0.71	0.82	0.67	0.84
55	0.61	0.76	0.57	0.80
60	0.50	0.71	0.45	0.75

[from table 4B1 of BS7671:2018]

A7.(h) Rating factors with respect to grouping of cables

Because of mutual heating effects, the following correction factors should be applied to the tables in Appendix A7(a) to A7(e) for situations where a number of cables are installed close together. These factors assume all cables are fully loaded; however, if an individual cable is loaded below 30% of its rating it may be excluded from the total number in the group.

	Method of installation			
Number of cables	Enclosed in conduit (surface or buried) or bunched on a non- metallic surface	Single layer, clipped to a non-metallic surface (wall or floor)	Single layer multi-core on a perforated Cable Tray	Single layer multi-core on cable ladder system or cleats
2	0.80	0.85	0.88	0.87
3	0.70	0.79	0.82	0.82
4	0.65	0.75	0.77	0.80
5	0.60	0.73	0.75	0.80
6	0.57	0.72	0.73	0.79
7	0.54	0.72	0.73	0.79
8	0.52	0.71	0.72	0.78
9	0.50	0.70	0.72	0.78
12	0.45	0.70	0.72	0.78
16	0.41	0.70	0.72	0.78
20	0.38	0.70	0.72	0.78

[taken from table 4C1 of BS of BS 7671:2018]

Note 1: *these factors are applicable to uniform groups of cable, equally loaded.*

Note 2: *where horizontal clearances between adjacent cables exceed twice their overall diameter, no rating factor need to be applied*

A8. Colour identification for cables

Conductor	Colour
Non-flexible fixed wiring and all three-phase cables:	
Phase 1	Red
Phase 2	Yellow
Phase 3	Blue
Neutral	Black
Earth Conductors	Green / yellow
Functional Earth	Cream
Solar PV system DC cables	Black
Flexible cables for single-phase Appliances:	
Phase 1	Brown
Neutral	Blue
Earth Conductors	Green / yellow
Functional Earth	Cream

Note 1: *the harmonised cable colours now implemented in Europe (BS EN 60445 effective from December 2017) of Brown, Black and Grey for phase 1, phase 2, and phase 3 respectively have not been adopted for the Emirate of Abu Dhabi.*

A9. Capacity of conduits, trunking and Cable Trays

Conductor (mm2)	Diameter of Conduit (mm)		
	20	25	32
	Maximum number of conductors		
1.5	7	12	-
2.5	5	9	12
4.0	3	6	9
6.0	-	5	8
10.0	-	3	6
16.0	-	-	4
25.0	-	-	3

Note 1: *for Cable Trunking, the space factor (total cross-sectional area of cables compared with the interior cross-sectional area of trunking) must not exceed 50%. Trunking is sized by multiplying the number of cables by the cable factor for each cable, applying the space factor to determine the capacity required. The appropriate trunking is then selected from the capacity chart published by the manufacturers.*

Note 2: *for Cable Trays, the sum of the combined diameter of all cables installed on the tray shall not exceed 60% of the internal Cable Tray width. Where cables are spaced on the Cable Tray, this can be used as part of the space factor.*

A10. IP coding for ingress protection

Ingress protection: IP codes	
First digit: protection against ingress by solid objects	Second digit: protection against ingress of water
X Not tested or not applicable	X Not tested or not applicable
0 No protection	0 No protection
1 Human hand or objects > 50mm	
2 Human finger or objects > 12mm	2 Sprays of water < 15˚ from vertical
3 Objects > 2.5mm (e.g. tools or wires)	3 Sprays of water < 60˚ from vertical
4 Objects > 1.0mm (e.g. small wires)	4 Splashes of water (from any direction)
5 Limited protection against dust (to the extent that does not harm the equipment or impair safety)	5 Low pressure jets of water (from any direction)
6 Totally protected against dust	6 Strong jets of water (from any direction)
	7 Temporary immersion
	8 Total immersion

The IP coding system is specified in BS EN 60529: 1992 (adopted from IEC 529:1989). The first digit specifies protection against ingress of foreign objects of varying size, ranging from human hands or fingers to fine dust particles. The second digit specifies protection against ingress of water, ranging from free falling water, to immersion in water.

BS EN 60529 does not specify protection against the risk of explosion, humidity or corrosive gases. If enclosures of equipment are drilled or knockouts removed, suitable measures should be taken to restore the equipment to the original IP rating.

A11. Standard wiring diagram symbols

Symbol	Description
	Main Distribution Board (MDB)
	Sub Main Distribution Board (SMDB)
	Distribution Board (DB)
	Air Circuit Breaker (ACB)
	Moulded Case Circuit Breaker (MCCB)
	Miniature Circuit Breaker (MCB)
	Earth Leakage Protective Device (RCD)
	Fuse
	Link
	kWh meter (direct reading)
	kWh meter (ct operated)
	Switched line (e.g. connecting all outlets controlled by one switch)
	Circuit line (e.g. connecting all outlets on the same circuit)
	13 A switched socket outlet
	15 A switched socket outlet
	Switched fuse connection unit
	Unswitched fuse connection unit
	Industrial socket-outlet
	20 A double pole switch with neon indicator

Note: *additional wiring symbols may be taken from IEC 60617- Graphical symbols for diagrams*

A11. Continued

Symbol	Description
	Three phase isolator
	Single phase isolator
	Shaver socket to BS EN 61558-2-5
	Cooker control unit
	Tungsten light fitting - ceiling mounted
	Tungsten light fitting - wall mounted
	Fluorescent light fitting - ceiling mounted
	Fluorescent light fitting - wall mounted
	Light switch - 1 way
	Light switch - 2 way
	Light switch - intermediate way
	Light switch - pull cord operated
	Light switch - key operated
	Light switch - weather proof type
	Exhaust fan
	Ceiling mounted fan
	Low level cooker outlet connection
	Earth connection

Note: *additional wiring symbols may be taken from IEC 60617- Graphical symbols for diagrams*

A12.(a) Labelling of Electrical Installation

See clauses 3.6.1, 3.6.7, 8.1.5 and 9.9.21

See Appendix A10(f)

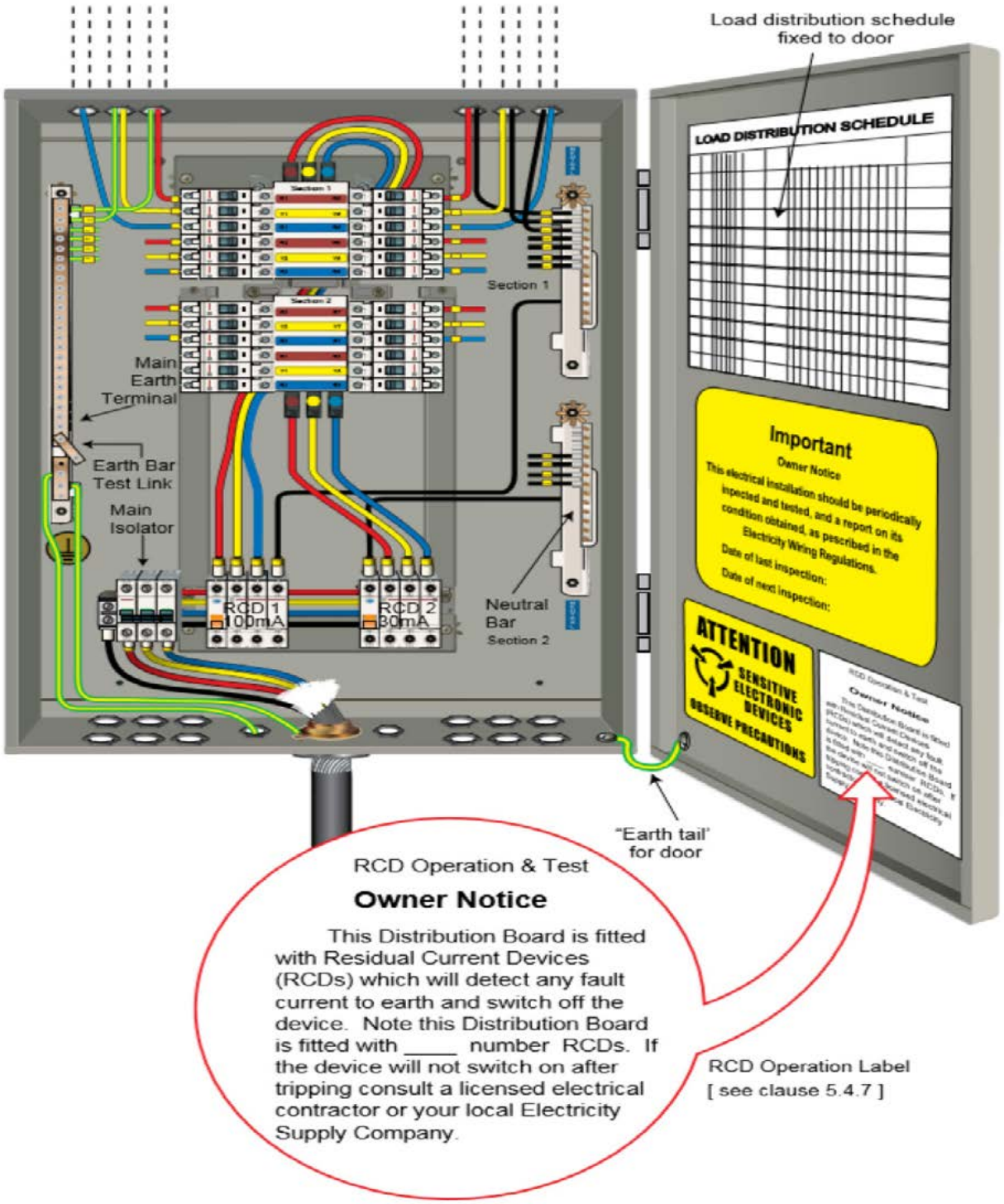
See Regulations 9.10

A12.(b) Minimum sizes of LV switchrooms

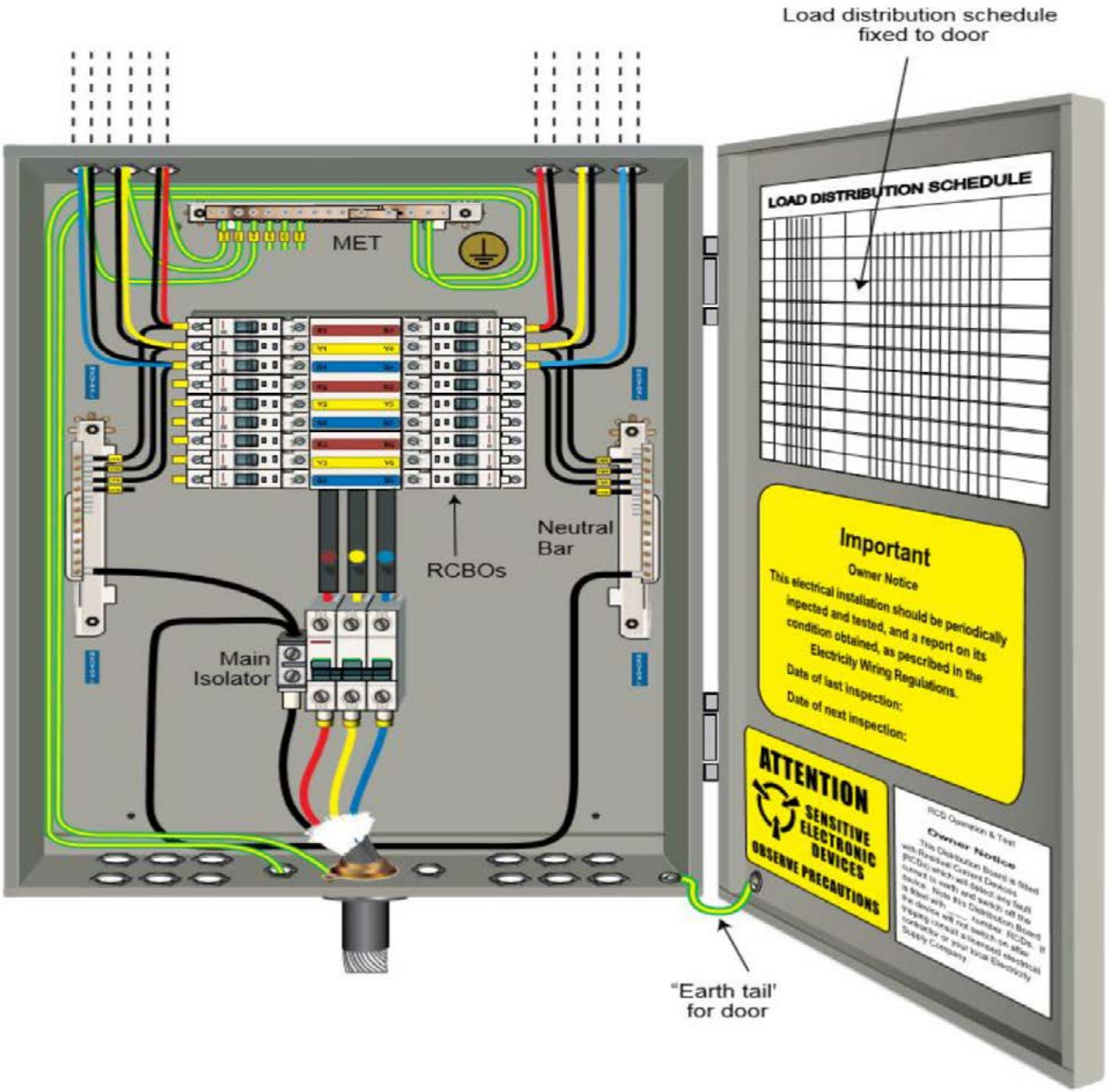
Minimum size of LV switchrooms	
Main circuit breaker rating (A)	Intake room dimensions (m)
1600 - 2500	3.5 x 3.5
1000 - 1200	3.0 x 3.0
600 - 800	2.5 x 2.5
400 - 500	2.5 x 2.0
200 - 300	2.0 x 2.0

Note: *the above rooms sizes are given for guidance and other requirements for access and safety should be taken into account (see Regulation 3.5, 4.2 and Appendix A 12(d))*

A12.(c) Typical layout of Final Distribution Boards (FDB) and RCD label

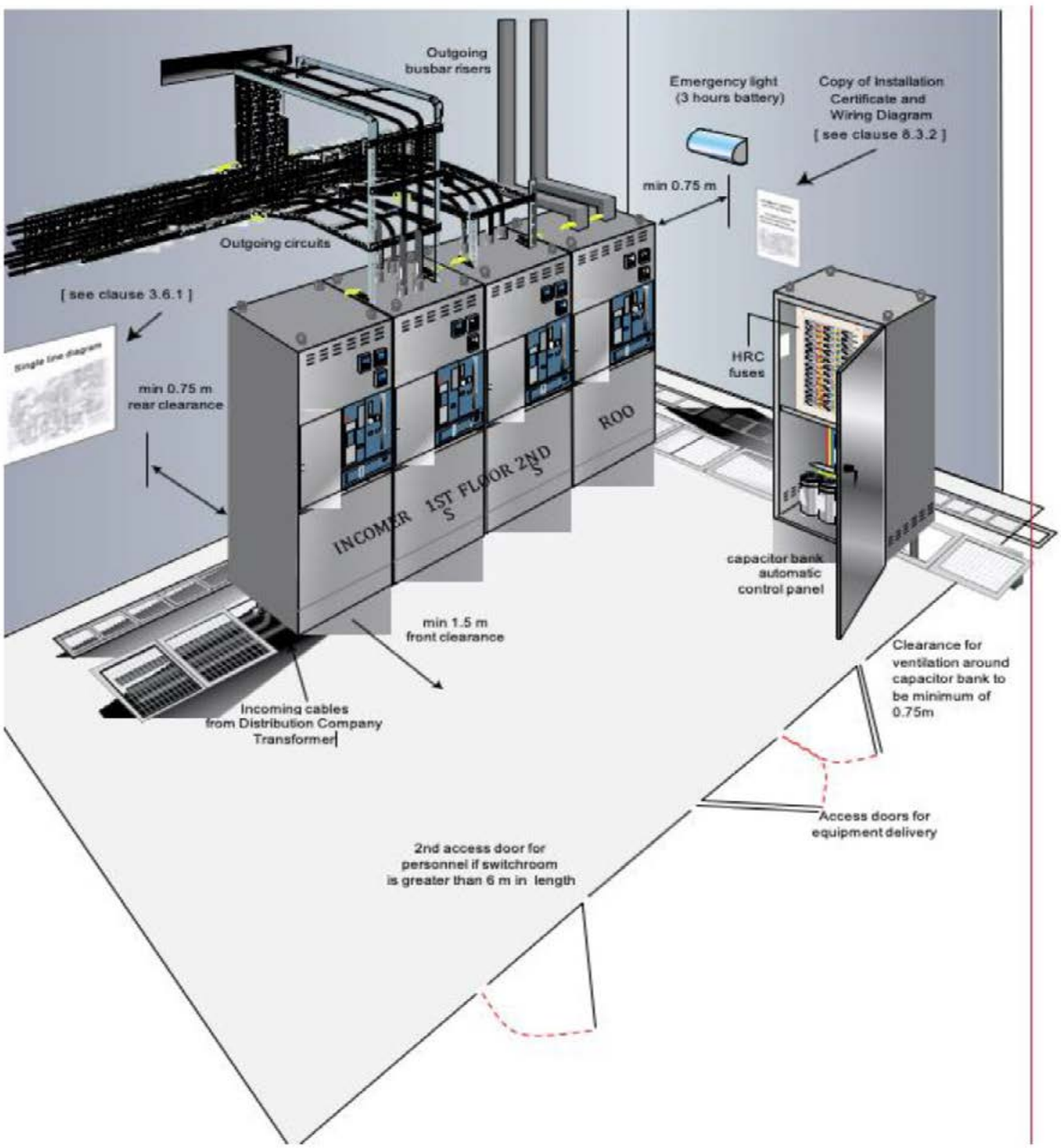


A 12.(c) Continued...



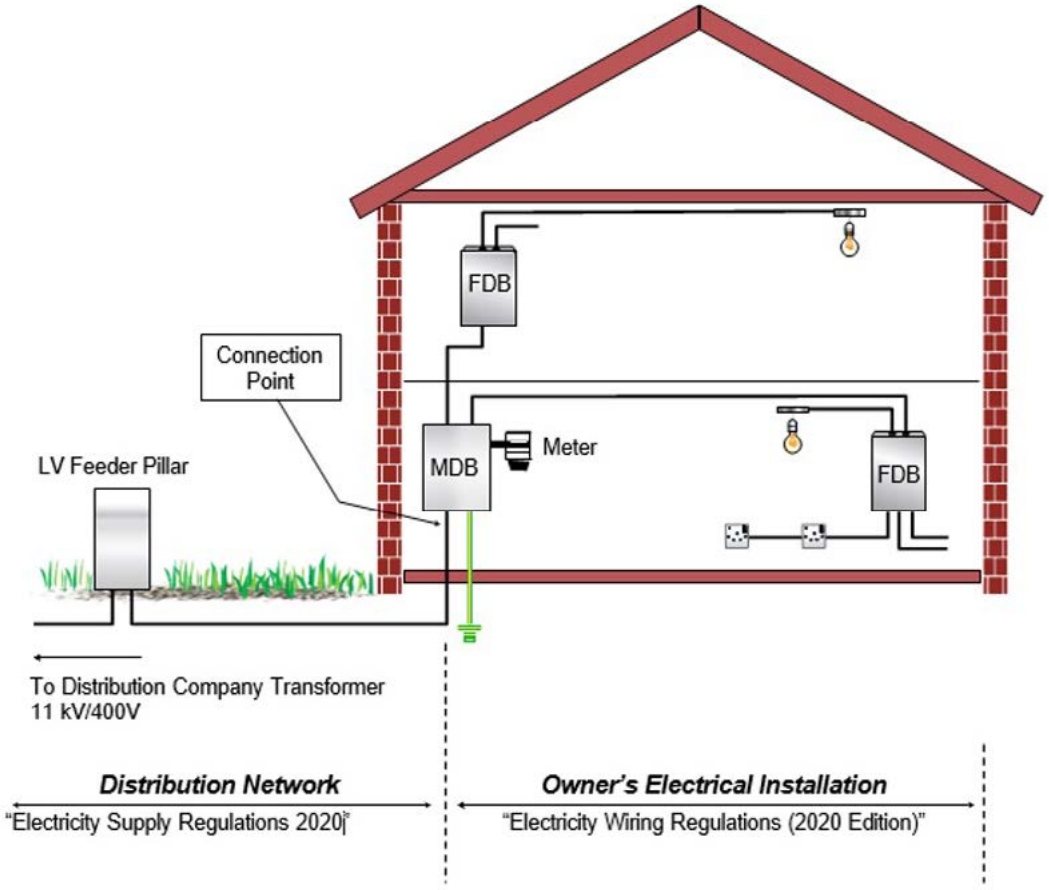
Note: *RCBOs Functional Earthing arrangements are not shown for clarity.*

A12.(d) Typical layout of LV switchroom



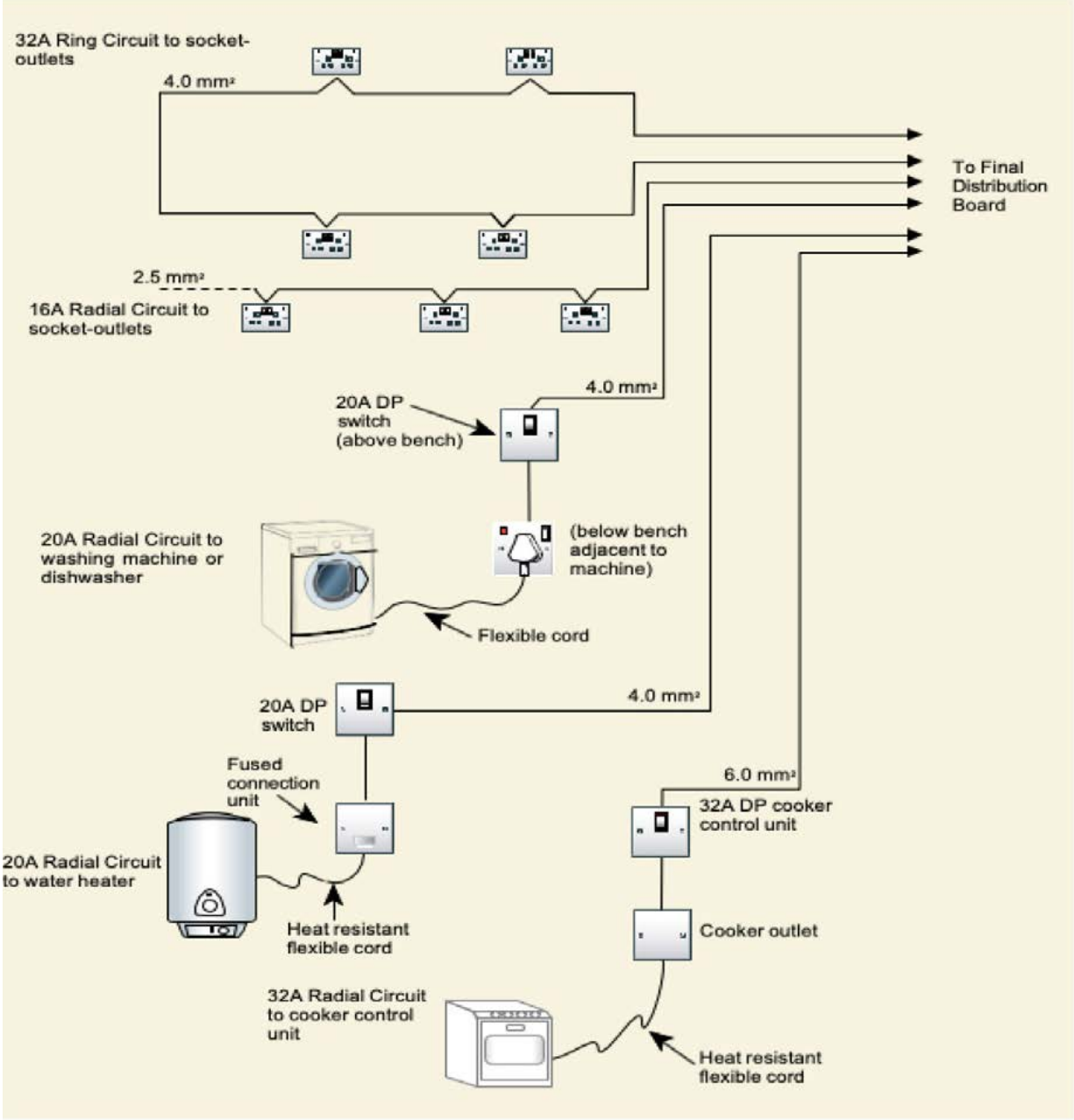
Note: *LV switchroom to be sized to accommodate the number of panels required (including spare positions) with minimum access clearances shown above. Headroom clearance should be sufficient to allow safe access for operation, maintenance and repairs in compliance with Clause 3.5.9.*

A 13. Boundary of Connection Point and scope of the Regulations



[see Regulation 4.3 and Clause 1.4.2]

A14. Typical layout for small power and lighting circuits

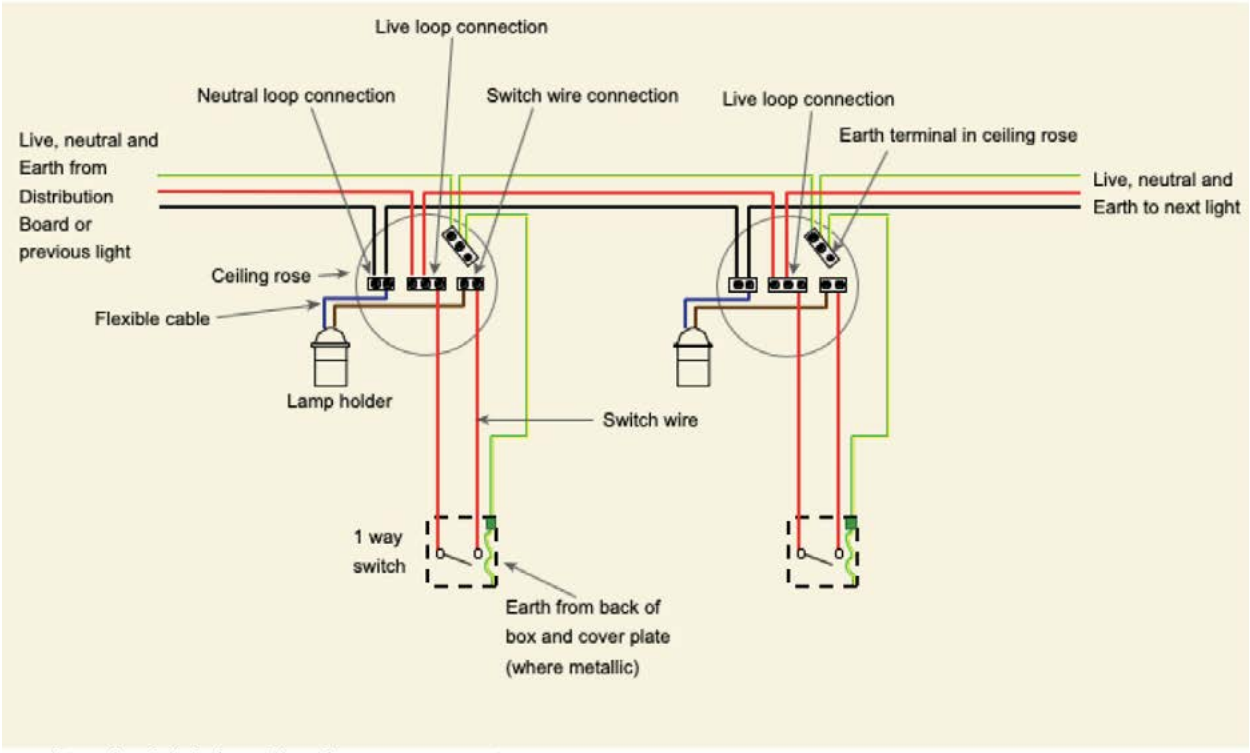


Note 1: *heat resistant flexible cords to be sized to match the rating of the Circuit.*

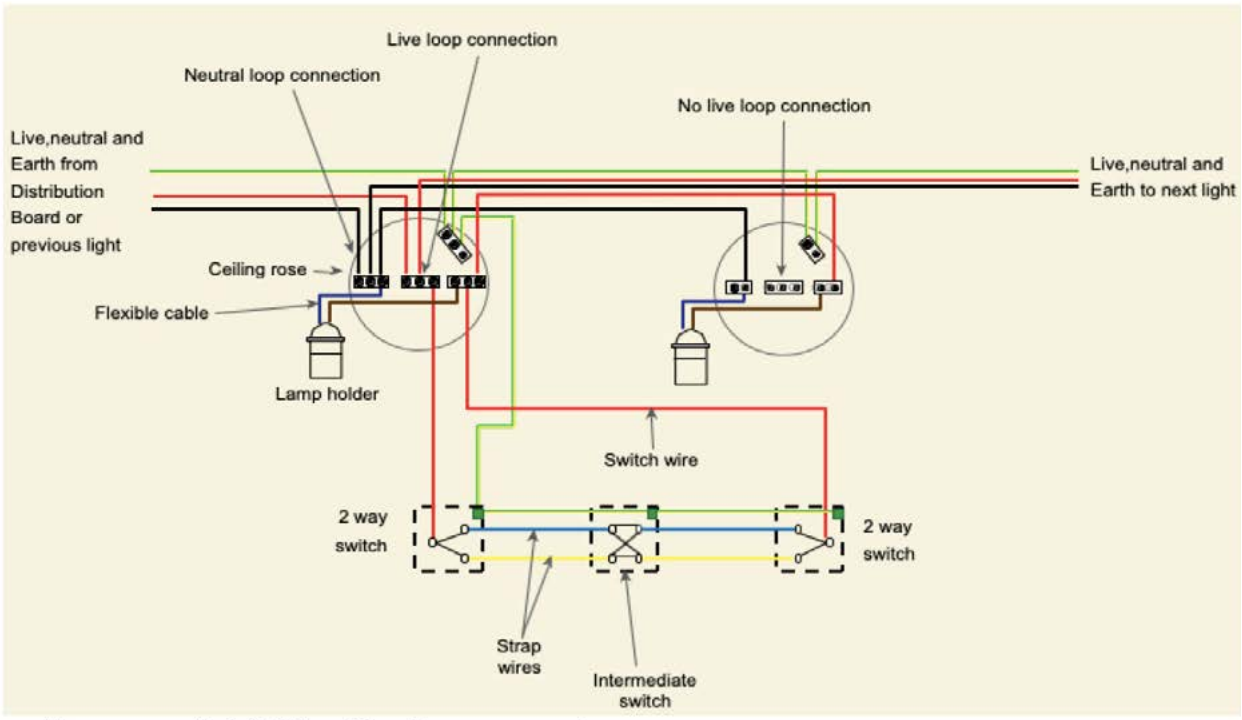
Note 2: *for cookers with higher power ratings, sizing of the Circuit to be increased accordingly.*

Note 3: *for connection to fixed Appliances, either fused connection unit or socket-outlet may be provided.*

A 14. Continued...



Standard lighting Circuit arrangement



Two-way switch lighting Circuit arrangement

A15. Minimum number of socket-outlets and connection points

Room	Minimum number of outlets for domestic premises
Kitchen:	
13A switched socket-outlets (worktops)	Minimum 2 double, plus every 2m of worktop
13A switched socket-outlets (Appliances)	Minimum 1 single, plus as required for free standing Appliances (e.g. fridge)
Connection points (for washing machine, dryer etc.)	Minimum 1, plus as required for number of items installed (flex outlets or socket- outlets)
Cooker control unit (if fitted with an integral socket- outlet)	1 (see note 5)
Bedrooms	3 double
Lounge or dining	4 double
Hall or corridor	1 double
Bathrooms	only BS EN 61558-2-5 shaver socket (if required)

Note 1: *in general, double socket-outlets should be used in preference to single socket-outlets wherever possible.*

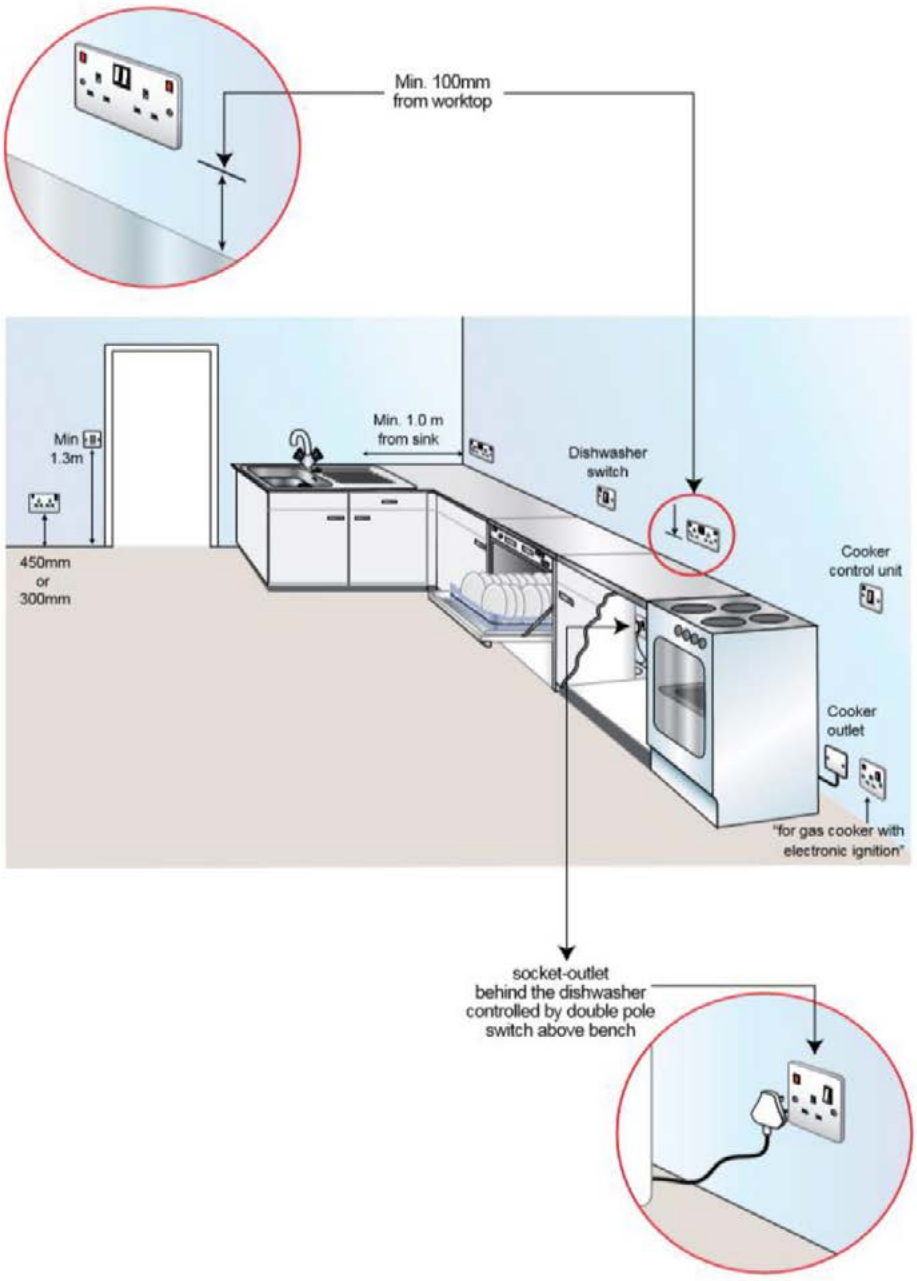
Note 2: *socket-outlets should be conveniently located to avoid the need for extension cables and adapters (which introduce risk of overheating and fire).*

Note 3: *15A BS 546 socket-outlets are not permitted in domestic premises (see Clause 7.1.1).*

Note 4: *the maximum number of socket-outlets on a Circuit is not limited and is dependent on the load supplied, the wire size and floor area served (see Appendix A6(f) and Guidance note G2).*

Note 5: *for Electrical Installation with a potential use of gas cookers, a provision for socket- outlet should be provided alongside the cooker outlet for the purpose of electronic ignition.*

A16. Mounting height for Accessories and socket-outlets



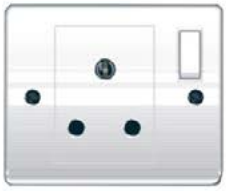
Note: *mounting height may be varied for special circumstances such as access for disabled persons or children, etc.*

[see Clauses 7.1.7, 7.1.9 and 7.2.5]

A17.(a) Approved and prohibited plugs and socket-outlets (domestic)

Approved BS 1363 plug and socket (13A fused)


Approved BS 1363 plug and socket (13A fused)

(non-domestic only)

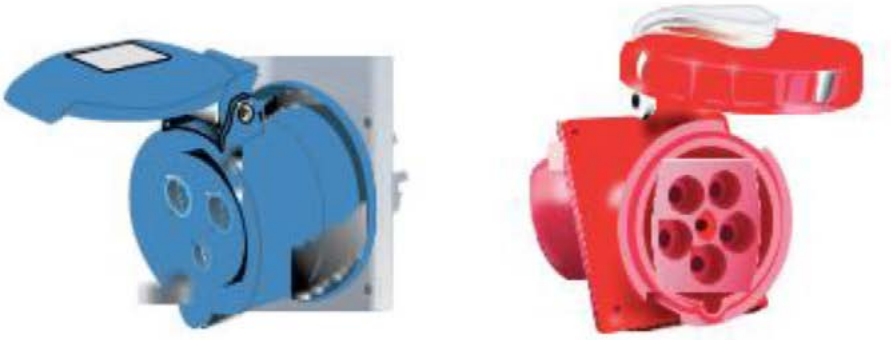
Prohibited C E7/7 'shuko' plug and socket


Type CEE7/16 'europlug' permitted only with a correct adapter


[see Regulation 7.1]

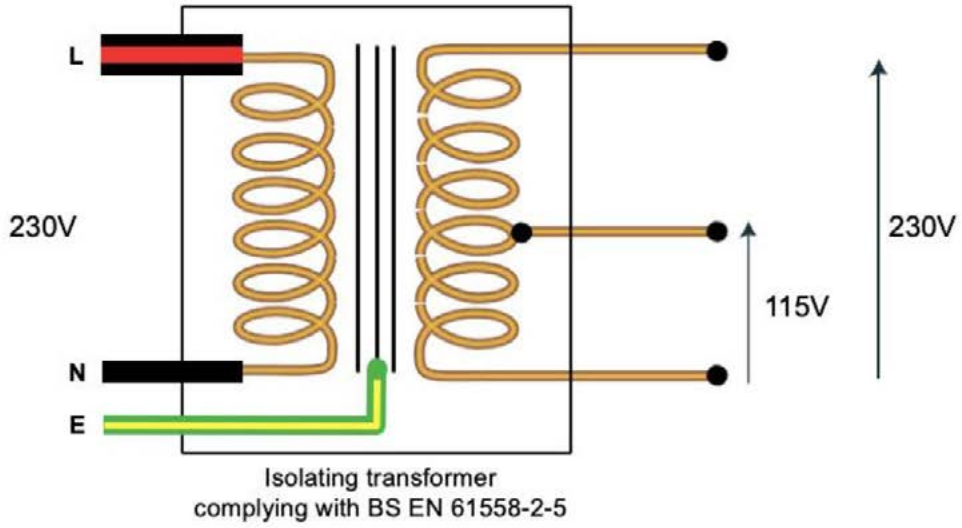
A17.(b) Industrial plugs and socket-outlets

[BS EN 60309]



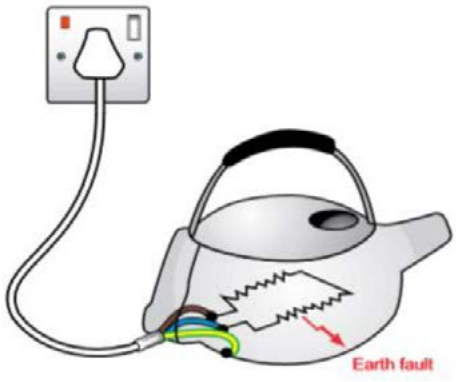
[see Clause 7.1.6]

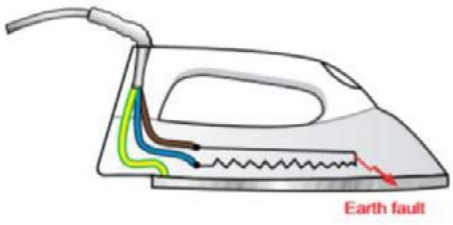
A17.(c) Shaver socket-outlets for bathrooms



[see Regulation 9.3 and Clause 7.1.4]

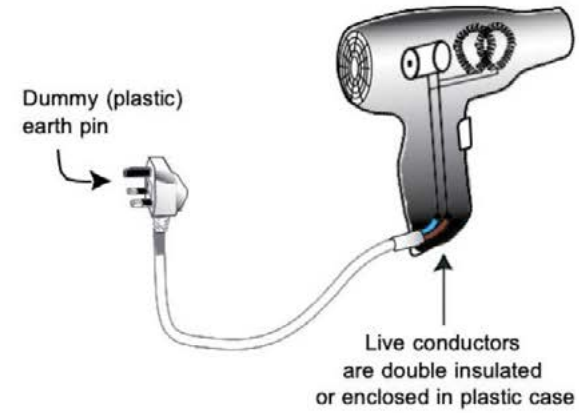
A18.(a) Class I Equipment (Earthed Conductive Parts)

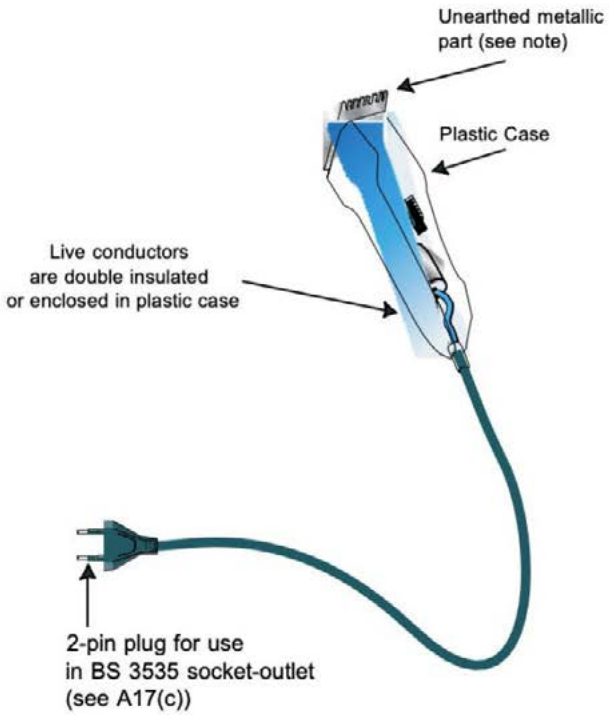




[see Clause 6.6.3]

A18.(b) Class II Equipment (double insulated)

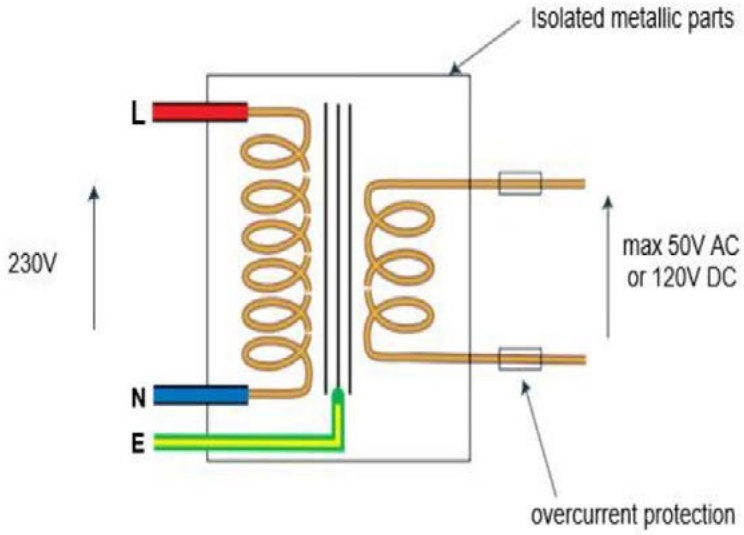




[see Clause 6.6.3]

Note: *conductive parts of Class II Appliances are sufficiently remote from live conductors so as not to require a connection to Earth*

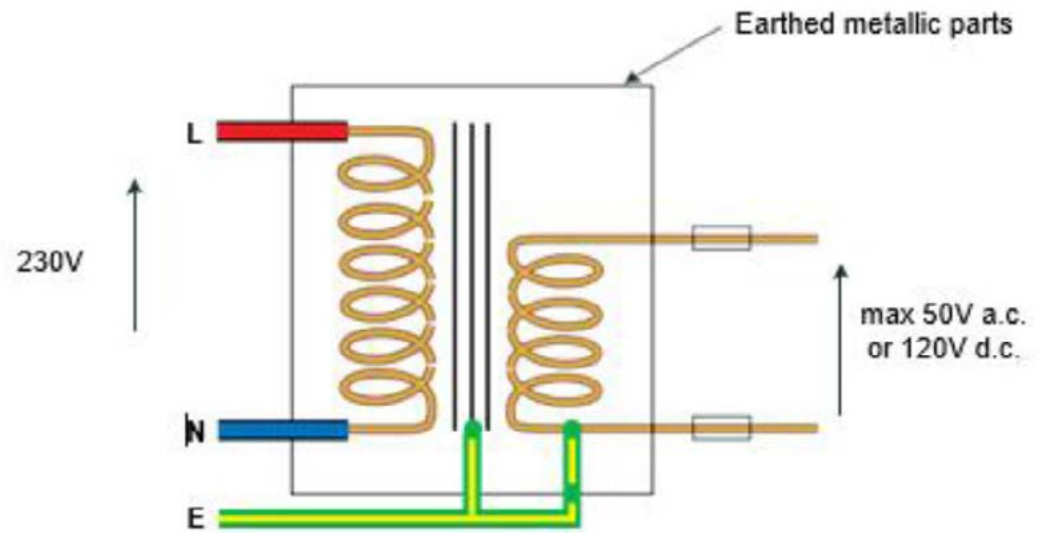
A18.(c) Separated Extra-Low Voltage (SELV) supply



Symbol for safety
isolating transformer complying
with BS EN 61558-2-5

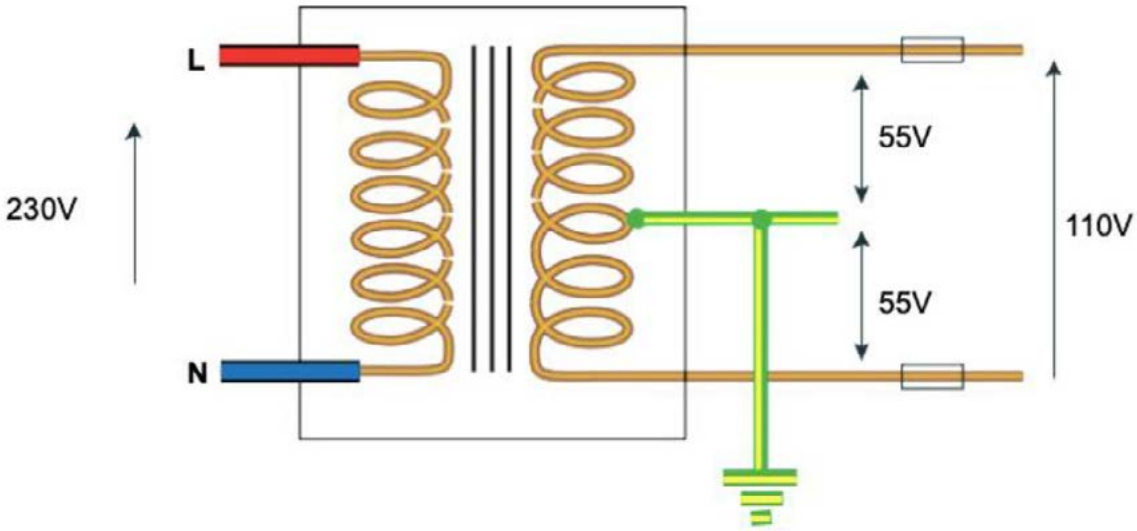
[see Clauses 5.3.1, 5.7.4, 7.3.13 and 9.1.1]

A18.(d) Protective Extra-Low Voltage (PELV) supply



[see Clauses 9.2.1]

A18.(e) Reduced Low Voltage (RLV) supply



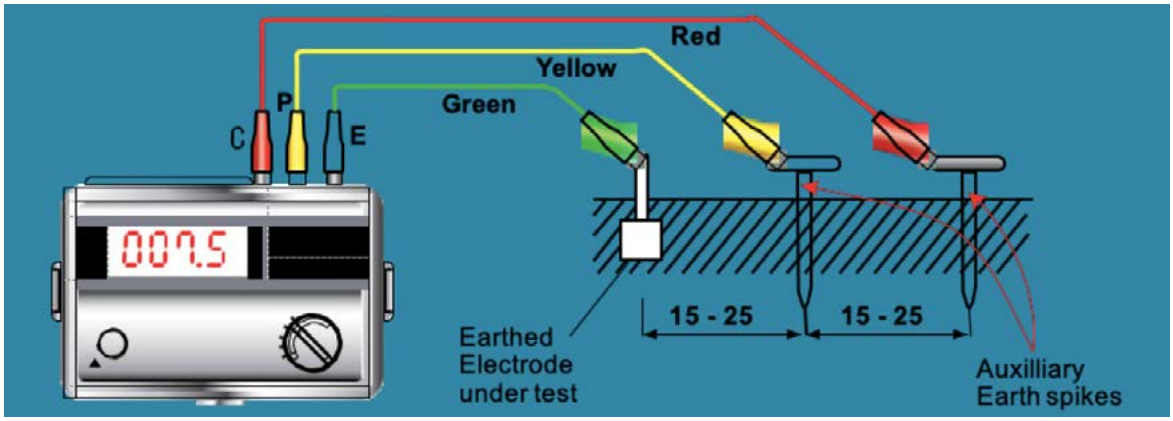
[see Clauses 5.3.1 and 9.6.3]

A19.(a) Measurement of Earth Electrode resistance

These Regulations describe three methods to measure the resistance of an Earth Electrode. Method 1 uses a dedicated Earth Electrode tester, method 2 uses a dedicated stakeless Earth Electrode tester, and method 3 uses Earth Fault Loop Impedance measurement.

For complete testing methodology of the measurement of Earth Electrode resistance refer to the respective Guidance notes of BS 7671:2018.

Method 1: measurement using dedicated Earth Electrode tester



i) a proprietary Earth Electrode test device should be used.

ii) auxiliary Earth spikes should be applied at least 15m apart and 15m distant from the Earth Electrode under test.

iii) an Earth resistance value of less than 10 ohms is required for a Locally Earthed System [see Regulation 6.2].

iv) an additional number of Earth Electrodes may be required (or deeper electrodes) to achieve the required Earth resistance value.

v) due consideration should be given to future changes in soil condition (e.g. drying out).

vi) sufficient time should be allowed if special chemicals or salts are added to the ground to improve the Earth resistance values.

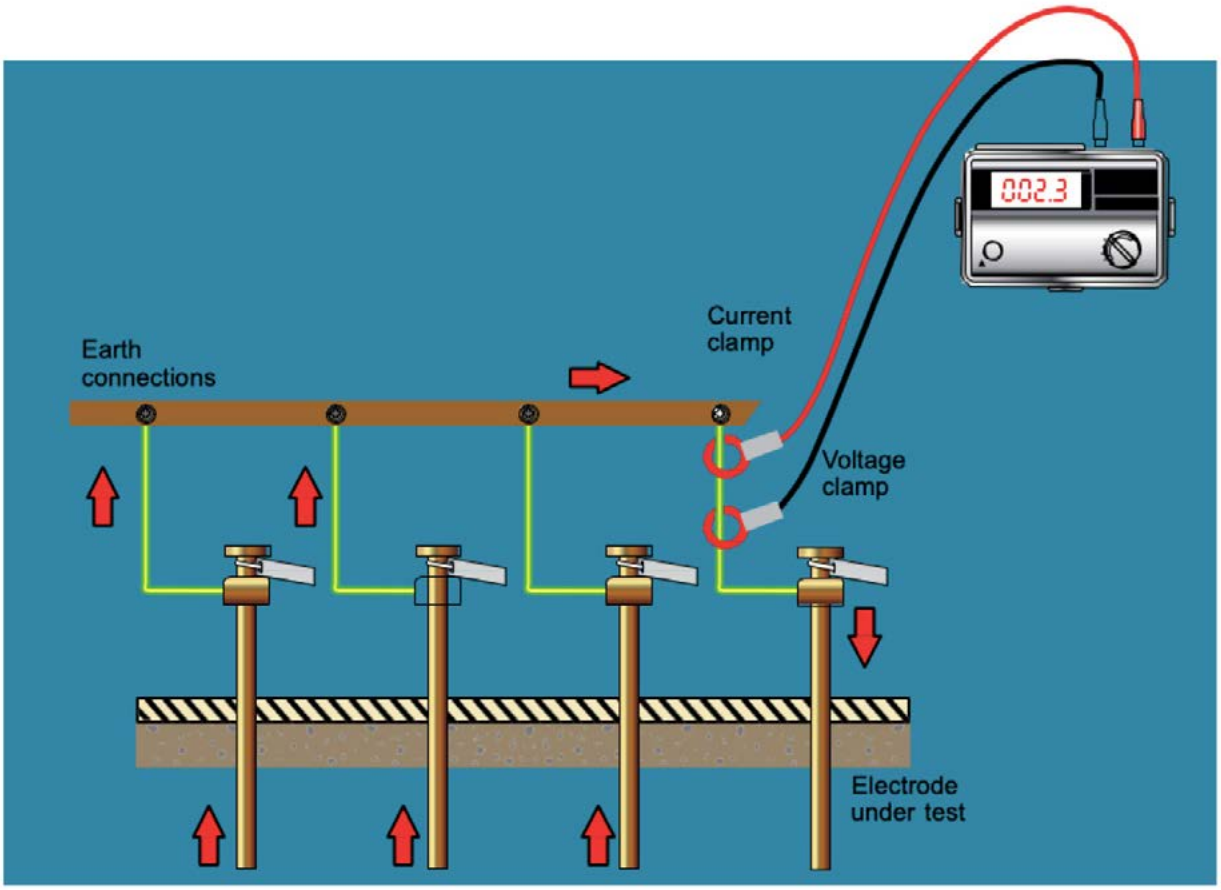
Note: *where possible and practical, method 1 should be used to measure the resistance of an Earth Electrode*

Earth Pit

Earth Test Spike

A19.(a) Continued...

Method 2: measurement using dedicated stakeless Earth Electrode tester



i) This method uses an Earth clamp-based tester without the need to disconnect the Earthing Conductor.

ii) This method is used when there are a number of Earth Electrodes and it is not possible to use Method 1.

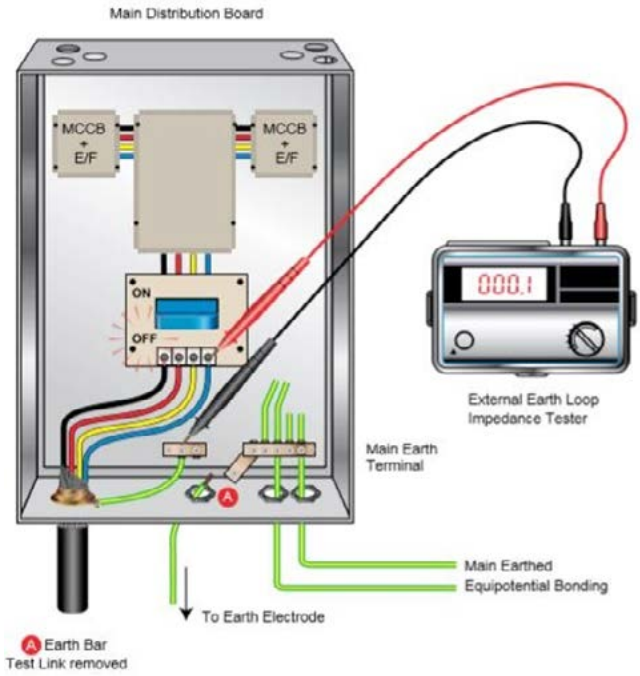
iii) The larger the number of Earth Electrodes, the closer the measurement would be to the electrode under test as the measurement is the Earth Electrode under test in series with all other Earth paths in parallel.

iv) It is important to highlight that for this method to be effective, there must be a loop resistance to measure and the Earth mass must be part of the measurement.

Method 3: measurement using an Earth Fault Loop Impedance tester

Refer to Appendix A19(b) and A19(c).

A19.(b) Measurement of Distribution Company supply impedance (Ze)



Note 1: *caution: this test is carried out under live conditions but with the main isolator secured in the off position.*

Note 2: *Ze may be measured directly at the Electricity Intake with a specialist Earth Loop Impedance tester. Such devices apply a resistance (typically 10 ohms) between a phase conductor and the earth conductor of the incoming supply. The test draws a current of around 20A but is only applied for a few cycles (e.g. 40ms). The device measures the drawn current and divides this into the measured supply voltage to give the loop impedance (the test resistance applied by the device is subtracted).*

Note 3: *as an alternative Ze may be calculated from measurement of the total Earth Fault Loop Impedance measured within the Electrical Installation (see A19(c)) using the formula:*

$$Z_s = Z_e + Z_{R1+R2}$$

Where:

Zs = total earth Fault Loop Impedance

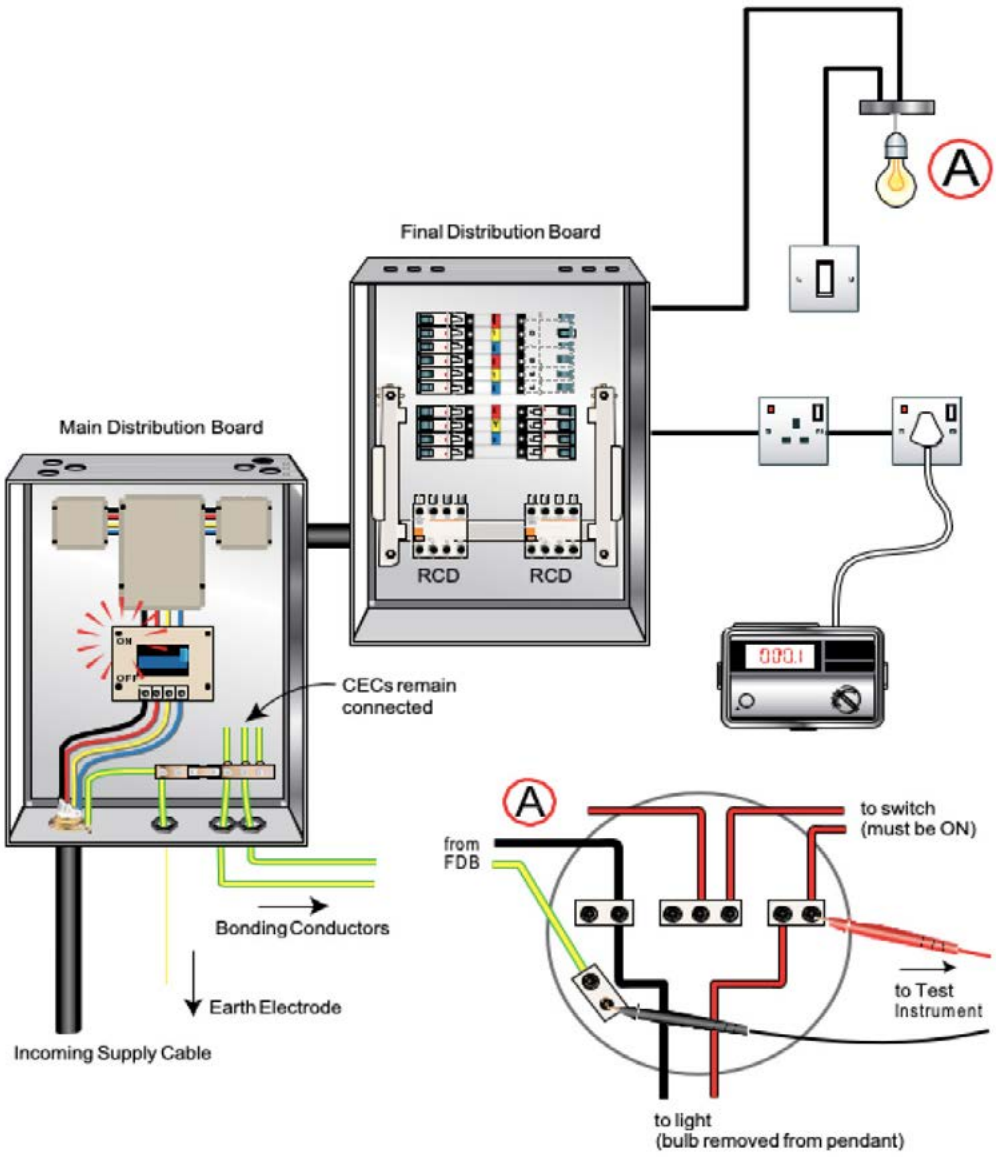
Ze = Distribution Company supply impedance

ZR1+R2 = impedance of the longest circuit in the Installation, taken by measuring a circuit phase conductor impedance R1, and the same circuit's Earthing Conductor impedance R2.

Note 4: *For further advice see reference book "Advanced Testing Technique". Test should be repeated for the Earth Electrode.*

Note 5: *Test should be repeated for the Earth Electrode.*

A19.(c) Measurement of total Earth Fault Loop Impedance (Zs)



Note 1: *caution: this test is carried out under live conditions with the circuits under test energised but no load is connected.*

Note 2: *a specialist instrument is used which measures the total Earth Loop Impedance Zs using a similar principle as described in A19(b). The instrument must not operate any RCD in circuit.*

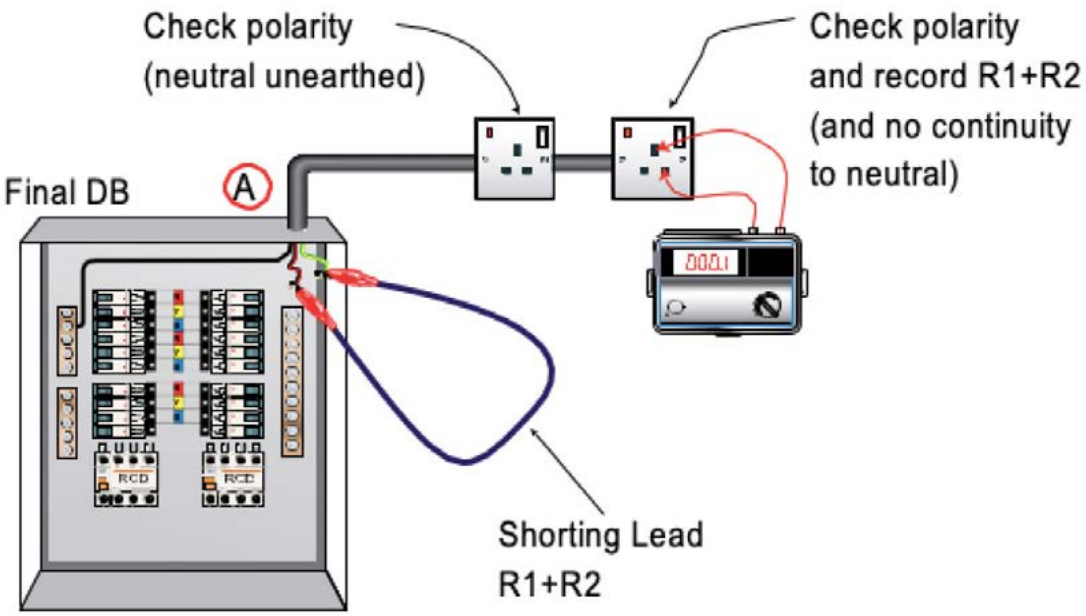
Note 3: *the instrument may be directly connected to a socket-outlet (using the test plug provided) and should be used at the farthest point on a radial circuit or the midpoint of a ring circuit. Alternatively, the instrument may be used at an Accessory connection point (e.g. lighting ceiling rose) with the appropriate test probes.*

Note 4: *for further advice, see reference book "Testing Electrical Installations".*

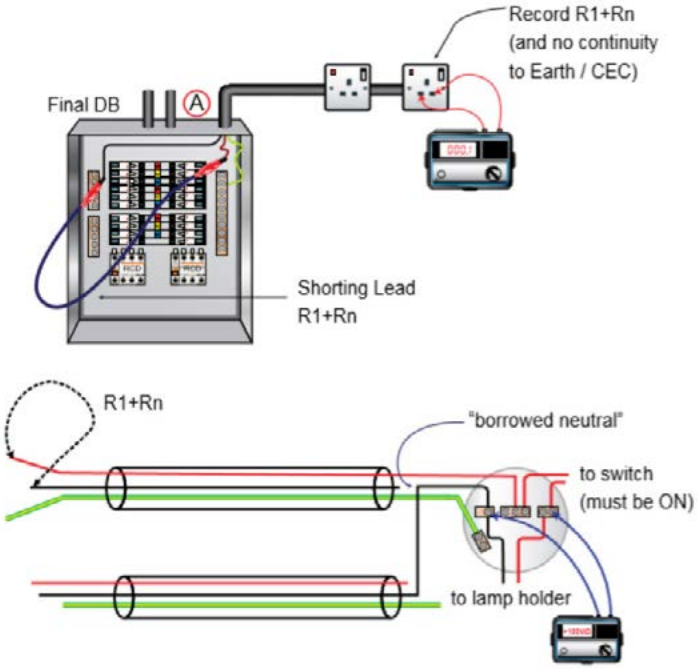
A19.(d) Circuit continuity, (R1+R2) and (R1+Rn) tests

Radial Circuits and lighting Circuits:

1. This method tests the combined phase and Earth resistance (R1+R2) and phase and neutral resistance (R1+Rn) for each Circuit by applying short leads (not at the same time) at the Distribution Board, and measuring from the terminals of the farthest connection point or socket-outlet.
2. The polarity can be checked at each Accessory (i.e. only one of the live / neutral terminals should show continuity to Earth, and there should be no continuity between live and neutral).
3. If an Accessory has been wired incorrectly from another phase or neutral conductor, the test will not work (e.g. crossed Circuits or “borrowed neutral”).
4. For lighting Circuits, the light switches should be ON to test the wire through the switch.
5. For metal conduit Circuits the CEC at the conduit/ back-box should be disconnected in order to accurately measure R1+R2.



A19.(d) Continued...



Ring Circuits

1. For Ring Circuits, the test consists of two stages:

   (a) the measurement of end to end resistance of each conductor.

   (b) the measurements of R1+R2, R1+Rn and checking there are no 'bridges' in the ring.

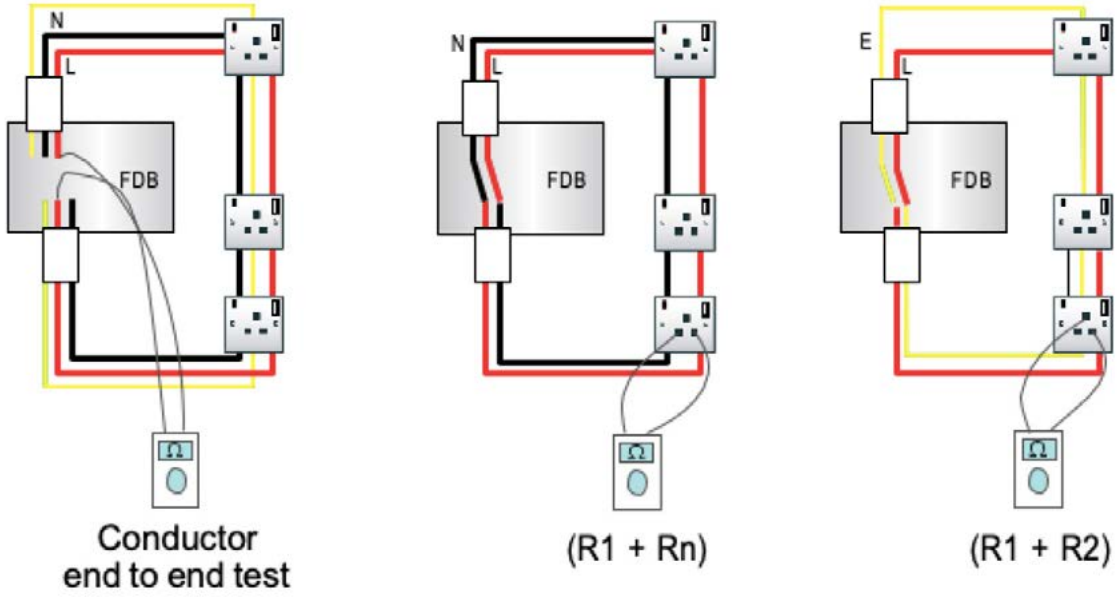
2. For part 1(a), measurement of the phase and neutral loops should give equal values. The Earth loop may be of slightly higher resistance if it is wired with a smaller conductor.

3. For part 1(b), measurement at any point on the ring between phase and neutral gives ½ the value measured in part 1(a).

4. To measure R1+Rn for a Ring Circuit, the two phase and neutral conductors from the ring are cross connected. The measurement at any point on the ring between phase and neutral should give ½ the value measured in part 1(a). If equal resistances are not observed around the ring, then this indicates the presence of a bridge or wrong cross-connections at the FDB end of the Circuit.

A19.(d) Continued...

5. To measure R1+R2 for a Ring Circuit the two phase and Earth conductors from the ring are cross connected. The readings at each point in the ring may vary slightly for a very long circuit (since the CEC is a smaller cross-section).
6. The highest value obtained represents the maximum R1+R2 value for the Circuit, and should be recorded on the test form

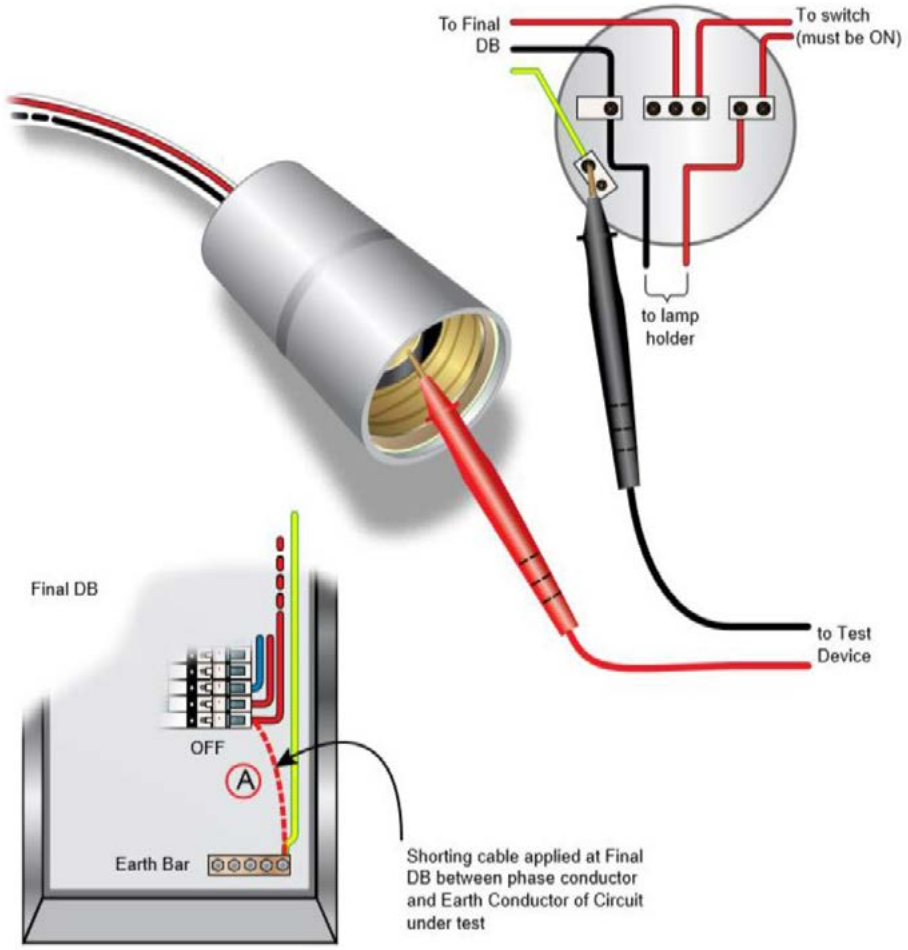


Note 1: *these tests are carried out on dead Circuits. The main isolator must be secured in the off position.*

Note 2: *for new Electrical Installations, these tests should be carried out when Accessories are in position but prior to energising the Electrical Installation.*

Note 3: *Circuit continuity tests must be measured for all Circuits and the resistance values recorded on the test report, see Appendix A20(d).*

A19.(e) Lamp holder Circuit polarity tests



Note 1: *this test is carried out on dead Circuits. The main isolator must be secured in the OFF position.*

Note 2: *the polarity test is required to confirm that all single pole devices, and lamp holders with an outer neutral contact (i.e. ES screw type) are correctly connected.*

Note 3: *single pole devices (e.g. light switches) must only be connected in the live conductor.*

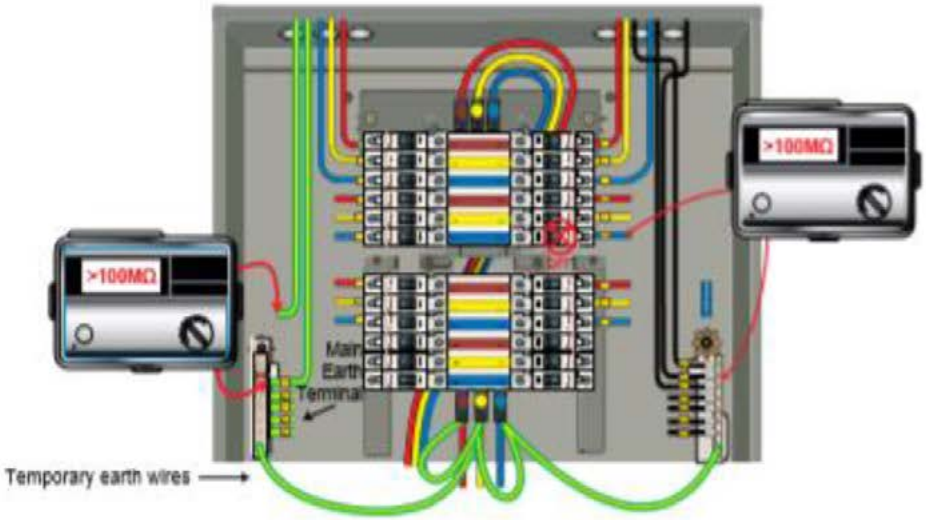
Note 4: *the test is carried out by measuring continuity between the Earth terminal and live terminal at an Accessory such as an ES pendant light fitting, after a shorting cable has been applied between the relevant phase conductor and Earth bar at the Final Distribution Board.*

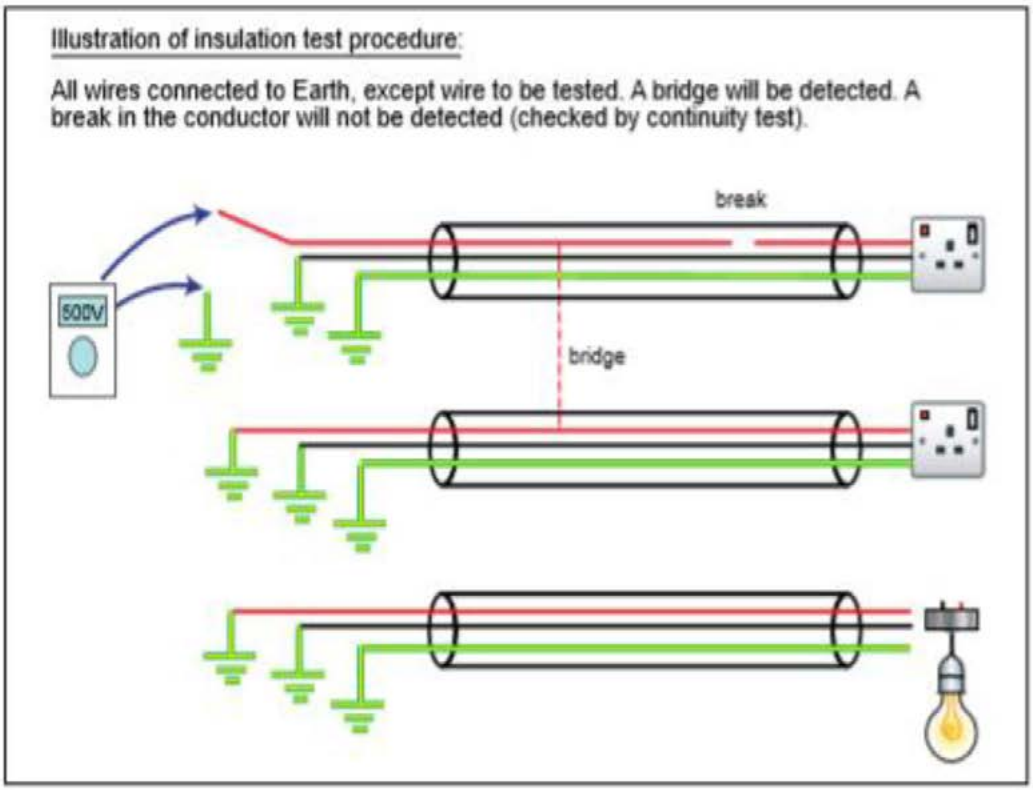
A19.(f) Segregation and insulation resistance tests

Circuit Nominal Voltage	Test Voltage (DC)	Minimum insulation resistance (MΩ)
SELV and PELV	250	0.25
up to 500 V	500	0.5

1. Insulation resistance should be checked between all live conductors, and between live conductors and Earth. For SELV and PELV systems, insulation resistance should be measured between the Extra-Low Voltage and higher Voltage conductors at a DC test Voltage of 500V.
2. The test instrument should be capable of producing a DC test Voltage of 500V when loaded to 1mA and be capable of measurement of up to 200 MΩ.
3. The minimum acceptable value of insulation resistance for any test is 0.5 MΩ for LV systems and 0.25 MΩ for SELV and PELV systems.
4. The supply should be disconnected and all current-using equipment switched off (including neon indicator lamps, Luminaires, voltmeters, electronic devices such as dimmer switches, starters, RCDs with amplifiers etc.). Alternatively, a limited test can be carried with the phase and neutral conductors connected together and testing to Earth.
5. The method of testing requires the connection of all three phases and neutral bar to Earth using temporary Earth wires.
6. The test measures the insulation resistance of each conductor wire with all other conductors connected to Earth. The test is done with all phase wires, all neutral wires and all Earth wires and the values recorded in installation testing report, refer to Appendix A20(d).
7. This test method checks the segregation of the conductor from all other wires. Care is to be taken when testing the insulation resistance of the Earth connections to ensure that there is no continuity between the equipment and containment systems.
8. Insulation measurements should be made at each Distribution Board

A19.(f) Continued...





A19.(g) Sequence of testing for new Electrical Installations

Correct sequence for safe testing
Before supply is connected: 1. Continuity of Earth Conductors (Main Earth Conductors and Circuit Earth Conductors) 2. Continuity of main and supplementary bonding conductors 3. Continuity of Ring Circuit conductors 4. Polarity tests of all Circuits 5. Segregation and insulation resistance measurements of all conductors 6. Earth Electrode resistance
After supply is connected: 1. Distribution Company Earth Fault Loop Impedance measurement 2. Re-confirm polarity 3. Total Earth Fault Loop Impedance measurements 4. Prospective fault current measurements 5. Operation of RCD and Earth fault devices 6. Operation of switches and isolators

Note 1: *safety precautions must be observed during testing, including locking off isolators and switches, safeguarding against contact with test voltages, replacement of test links and removal of tools after completion. The order of test sequence must be observed, in particular testing of Earth Conductors (dangerous test voltages can appear on the installation metalwork if Earth Conductors are inadvertently disconnected or broken).*

Note 2: *testing of RCDs must include measure ment of the operating time (ms) at In and at 5 x In, as well as check of non-operation at 50% x In at both 0º and 180º.*

A20.(a) Electrical Installation Certificate

Project / Building Name: ..... Address / Location:	Certificate No. / Ref: .....

Details of Client / Customer: Electricity account no. / contact details: .....

New or modified installation: New: ☐ Modification: ☐ Existing: ☐
Brief description of work carried out: .....
..... Previous Certificate number: .....

Supply Characteristics:
Earthing System: (TT, TN-S, TN-S and TT); ..... Earth Electrode (s)Resistance: .....
Incoming Cable Size & Type: ..... Earth Electrode(s) Location: .....
Main CB type & rating: ..... Main Earth Conductor Size: .....
Protective System (ELPS, EEBS); ..... Earth Fault Loop Impedance: .....
Max Prospective Fault Current: ..... Total Connected Load: ..... Meter ref. no's and type: .....
Total Diversified Load: ..... Total Floor area: .....

Special Circuits:
Details (e.g. special circuits without RCD protection, functional earthing arrangements): .....
.....
.....

Details of D e s i g n e r : .....
Contact Details: ..... We hereby declare that the work completed by us in relation to the above named electrical installation, and detailed in the reference drawings and documents listed below, has been carried out with due skill and care, and in accordance with the Electricity Wiring Regulations published by the Department of Energy for the Water, Wastewater and Electricity Sector in Abu Dhabi:
Authorised signatory & name: ..... Date: .....
.....
Reference drawings and schedules: ..... Company Stamp ..... Registered Engineer Certificate No.....
Certificate Expiry Date: .....

Details of Installer: ..... License Number: .....
Contact Details: .....
We hereby declare that the work completed by us in relation to the above named electrical installation, and detailed in the reference drawings and documents listed below, has been carried out with due skill and care, and in accordance with the Electricity Wiring Regulations published by the Department of Energy for the Water, Wastewater and Electricity Sector in Abu Dhabi:
Authorised signature & name: ..... Date: .....
.....
Reference drawings and schedules: ..... Company Stamp Registered Engineer Certificate No. .....
Certificate Expiry Date: .....

A20.(b) Inspection report (front)

Project / Building Name: ..... Address / Location:	Report No .....

Details of Client / Customer:
Electricity account no. / contact details: .....

New or modified installation: New: ☐ Modification: ☐ Existing: ☐

Reason for Inspection (first inspection, routine inspection, other): .....

..... Installation Certificate number: .....

Supply Characteristics:
Earthing System: (TT, TN-S, TN-S and TT); ..... Earth Electrode (s)Resistance: .....
Incoming Cable Size & Type: ..... Earth Electrode(s) Location: .....
Main CB type & rating: ..... Main Earth Conductor Size: .....
Protective System (ELPS, EEBS); ..... Earth Fault Loop Impedance: .....
Max Prospective Fault Current: ..... Total Connected Load: ..... Meter ref. no's and type: .....
Total Diversified Load: ..... Total Floor area: .....

General Details of Inspection & Testing:
Date of last inspection & test: .....
Any modifications noted: No ☐ Yes ☐ Details: .....
Estimated age of installation & estimated age of modifications:Date of next planned inspection: .....
Any dangerous conditions or urgent work required (give details over leaf): No ☐ Yes ☐
Any work or improvements recommended (give details over leaf): No ☐ Yes ☐
Extent of inspection: All: ☐ Part: ☐ Areas not tested / inspected:.....

Inspection carried out by: .....
Contact Details: .....
We hereby declare that the inspection and testing completed by us in relation to the above named installation, and detailed over leaf, has been carried out with due skill and care, and in accordance with the Electricity Wiring Regulations published by the Department of Energy for the Water, Wastewater and Electricity Sector in Abu Dhabi:

Authorised signature & name:..... Date:.....
Company Stamp: ..... Registered Engineer Certificate No: .....
Certificate Expiry Date: ..... Company Stamp: .....

A20.(c) Inspection report (back)

Equipment Inspected:	☑ satisfactory ☒ not satisfactory (give details /comments) ☐ not applicable ⊗ urgent work required

Main intake room condition: ..... ☐ ○

Metering Equipment: ..... ☐ ○

Main Distribution Board: ..... ☐ ○

Main Isolation Device (CB): ..... ☐ ○

Main LV switchboard (if any): ..... ☐ ○

Incoming supply cable(s): ..... ☐ ○

Main earth conductor, earth pits, and MET; ..... ☐ ○

Sub Distribution Boards (give ref. no's): .....

.....

.....

Distribution Cables (between DBs): ..... ☐ ○

.....

Main Earth Leakage Protective Device(s):

.....

Circuit cables (where visible): ..... ☐ ○

Power factor correction equipment: ..... ☐ ○

Standby generation equipment: ..... ☐ ○

Power points & socket outlets: ..... ☐ ○

.....

Internal Inspection of sample points (10% sample):

List circuits/connections inspected ..... ☐ ○

.....

A20.(d) Electrical Installation testing report

Project / Building Name:.....						Document No. / Ref:.....												RCD tester		(serial no.)	
Address / Location:						Tested by:												Loop impedance tester		(serial no.)	
Distribution Board No. / Ref:						.....												Continuity tester		(serial no.)	
Fed from:						Date:												Insulation tester		(serial no.)	
	Busbar section/ RCD	CCTref. No.	MCB rating (A)	Phase & Neutral Size mm2	Earth size mm2	Circuit Description	Continuity Test (ohms)					Insulation Resistance (MΩ)			Polarity (see note 2)	Total Earth Loop Impedance (z)	Short Circuit current PSCC (kA)	RCD Test		Remarks / Faults (SELV circuits, etc.)
							R1 + R2 (Ohms)	R1 + Rn (Ohms)	Ring			L see note 1	N see note 1	E see note 1				1 x In (ms) 5 x In (ms) 1/2 x In (trip / no trip)		
									R1 (Line)	Rn (Neutral)	R2 (Earth)									
		R1																		
		Y1																		
		B1																		
		R2																		
		Y2																		
		B2																		
		R3																		
		Y3																		
		B3																		
		R4																		
		Y4																		
		B4																		

Note 1: *insulation resistance measured for each conductor with all other phase, neutral and Earth Conductors connected to Earth.*

Note 2: *for polarity test, check all 3 combinations on N-E, N-Ph, Ph-E, and record number of points/accessories checked.*

Note 3: *main and supplementary bonding conductors to be tested for continuity and results to be recorded.*

A20.(e) Load distribution schedules

Project/Building: ..... Main Contractor Final Distribution Board

Address/Location: ..... Electrical Contractor: ..... Date: Distribution Board No./Ref: ..... Incoming Cable size / type: .....

Fed from: ..... Main breaker type & rating: ..... Document No. .....

	Busbar section/ RCD	CCTref. No.	MCB rating (A)	Cable Size: Phase & Neutral Size mm2	Cable Size: Earth size mm2	Cable rating A (kW) [see notes]	Circuit name / Point reference	wNo. of points (double / single): Number	Type	Number	Type	Number	Cable Type	Cable Type	Connected Load per point			Circuit Load in (kW): R	Y	B	Diversity Type	Diversity Factor	Remarks
	Section 1	R1																					
		Y1																					
		B1																					
		R2																					
		Y2																					
		B2																					
		R3																					
		Y3																					
		B3																					
	Section 2	R4																					
		Y4																					
		B4																					
		R5																					
		Y5																					
		B5																					
		R6																					
		Y6																					
		B6																					

Gross Area = ... sq m	Diversified Load Types	P W R	L T G	W H	M O	A O	Total Connected Loads (kW)				TCL=..... kW
Floor Area Diversified Load =.....W/sq m	DB Load										
	W/sq m										

Note 1: *cable ratings taken at ..... ºC and power factor, installed as single Circuits in conduit.*
Note 2: *cable rating must be above Circuit Connected Load and at least 1.15 times MCB nominal rating.*
Note 3: *where RCBOs are used, the busbar section in the above is replaced with the mA rating.*
Note 4: *Diversified Load types can be categorised as power, lighting, water heating, motor loads, a/c etc.*
Note 5: *Circuit types can be categorised as radial, ring, lighting.*

A20.(e) Continued...

Project / Building Name: ..... Main Contractor Sub Main Distribution Board

Address / Location:..... Electrical Contractor:..... Date: .....

Distribution Board No. / Ref:..... Incoming Cable size / Type:.....

Fed From:..... Main Breaker Type & Rating:..... Document No. .....

	Single Three Phase	Rating (Amps)		Cable Type	Cable Type/ Size				Connected Load			Total	Diversity Type	Diversity Factor	Diversified Load			Total	Remarks
		RCD mA	MCCB		No. of Cables	No. of Cores	Size mm2	Earth mm2	R-Ph (kW)	Y-Ph (kW)	B-Ph (kW)	(kW)			R-Ph (kW)	Y-Ph (kW)	B-Ph (kW)	(kW)	
Outgoing Ways																			
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
					Total Connected Phase Loads							Total Diversified Phase Loads							

Gross Area ..... sqm	Diversified Load Types	PWR	LTG	WH	MO	AC	Total Connected Load	KW
Floor Area Diversified Load.....W/sq m	SMDB Load						Load after Diversity	KW
	W/sq m						Overall Diversity	%

Note: *SMDB outgoing ways must be sized in accordance with the Connected Load and SMDB incomer will typically be sized in accordance with the diversified load.*

A20.(e) Continued...

Project / Building Name:..... Main Contractor ..... Main Distribution Board

Address / Location:..... Electrical Contractor:.....

Date: .....

Distribution Board No. / Ref:..... Incoming Cable size / Type:.....

Fed From:..... Main Breaker Type & Rating:..... Document No. .....

	Single Three Phase	Rating (Amps)		Cable Type	Cable Type/ Size				Connected Load			Total	Diversity Type	Diversity Factor	Diversified Load			Total	Remarks
		RCD mA	MCCB		No. of Cables	No. of Cores	Size mm2	Earth mm2	R-Ph (kW)	Y-Ph (kW)	B-Ph (kW)	(kW)			R-Ph (kW)	Y-Ph (kW)	B-Ph (kW)	(kW)	
Outgoing Ways																			
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
					Total Connected Phase Loads							Total Diversified Phase Loads							

Gross Area ..... sqm	Diversified Load Types	PWR	LTG	WH	MO	AC	Total Connected Load	KW
Floor Area Diversified Load.....W/sq m	SMDB Load						Load after Diversity	KW
	W/sq m						Overall Diversity	%

Note: *MDB outgoing ways and incomer will typically be sized in accordance with the diversified load.*

A20.(f) Solar PV test report

Solar PV Test Report	☐ Initial Verification ☐ Periodic Verification					
Electrical Installation address				Reference		
				Date		
Description of work under test				Inspector		
				Test Instruments		
String		1	2	3	4		n
Array	Module						
	Quantity						
Array parameters (as	Voc (stc)						
	Isc (stc)						
String	Type						
	Rating (A)						
	DC Rating (V)						
	Capacity (kA)						
Wiring	Type						
	Phase (mm^2)						
	Earth (mm^2)						
String test	Voc (V)						
	Isc (A)						
	Irradiance						
Polarity check							
Array insulation resistance	Test Voltage (V)						
	Pos Earth (MΩ)						
	Neg Earth (MΩ)						
Earth Continuity (where fitted)							
Switchgear functioning							
Inverter make/ model							
Inverter serial number							
Inverter functions correctly							
Loss of mains test							

Details of D esigner : .....

Contact Details: .....

We hereby declare that the work completed by us in relation to the above named electrical installation, and detailed in the reference drawings and documents listed below, has been carried out with due skill and care, and in accordance with the Electricity Wiring Regulations published by the Department of Energy for the Water, Wastewater and Electricity Sector in Abu Dhabi :

Authorised signatory & name: ..... Date: .....

Reference drawings and schedules: ..... Company Stamp: .....

Registered Engineer Certificate No.....

Certificate Expiry Date: .....

Details of Installer: ..... **License Number:** .....

Contact Details: .....

We hereby declare that the work completed by us in relation to the above named electrical installation, and detailed in the reference drawings and documents listed below, has been carried out with due skill and care, and in accordance with the Electricity Wiring Regulations published by the Department of Energy for the Water, Wastewater and Electricity Sector in Abu Dhabi:

Authorised signature & name: ..... Date: .....

Reference drawings and schedules: ..... Company Stamp: .....

Registered Engineer Certificate No.....

Certificate Expiry Date: .....

A20.(g) Solar PV system inspection report

Solar PV Test Report	☐ Initial Verification ☐ Periodic Verification	
Installation address		Reference
		Date
Circuits inspected		Inspector
		Test Instruments

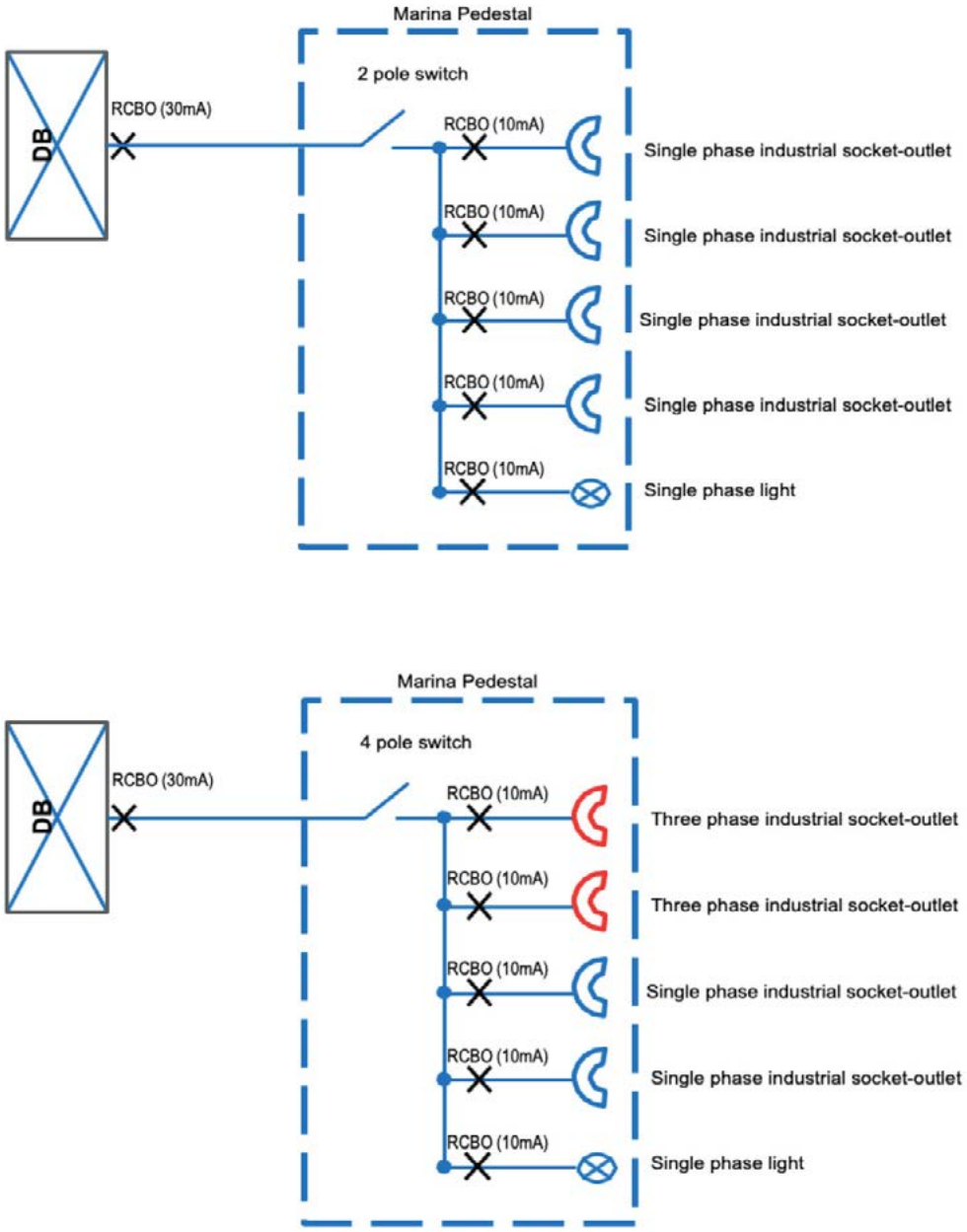
Equipment/Circuits Inspected	☑ satisfactory ☒ not satisfactory (give details /comments) ☐ not applicable ⊗ urgent work require	
General		☐ O
a.c part of the Electrical Installation is tested in accordance with Regulations 8.1		☐ O
PV Distribution Boards room condition		☐ O
PV Distribution Boards condition		☐ O
Proper ventilation behind PV Array		☐ O
Cable entry weatherproof		☐ O
Array frame suitably supported and secured; roof fixings weatherproof		☐ O
PV Array design and installation		☐ O
All DC components are rated for continuous operation at DC and at the maximum possible DC system voltage and maximum possible DC current		☐ O
Protection by use of class II insulation adopted on the DC side		☐ O
PV String cables and PV DC main cables are black in colour and Double Insulated		☐ O
Wiring systems have been selected and erected to withstand the expected external influences such as wind, temperature and solar radiation		☐ O
String cables are sized to accommodate the maximum fault current		☐ O
Wiring systems are adequately supported and protected		☐ O
If applicable, String over-current Protective Devices are fitted and correctly specified		☐ O
Verify that a DC switch disconnector is provided on the DC side of the Inverter		☐ O
If applicable, where blocking diodes are fitted, the reverse voltage rating is at least 2 × Voc stc of the PV String in which they are fitted		☐ O

A20.(g) Continued...

Equipment/Circuits Inspected	☑satisfactory ☒not satisfactory (give details /comments) ☐ not applicable ⊗ urgent work require	
Protection against overvoltage / electric shock		
To minimise voltages induced by lightning, verify that the area of all wiring loops has been kept as small as possible		☐ O
Module frame protective Earthing Conductors have been correctly installed and are connected to Earth		☐ O
If applicable, check that a type B RCD is installed		☐ O
Means of isolating the Inverter have been provided on the AC side		☐ O
PV Array design and installation		☐ O
All Circuits, Protective Devices, switches and terminals are suitably labelled		☐ O
All DC junction boxes (PV generator and PV Array boxes) carry a warning label indicating that active parts inside the boxes are fed from a		☐ O
PV Array and may still be live after isolation from the PV Inverter and public grid supply		☐ O
The main AC and DC isolating switches are clearly labelled		☐ O
Dual supply warning labels are fitted at point of interconnection		☐ O
A single line wiring diagram is displayed on site		☐ O
Emergency shutdown procedures are displayed on site		☐ O
All signs and labels are suitably affixed and durable		☐ O

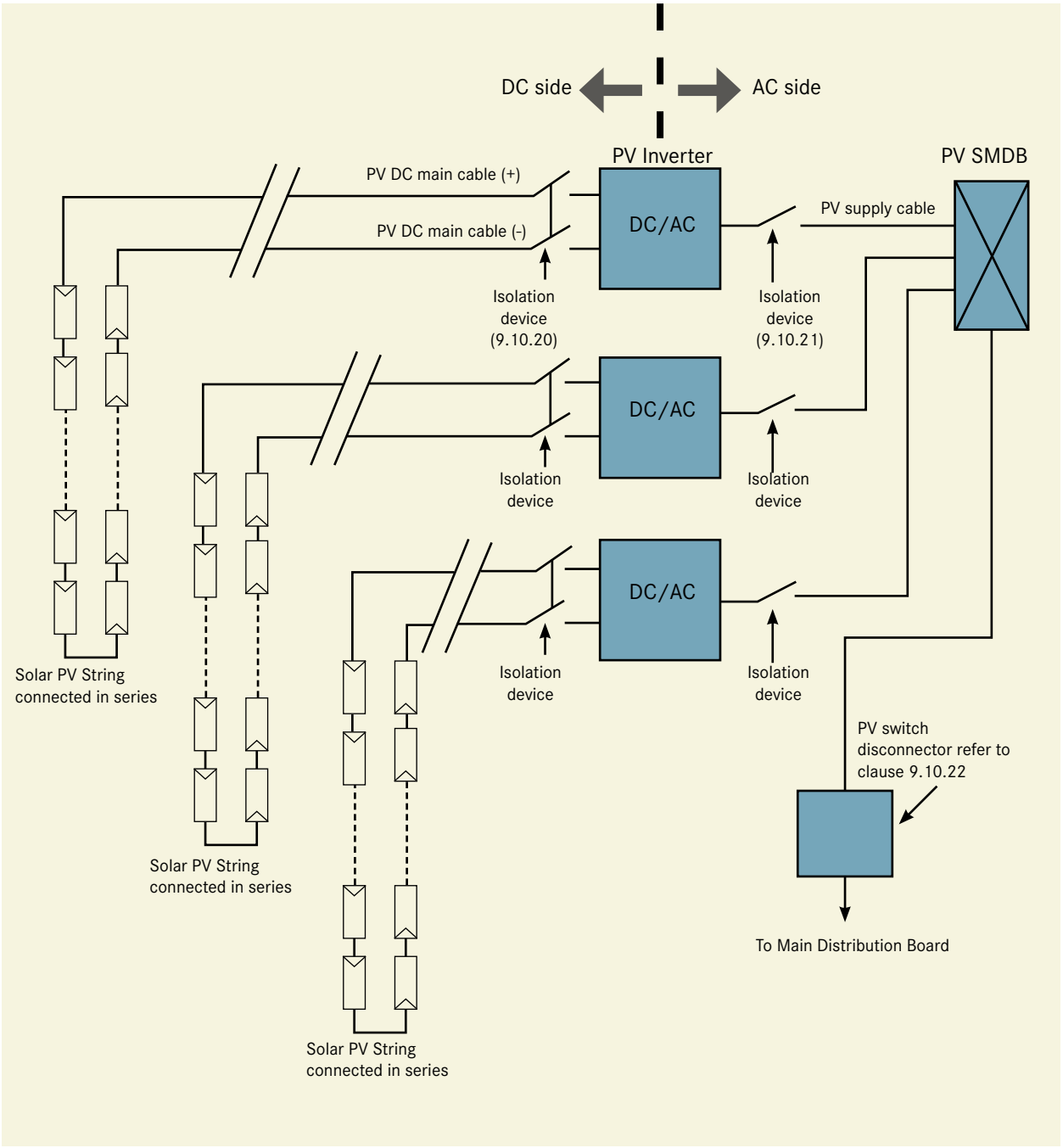
A21. General Marinas connection arrangements

Connection to mains supply (single phase and three phase)



Note 1: *protection can be provided by a combination of suitably rated MCBs and suitably rated RCDs.*
Note 2: *Earth Leakage Protection shall be effective for leakage currents of no greater than 30mA, refer to Clause 9.9.16.*

A22. General solar PV connection arrangements



18.

Guidance Notes

18. Guidance Notes

G1. Guidance note on supply Voltage change

G2. Estimation of Connected Load and diversity factors

G3 Photographs

(a) Photograph of busbar riser

(b) Photograph of Final Distribution Board (horizontal DIN rail)

(c) Photograph of Final Distribution Board (vertical, split busbar type)

G4. Electric shock, ELP and EEB systems

(a) Direct Contact with electricity

(b) Indirect Contact with electricity

(c) Main and Supplementary Earthed Equipotential Bonding (EEB)

(d) Illustration of Earth Leakage Protected System (ELPS)

(e) Grading of RCDs in an ELP system

(f) ELP system supplied from LV switchroom

(g) Calculation of Touch Voltage (ELP system)

(h) Calculation of Touch Voltage (EEB system)

G5. Electric shock and RCD characteristics

(a) RCD operating characteristics and electric shock

(b) Typical values of body resistance and physiological effects

(c) RCD operating principle

(d) Types of RCDs

(e) Sources of tripping of RCDs

G6. Protection of buried cables

G7. Common errors

(a) Exposed unsheathed cables at termination points

(b) Protection of high temperature connections

(c) Weather protected outdoor socket-outlets

(d) Earth tails in Accessories and connection boxes

(e) Minimum depth of buried plastic conduit

(f) Circuit identification numbers on Accessories and Earth Conductors

(g) Missing grommets and sharp edges on Cable Tray

(h) Cables in ceiling-voids

(i) Cable glands for Earthing of armoured cable

(j) Earth continuity connections across Cable Tray and conduit

(k) Prohibited terminal blocks and taped connections

(l) Slotting of steel gland plates for single core cables

(m) Flex-outlets

G8. Typical lighting Circuit installations

G9. Isolation and switching

G 10. Typical lightning protection system details

(a) Typical lightning protection system details

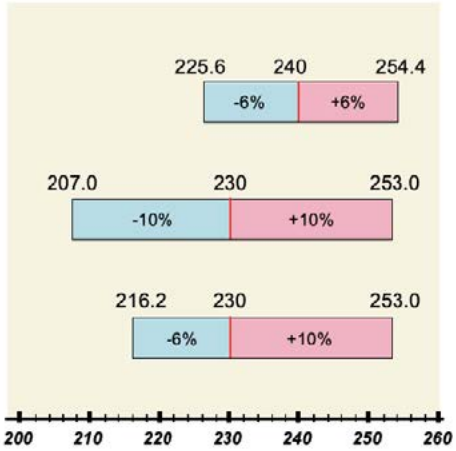
(b) Lightning Earth Electrodes

G 11. Changes in this Edition (April 2020)

G1. Guidance note on supply Voltage change

Distribution Companies in the UAE have traditionally based the design of their networks on the UK power system. Previously, the Voltage of supply was declared to be 240V single-phase or 415V three phase, with an allowed variation in Voltage of +/- 6%. With the harmonization of supply Voltages in Europe (in line with BS EN 50160) the supply Voltage is 230 / 400V +/- 10%. In the UK, the variation is currently limited to +10% -6%.

These Regulations have adopted the same nominal Voltage of supply with a variation of +10% - 6% (Clause 4.1.3). This range has been adopted to allow existing distribution network assets to continue to operate without modification, and also provides a superior Voltage range to Customers. With an allowed Voltage drop of 4% within an Owner's Electrical Installation (Clause 7.5.10) this ensures the total Voltage drop to Appliances will not exceed 10% of the nominal Voltage of 230/400V.



Old UK supply Voltage range previously used in Abu Dhabi

BS EN 50160 supply Voltage

Range of supply Voltage adopted in these regulations

G2. Estimation of Connected Load and diversity factors

Load Diversity

Where a Circuit consists of multiple points of utilisation (e.g. socket-outlets), the Circuit load current can be assessed by simply adding the individual full load current of all points of utilisation. While, this would provide a conservative design, it will lead to over sizing the Circuit because in reality the sum of individual loads rarely equal to the actual load current required by the Circuit. This is known as load diversity.

For example, the load seen at the Sub Main Distribution Board that is feeding multiple apartments in a residential building will rarely see all apartments at full load at the same time. Therefore, allowances for diversity between loads must be taken into consideration in sizing Final Circuits and other distribution Circuits. Moreover, certain Appliances such as a washing machine have a number of components that may be independently controlled and vary over time. Therefore, over the duration of the wash cycle, the total demand will not always be maintained at the full load rating, as various components switch in and out.

The allowances for diversity in an Electrical Installation varies depending on many factors, these factors may include:

(a) type and nature of the Electrical Installation (residential, commercial, industrial, etc);

(b) intended use of utilisation points (e.g. general use socket- outlets for the connection of portable Appliances compared to dedicated socket-outlets for a fixed connection)

(c) number of utilisation points in a Circuit (e.g. a SMBD feed two FDBs compared to 10 FDBs); and

(d) operating characteristics of the Connected Load (e.g. the use of a/c units in Abu Dhabi is essential in the summer and in many cases it will be running most of the time).

It is important to note that allowances for diversity in an Electrical Installation may vary between similar installation. Therefore, the designer of the Electrical Installation may select different allowances representing the intensity of usage (e.g. higher value for high usage Circuits, such as communal kitchens, lower value for lower occupancy dwellings, etc).

This Guidance note provides diversity allowances for specific situations. The factors used may be increased or decreased by the designer depending on the intended design of the Electrical Installation. The designer must provide the relevant justification to the Distribution Company.

Sizing of Final Circuits

As indicated in Clause 5.2.5 and Appendix A6(f), the relationship between the Circuit load current (Ic), the Protective Device nominal current rating (In), and the current carrying capacity of the Circuit conductors (Id) is as follows:

$Ic \leq In \leq Id$ in addition;

G2. Continued...

Id ≥ 1.15 x In (cables must be selected with ratings at least 1.15 times the Protective Device nominal current rating).

For example, the Circuit full load current of a single phase 4 kW Appliance, can be calculated using the following formula (power factor = 1 for resistive load):

$$\text{Current (Ic)} = \frac{\textit{Power (W)}}{\textit{Voltage V x PF}}$$

$$\text{Current (Ic)} = \frac{4000}{230 \times 1} = 17.4\ A$$

Therefore, the Protective Device nominal current rating (In) must not be less than 20A (nearest standard rating), and the current carrying capacity for the Circuit conductor (Id) must be not less than 23A (20A x 1.15), assuming grouping and temperature rating factors to be 1. The above calculation ensures that the Circuit is suitably rated for the Appliance to draw 17.4A for a continuous period of time.

The relevant Protective Device nominal ratings, cable size and cable rating for typical Circuit applications are provided in Appendix A6(f). For other non-typical Circuit applications, the designer shall determine the appropriate Circuit rating based on the total Connected Load of all Appliances and knowledge of the intended Circuit application.

Final Circuit estimated Connected Load for sizing Final Distribution Board

For sizing the Final Distribution Board, the Connected Load of a Final Circuit is estimated by adding the load of all points of utilisation (e.g. socket-outlets) and items of Appliance connected to the Circuit and where appropriate making allowances for diversity. The table below gives the estimated Connected Load for typical Appliances that can be used for sizing Final Distribution Boards. Specific site information should be used where available.

G2. Continued...

Connected Appliance per Final Circuit	Assumed Connected Load
Lighting	• sum of wattage of all Luminaires or assume 100W for each lighting point (note 1) • chandelier lighting point – 500W • lamp wattage plus losses of associated control gear such as ballasts and capacitors for fluorescent lighting (note 2)
13A socket-outlets – (for general use for the connection of portable Appliances)	• 200W each (note 3)
Water heater	• 1,500W or actual rating of Appliance
Washing machine, dryer, dishwasher	• 1,500W each or actual rating of Appliance
Cooker	• 3,000W plus the largest ring or actual rating
Fridge	• 300W or full rating of Appliance
Motors (e.g. lifts)	• actual rating
Air Conditioning	• split air-conditioning units – full rating • window air-conditioning units – full rating • central a/c units – full rating

Note 1: *where the Connected Load of a Luminaire is less than 100 W, then the design of the lamp holder associated with that Luminaire must only permit the insertion of this type of lamp. The Connected Load in this case should be the highest actual lamp wattage that can be accommodated by such lamp holder or that the control gear can deliver.*

Note 2: *where no exact information is available, the lamp wattage must be multiplied by not less than 1.8.*

Note 3: *if the Connected Load on socket-outlet Circuits are known then the designer may choose to use specific values. For example, in an office building where the socket- outlet Circuits comprise of business machines each rated at 150 W, then the demand of each socket-outlet point will be counted as 150 W.*

Note 4: *standby loads should not be considered when sizing the Final Distribution Board. For example, where three pumps are configured with two run and one standby, the standby pump load should not be included in sizing of the Final Distribution Board. In such cases provision for interlocks must be provided to prevent operation of all pumps simultaneously.*

G2. Continued...

Diversity allowance between Final Circuits for sizing Sub Main Distribution Board

The diversity allowances shown in the table below are for specific situations and meant to only provide guidance. The figures given in the table may need to be increased or decreased depending on the particular circumstances. **The table below is used as a guide for sizing of the Sub Main Distribution Boards only.**

The table below can be used as a guide for sizing the Sub Main Distribution Boards feeding multiple Final Circuits downstream. For e.g., if a SMDB in a villa feeds one central water heater, then no diversity allowance is allowed. However, if a SMDB in a high rise building feeds a number of flats each with multiple water heaters then, 50% diversity allowance can be used.

Total sum of the estimated Connected Loads on all Final Circuits	Residential ,premises villas, flats	Shops, stores, offices, schools, mosques, business premises	Hotels, motels, accommodation houses
Lighting	75%	90%	90%
13A socket- outlets – (for general use for the connection of portable Appliances	50%	70%	50%
13A socket- outlets/flex outlets (fixed Appliances) –	50%	50%	50%
Water heater	*50%	*50%	*50%
Washing machine, dryer, dishwasher	50%	50%	50%
Cooker	50%	75%	80%
(Motors (e.g. lifts	50%	70%	70%
Air-Conditioning	90%	90%	90%

***if water heating is centralised, then no diversity allowance is allowed.**

Note 5: *a 90% diversity factor may be applied for split or window type air-conditioning units; diversity factors for central a/c units should be based on manufacturers data or load data taken from other similar installations (during summer temperature conditions).*

Note 6: *additional diversity factors of typically 0.9 may be applied at Sub Main Distribution Boards (in consideration of the diversity between downstream Final Distribution Boards) and Main Distribution Boards (in consideration of the diversity between downstream Sub Main Distribution Boards). Hence, the expected demand at the Electricity Intake may be 0.81 times the sum of the FDB Diversified Loads.*

Power demand

The calculated Diversified Load for Premises should be checked against electricity usage data for similar Premises. The following table provides some guidance to the total demand for ighting and small power (with air-conditioning) for various Premises types at MDB level. It is important to note that the values below depends on a number of factors including weather,

G2. Continued...

occupancy hours, use of smart technology, thermal performance and building management system.

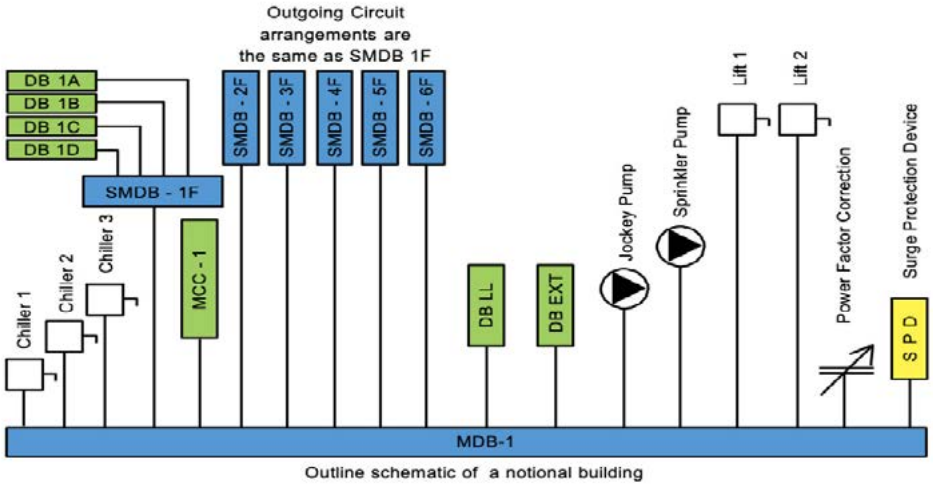
Premise type	Power demand	
	Range W/m²	Average W/m²
Domestic	30-80	55
Offices	100-150	125
Hotels	75-100	88
Shops	40-100	70
Car Parks (open air)	0-10	5
Car Park (basement without a/c)	10-20	15

Note 7 : *during summer, air-conditioning make up 70% to 80% of the total power demand.*

Note 8: *the above figures represent power demand values at building plot level.*

Worked example

The worked example shows how diversity may be applied to a Low Voltage Electrical Installations for a typical project. It is not intended that the figures provided are to be used on projects but are guidance on where diversities can be applied within the installation. The sample is not intended for use in sizing sub-mains or Final Circuits, their evaluation for Voltage drop and applied grouping and rating factors.



Outline schematic of a notional building

The notional building comprises a 7 story apartment building (G+6) with a ground floor common area, car park and landscape area externally. All apartments are the same size, 3 bedrooms and are located from first to sixth floor. Each apartment is provided with its own dedicated Distribution Board supplied from a tenant Sub Main Distribution Board located at each floor level. Centralised chillers are provided configured with 2 duty and 1 standby, these are interlocked to prevent all 3 of them running simultaneously. A centralised plant room provides:

G2. Continued...

- Air handling facilities for fresh air and extract to the building configured in duty only.
- Pumped water facilities for domestic water configured in duty standby.
- Pumps associated with the chilled water systems configured in duty standby.

A sprinkler system is provided with a main electric pump and jockey pump to prime the system. The back up is provided by a diesel fire pump.There are two lifts in the building to serve the upper floors.

Differing types of loads allows the Watts per square metre to be checked at each stage of the calculation. Spare allowances are not included within the elemental calculation of Watts per square metre, only in the overall calculation. The range of diversity applied will be dependent on the building type, its intended use, its location and the construction standards adopted (for example the level of thermal insulation will impact on the energy usage within a building).

The arrangement of the Distribution Boards allows the designer to identify the diversity type and factor as well as the Circuit type. Abreviations contained within the schedules are detailed below:

Abbreviation	System	Comments
PWR	Power including fixed Appliances, socket outlets, cookers and other dedicated equipment supplies.	
LTG	Lighting both internal and external	
WH	Water heating	Applies to local and centralised systems.
MO	Motors including lifts, sanitary pumps, water pumps etc.	Air-conditioning motors for air handling units and chilled water systems are included within the A/C Section
A/C	Air-conditioning units including chillers, fan coils, air handling units and chilled water pumps	Motors associated with ventilation and air-conditioning are included in this section.
SM	Sub-Main Distribution diversity applied across the equipment served.	The applied diversity applied to all of the distribution on an elemental basis.
RAD	Radial Circuit	
RNG	Ring Circuit	
ELA	Earth leakage alarm	
RCD (S)	Time delayed RCD	
ELR	Earth leakage relay	

Loads that are standby such as sprinkler pumps which are not normally required except in an emergency may be omitted from the diversified load calculation. For loads that are configured in run/standby, the standby element of the distribution may be omitted from the diversified load. Where the loads are connected in 2N format, for example data centres, only a single load may be counted for the diversified loads. The area used in the calculation of the Watts per square meter is the gross internal floor area.

G2. Continued...

Project/Building : Mr Mubarak Al Hosni Building	Main Contractor :	Sedmund Construction LLC	
Address/Location : Sector ME 10 Plot C-96, Abu Dhabi	Electrical Contractor :	Al Rama EC	
Distribution Board No/Ref : MDB-1 Electrical Intake Room	Incoming Cable size / type :	Cables by Distribution Company	Date :16/02/2020
Fed From : Transformer 1	Main Breaker Type & Rating :	1000A ACB	Document No : ARE-34-1

	Single/ Three Phase	Rating (Amps)		Cable Type	Cable Type / Size				Connected Load			Total	Diversity Type	Diversity Factor	Diversified Load			Total	Remarks
		RCD (mA)	MCCB / ACB		No. of Cables	No. of Cores	Size mm²	ECC mm²	R-Ph (kW)	Y-Ph (kW)	B-Ph (kW)	(kW)			R-Ph (kW)	Y-Ph (kW)	B-Ph (kW)	(kW)	
:Outgoing Ways																			
1 Chiller 1	3	500(S)	200	LSF/ SWA	1	3	95	1c 50	25.00	25.00	25.00	75.00	A/C	0.90	22.50	22.50	22.50	67.50	Run
2 Chiller 2	3	500(S)	200	LSF/ SWA	1	3	95	1c 50	25.00	25.00	25.00	75.00	A/C	0.90	22.50	22.50	22.50	67.50	Run
3 Chiller 3	3	500(S)	200	LSF/ SWA	1	3	95	1c 50	25.00	25.00	25.00	75.00	A/C	0.00	0.00	0.00	0.00	0.00	Standby
4 MCC-1	3	ELR	100	LSF/ SWA	1	4	35	1c 16	13.39	13.39	13.39	40.18	SM	0.66	8.84	8.84	8.84	26.52	
5 SMDB 1F	3	ELR	200	LSF/ SWA	1	4	70	1c 35	30.32	30.40	30.60	91.32	SM	0.85	25.78	25.84	26.01	77.63	
6 SMDB 2F	3	ELR	200	LSF/ SWA	1	4	70	1c 35	30.40	30.60	30.32	91.32	SM	0.85	25.84	26.01	25.78	77.63	
7 SMDB 3F	3	ELR	200	LSF/ SWA	1	4	70	1c 35	30.60	30.32	30.40	91.32	SM	0.85	26.01	25.78	25.84	77.63	
8 SMDB 4F	3	ELR	200	LSF/ SWA	1	4	70	1c 35	30.32	30.40	30.60	91.32	SM	0.85	25.78	25.84	26.01	77.63	
9 SMDB 5F	3	ELR	200	LSF/ SWA	1	4	70	1c 35	30.40	30.60	30.32	91.32	SM	0.85	25.84	26.01	25.78	77.63	
10 SMDB 6F	3	ELR	200	LSF/ SWA	1	4	70	1c 35	30.60	30.32	30.40	91.32	SM	0.85	26.01	25.78	25.84	77.63	
11 FDB-LL Landlords Services GF electrical room	3	300(S)	80	LSF/ SWA	1	4	25	1c 16	10.88	10.92	10.23	32.03	SM	0.90	9.79	9.83	9.21	28.83	
12 FDB-SL-EXT External Lighting GF Elect. Room	3	300(S)	63	LSF/ SWA	1	4	16	1c 16	6.85	6.86	6.51	20.23	SM	0.90	6.17	6.17	5.86	18.2	
13 Jockey Pump	3	ELA	16	LSF/ SWA	1	3	4	1c 4	1.50	1.50	1.50	4.50	MO	0.50	0.75	0.75	0.75	2.25	
14 Sprinkler Pump	3	ELA	125	LSF/ SWA	1	3	50	1c 25	20.00	20.00	20.00	60.00	MO	0.00	0.00	0.00	0.00	0.00	Emergency Only
15 Lift 1	3	300(S)	63	LSF/ SWA	1	4	16	1c 16	8.00	8.00	8.00	24.00	MO	0.50	4.00	4.00	4.00	12.00	
16 Lift 2	3	300(S)	6	LSF/ SWA	1	4	16	1c 16	8.00	8.00	8.00	24.00	MO	0.50	4.00	4.00	4.00	12.00	
17 Power Factor Correction (100kVAr)	3	300(S)	200	LSF/ SWA	1	3	95	1c 50							0.00	0.00	0.00	0.00	
18 Secondary Lightning Surge Suppression Device (Type 1, 2 & 3)	3	ELA	125	LSF Singles	4	1	35	1c 35							0.01	0.01	0.01	0.03	Integral in MDB
					Total Connected Phase Loads				326.27	326.31	325.27	Total Diversified Phase Loads			233.81	233.85	232.92		

Gross Area	9000.00 sq m	Diversified Load Types	PWR	LTG	WH	MO	A/C	Total Connected Load:	977.8kW
Floor Area Diversified Load	52.05 W/sq m	MDB Load	149.16	49.11	26.03	29.69	214.45	Load After Diversity	700.61kW
		W/sq m	16.57	5.46	2.89	3.30	23.83	Overall Diversity	72%

G2. Continued...

Project/Building : Mr Mubarak Al Hosni Building									Main Contractor : Sedmund Construction LLC											
Address/Location : Sector ME 10 Plot C-96, Abu Dhabi									Electrical Contractor : Al Rama EC											
Distribution Board No/Ref : SMDB-1F First Floor Elect. Room									Incoming Cable size / type : 4C 70mm2 XLPE/LSF/SWA with 35mm2 Supplemental Earth										Date: 16/02/2020	
Fed From : MDB-1 (Intake Room)									Main Breaker Type & Rating : 125A MCCB										Document No: ARE-34-2	
	Single/ Three Phase	Rating (Amps)		Cable Type	Cable Type / Size				Connected Load			Total	Diversity Type	Diversity Factor	Diversified Load			Total	Remarks	
		RCD (mA)	MCCB ACB		No. of Cables	No. of Cores	Size mm²	ECC mm²	R-Ph (kW)	Y-Ph (kW)	B-Ph (kW)	(kW)			R-Ph (kW)	Y-Ph (kW)	B-Ph (kW)	(kW)		
Outgoing Ways:																				
1 FDB-1A First Floor Apartment	3	300(s)	63	LSF/ SWA	1	4	25	1c 16	7.58	7.60	7.65	22.83	SM	0.90	6.82	6.84	6.89	20.55		
1 FDB-1B First Floor Apartment	3	300(s)	63	LSF/ SWA	1	4	25	1c 16	7.58	7.60	7.65	22.83	SM	0.90	6.82	6.84	6.89	20.55		
1 FDB-1C First Floor Apartment	3	300(s)	63	LSF/ SWA	1	4	25	1c 16	7.58	7.60	7.65	22.83	SM	0.90	6.82	6.84	6.89	20.55		
1 FDB-1D First Floor Apartment	3	300(s)	63	LSF/ SWA	1	4	25	1c 16	7.58	7.60	7.65	22.83	SM	0.90	6.82	6.84	6.89	20.55		
					Total Connected Phase Loads				30.32	30.40	30.60	Total Diversified Phase Loads			14.8	16.5	16.5			
Gross Area				47.72 sq m	Diversified Load Types				PWR	LTG	WH	MO	A/C	Total Connected Load:				91.32kW		
Floor Area Diversified Load				43.38 W/sq m	SMDB Load				27.29	5.94	4.32	0.45	9.72	Load After Diversity				82.19kW		
					W/sq m				24.81	5.40	3.93	0.41	8.84	Overall Diversity				90%		

G2. Continued...

Project/Building : Mr Mubarak Al Hosni Building
Address/Location : Sector ME 10 Plot C-96, Abu Dhabi
Distribution Board No/Ref : FDB-1A First Floor Apartment
Fed From : SMDB-1F

Main Contractor: Sedmund Construction LLC
Electrical Contractor: Al Rama EC
Incoming Cable size / type: 4C 25mm2 XLPE/LSF/SWA with 16mm Supplemental Earth
Main Breaker Type & Rating : 63A isolator + 2 RCD's (See below)

Date : 16/02/2020
Document No : ARE-34-3

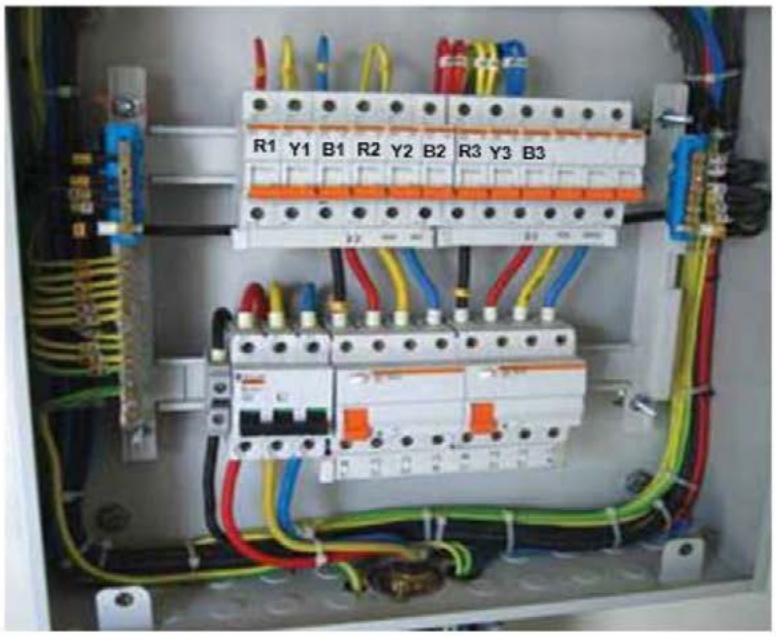
	Busbar Section/ RCD	CCT REF No.	MCB RTG (A)	CABLE SIZE		Cable Rating (kW)	ACircuit Name / Point reference Number	No Of Points (Double Single)						Cable Type	Cir-cuit Type	Connected Load per Point (kW)			Circuit Load in (kW)			Diversity Type	Diversity Factor	REMARKS
				CCT WIRE mm^2	ECC WIRE mm^2			Number	Type	Number	Type	Number	Type						R	Y	B			
63A TP&N Isolator	Section 1 - 40A, 3ph, 100mA	R1	6	1.5	1.5	17.5 (3.4)	Lighting Bedrooms 1, 2 3	9	A					Single Core	LTG	0.100	0.000	0.000	0.900			LTG	0.75	
		Y1	6	1.5	1.5	17.5 (3.4)	Lighting (fluorescent) - Kitchen	2	B	1	F	1	D	Single Core	LTG	0.050	0.050	0.050		0.200		LTG	0.75	
		B1	6	1.5	1.5	17.5 (3.4)	Lighting Lounge (Inc. Chandelier 500W)	4	A	1	C			Single Core	LTG	0.100	0.500	0.000			0.900	LTG	0.75	
		R2	6	1.5	1.5	17.5 (3.4)	Smoke Alarms	4	SA					Single Core	RAD	0.020	0.000	0.000	0.080			PWR	1.00	
		Y2	16	2.5	2.5	24.0 (4.7)	FCU-1, FCU-2, FCU-3	3	FCU					Single Core	RAD	0.200	0.000	0.000		0.600		A/C	0.90	
		B2	16	2.5	2.5	24.0 (4.7)	FCU-4	1	FCU-4					Single Core	RAD	1.200	0.000	0.000			1.200	A/C	0.90	
		R3	6	1.5	1.5	17.5 (3.4)	Intruder Alarm Panel	1	IAP					Single Core	RAD	0.100	0.000	0.000	0.100			PWR	1.00	
		Y3	20	4	4	32.0 (6.3)	A/C Unit	1	A/C					Single Core	RAD	1.200	0.000	0.000		1.200		A/C	0.90	
		B3	16	2.5	2.5	24.0 (4.7)	Drainage Pump	1	ESP					Single Core	RAD	0.250	0.000	0.000			0.250	MO	0.50	
	Section 2 - 40A, 3ph, 30mA	R4	32	6	6	41.0 (8.0)	Cooker	1	COOK					Single Core	RAD	3.000	0.000	0.000	3.000			PWR	0.50	
		Y4	20	4	4	32.0 (6.3)	Water Heaters: Bath-room & Kitchen	1	WH-1					Single Core	RAD	1.500	0.000	0.000		1.500		WH	0.50	
		B4	6	1.5	1.5	17.5 (3.4)	Lighting (fl) + shaver socket - bathrooms 1 & 2	4	E					Single Core	LTG	0.050	0.000	0.000			0.200	LTG	0.75	
		R5	32	2 x 4	2 x 4	51.2 (10.0)	Socket-Outlets-Kitchen Ring (Inc. fridge)	4	TSSO	2	SSO			Single Core	RNG	0.400	0.200	0.000	2.000			PWR	0.50	
		Y5	20	4	4	32.0 (6.3)	Sockets-Outlets - Maids room & Corridor	2	TSSO	1	SSO			Single Core	RAD	0.400	0.200	0.000		1.00		PWR	0.50	
		B5	20	4	4	32.0 (6.3)	Dishwasher Via Double pole switch & Sock-et-Outlet	1	DW					Single Core	RAD	1.500	0.000	0.000			1.500	PWR	0.50	
		R6	20	4	4	32.0 (6.3)	Washing Machine Via Double pole switch	1	WM					Single Core	RAD	1.500	0.000	0.000	1.50			PWR	0.50	
		Y6	32	2x4	2x4	51.2 (10.0)	& Socket-Outlet	5	TSSO	1	SSO			Single Core	RNG	0.400	0.200	0.000		2.20		PWR	0.50	
		B6	32	2x4	2 x4	51.2 (10.0)	Sockets-Outlets -Ring Lounge/Hall	9	TSSO					Single Core	RNG	0.400	0.000	0.000			3.60	PWR	0.50	

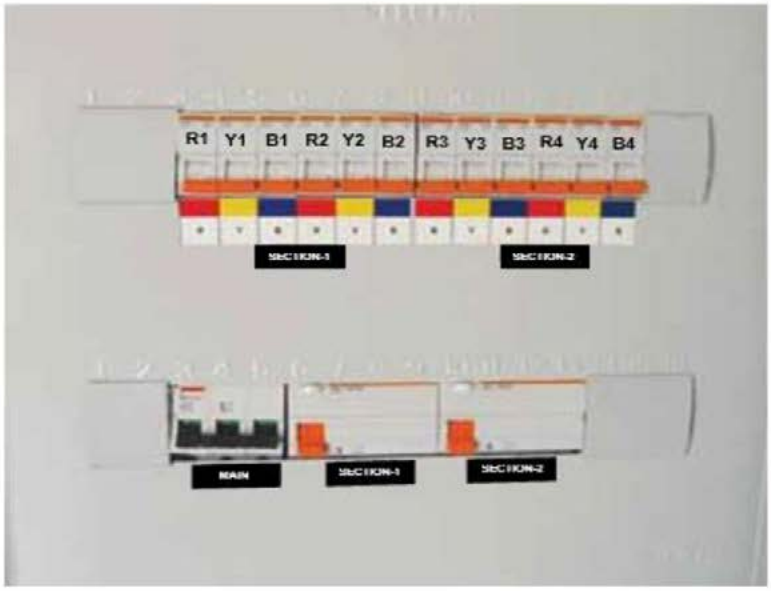
Gross Area	250.00 sq m	Diversi-fied Load Types	PWR	LTG	WH	MO	AC	Total Connected Loads	7.58	7.60	7.65			22.83kW
Floor Area Diversified Load	53.02 W/sq m	DB Load	7.58	1.65	1.20	0.13	2.70	Load After Diversity	4.11	4..57	4.58	58%		13.26kW
		W/sq m	30.32	6.60	4.80	0.50	10.80							

G3.(a) Photograph of busbar riser

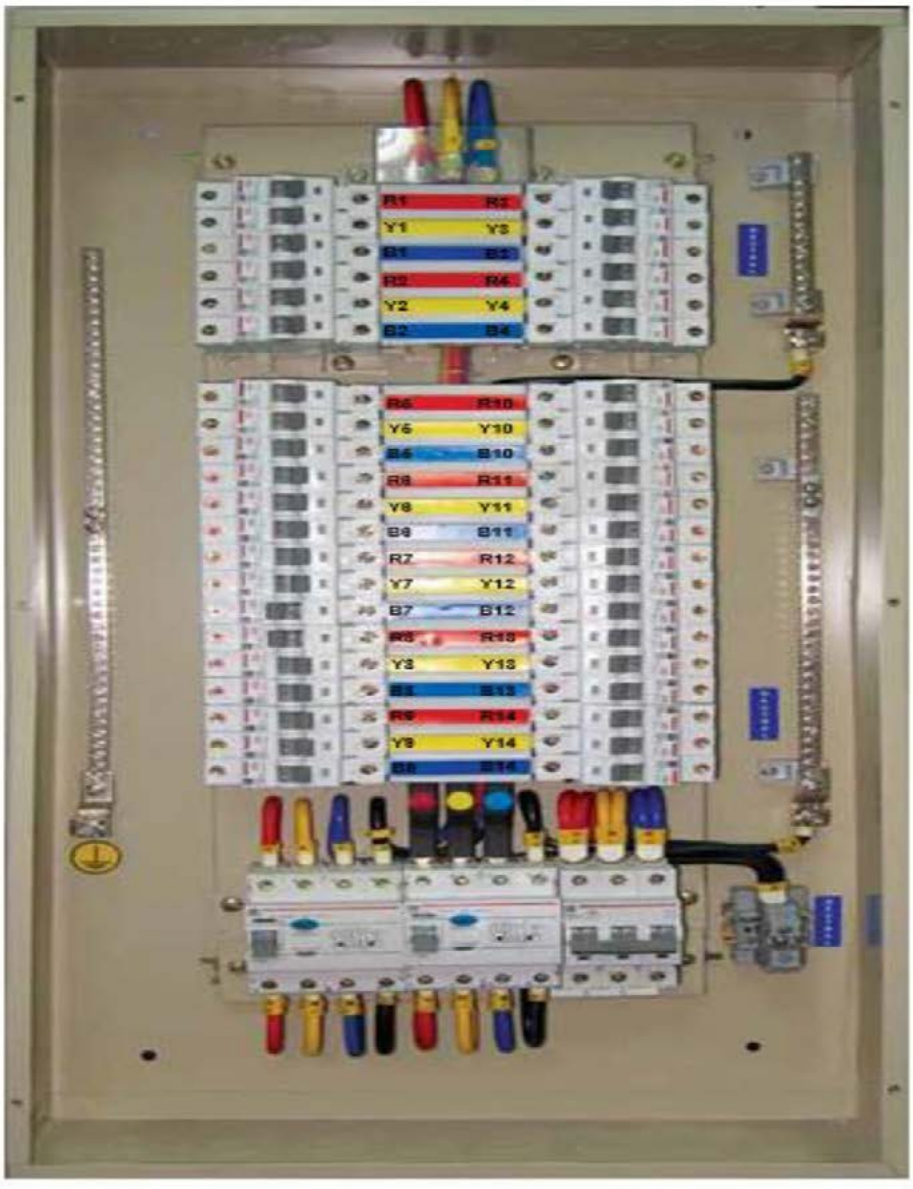
Typical busbar riser system including plug-in circuit breaker

G3.(b) Photograph of Final Distribution Board (horizontal DIN rail)

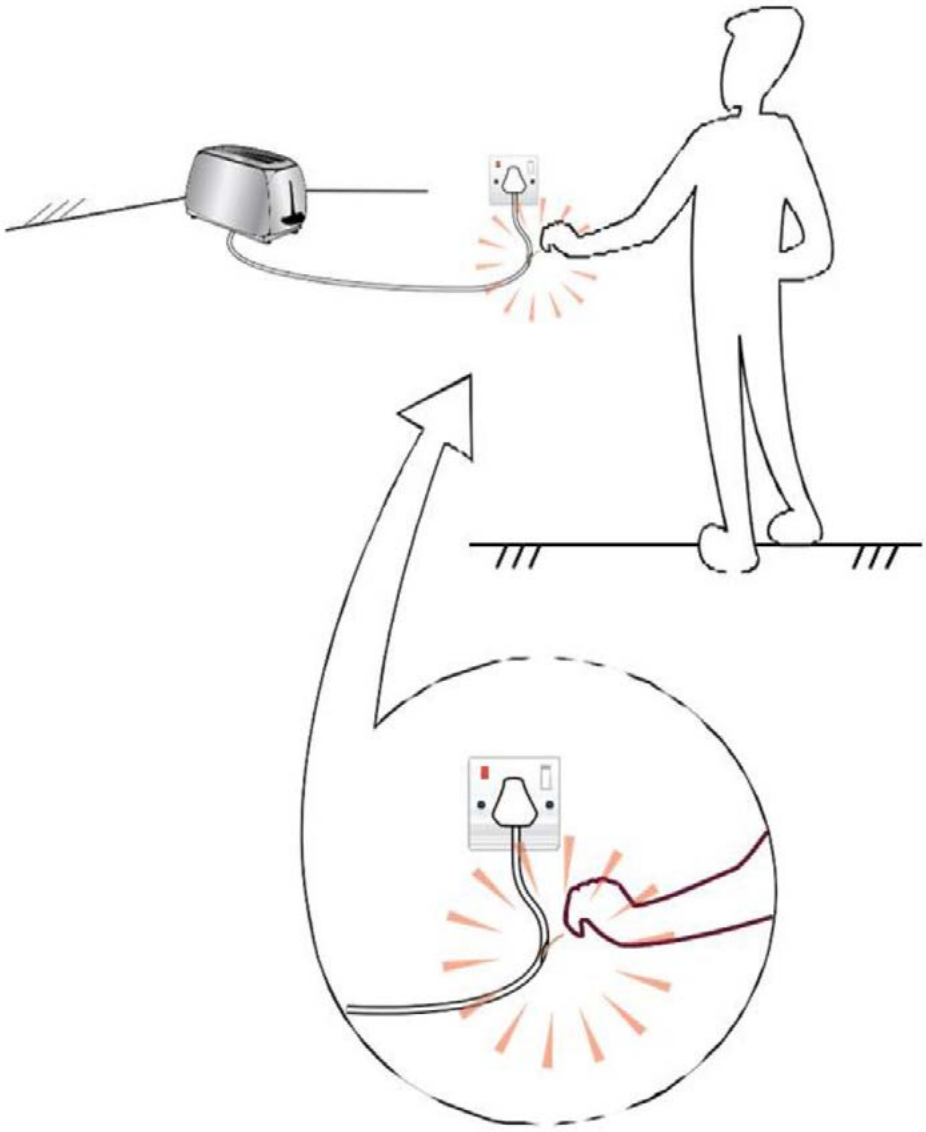




G3.(c) Photograph of Final Distribution Board (vertical, split busbar type)



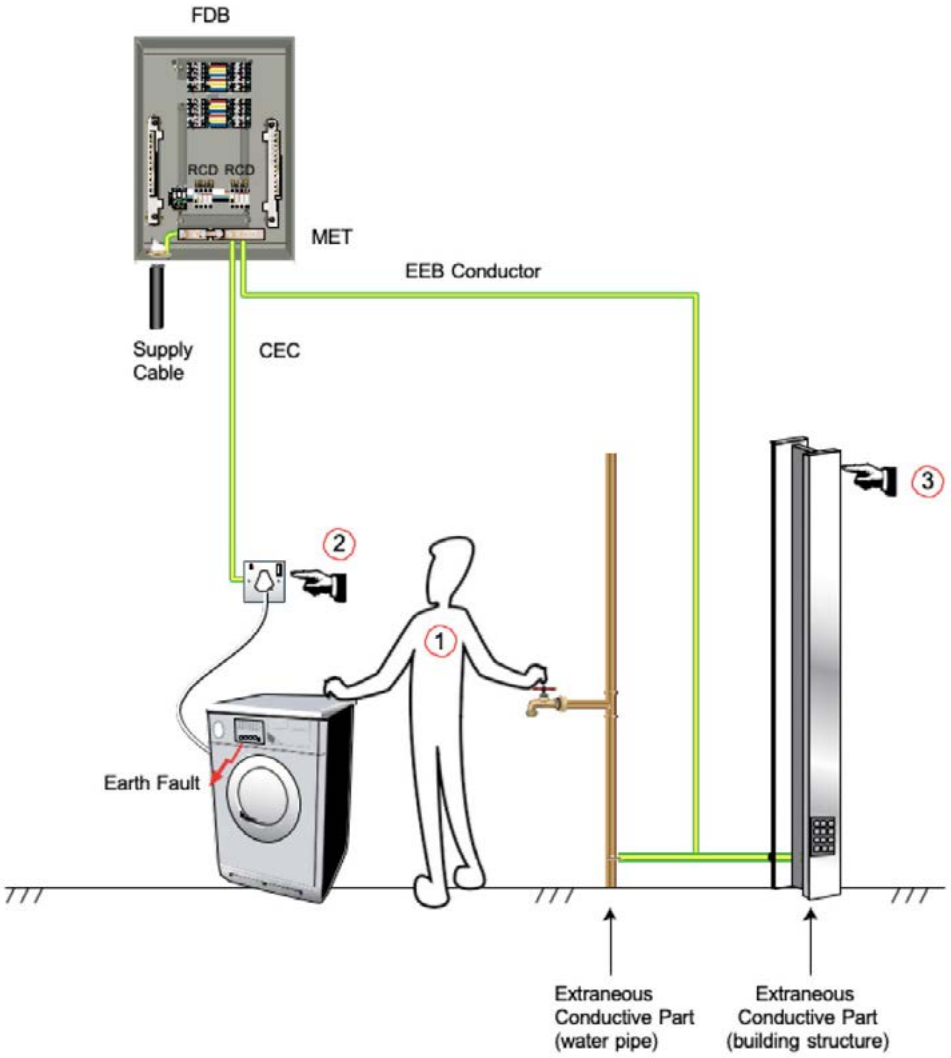
G4.(a) Direct Contact with electricity



[see Regulation 5.3]

G4.(b) Indirect Contact with electricity

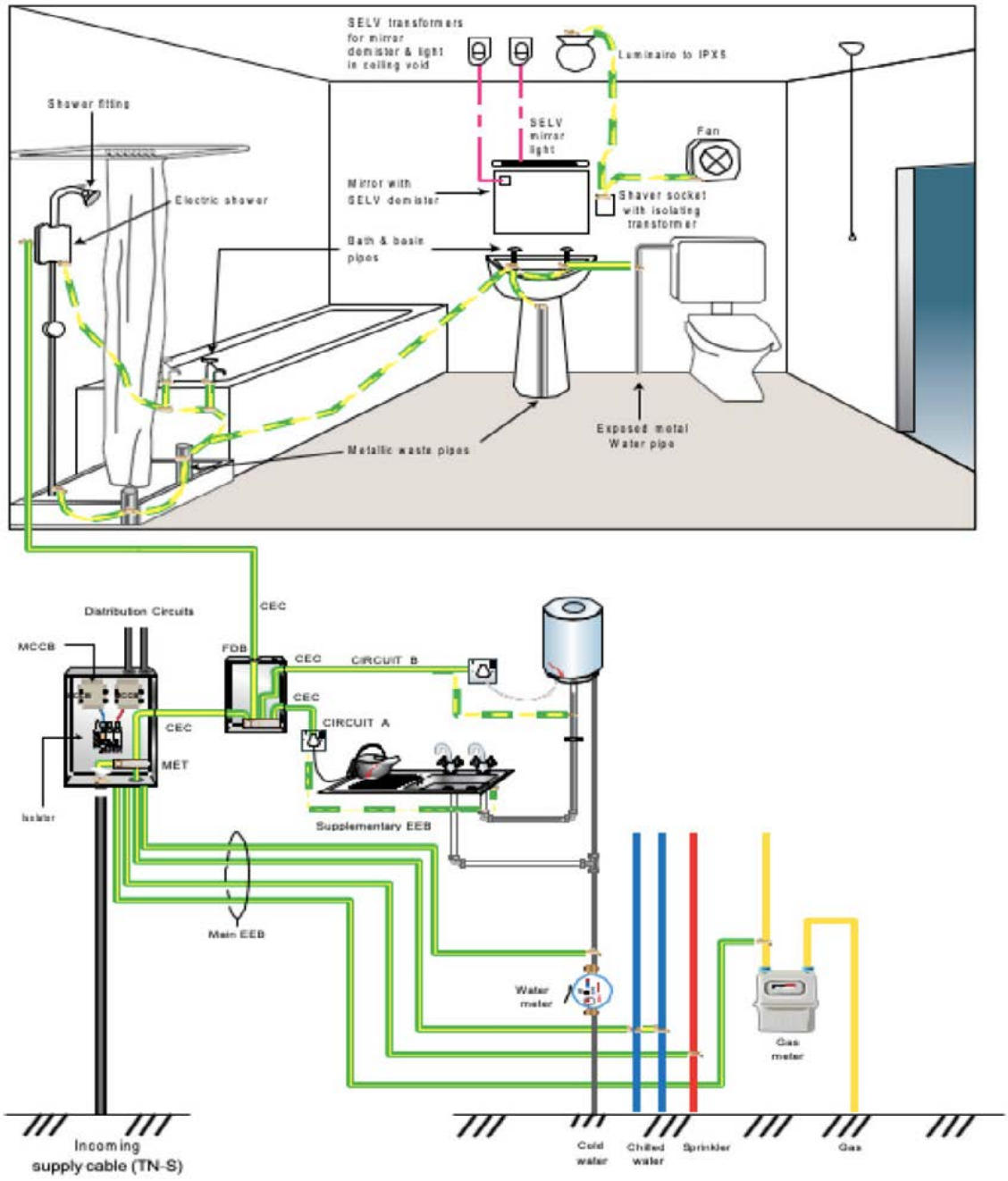
1. Contact between Exposed-Conductive-Part and Extraneous-Conductive-Part
2. Contact with Exposed-Conductive-Part
3. Contact with Extraneous-Conductive-Part



Note: *illustration shows TN-S supply system i.e. Distribution Company Earthed with Earthed Equipotential Bonding (EEB) of Extraneous metalwork. Live conductors are not shown for clarity.*

[see Regulations 5.3 and 5.5]

G4.(c) Main and Supplementary Earthed Equipotential Bonding (EEB)



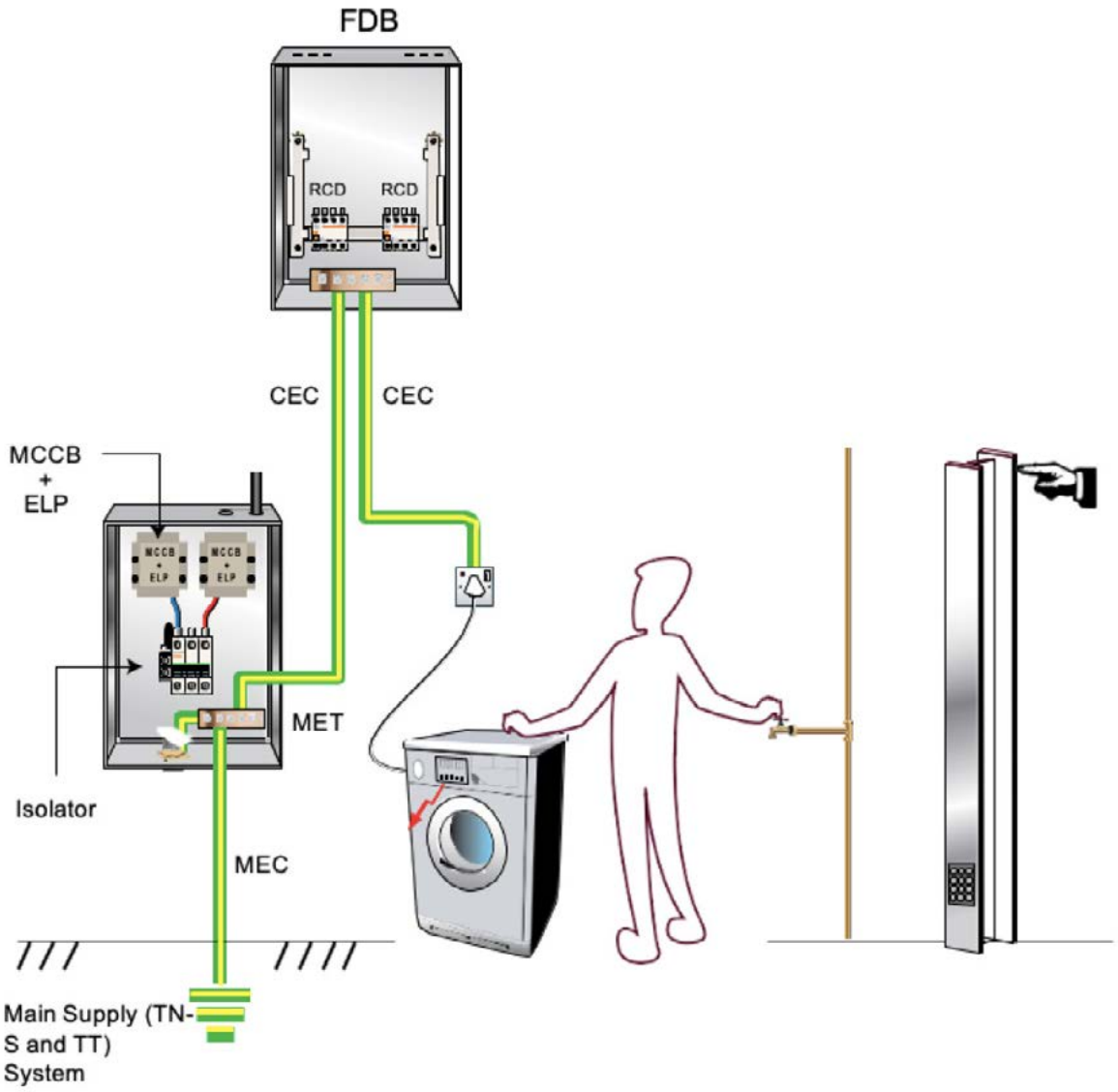
Note 1: *live conductors are not shown for clarity.*

Note 2: *characteristics of MCBs for Final Distribution Boards must be coordinated against Earth Fault Loop Impedance values to give a maximum of 0.4 Sec tripping for circuit A (socket-outlet supplying portable appliances) and for circuit B (fixed appliances). Also, MCCBs must coordinate to give a maximum of 0.4 Sec tripping time for distribution circuits. (see Clauses 5.5.2 and 5.5.3).*

Note 3: *clamps for Earthing and bonding shall be in accordance with BS 951. (see Clause 5.5.11).*

[see Regulation 5.5]

G4.(d) Illustration of Earth Leakage Protected System (ELPS)

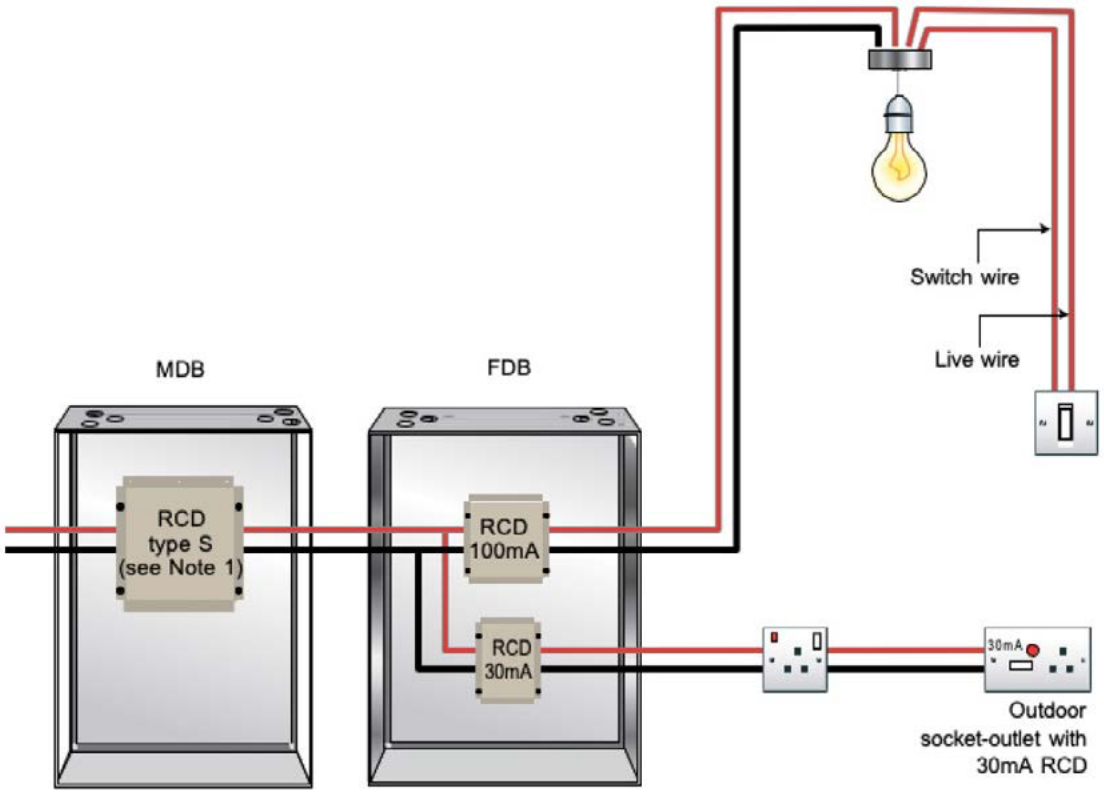


Note: *Main Distribution Board includes MCCB with Earth Leakage Protection.*

Live conductors are not shown for clarity.

[see Regulation 5.4]

G4.(e) Grading of RCDs in an ELP system

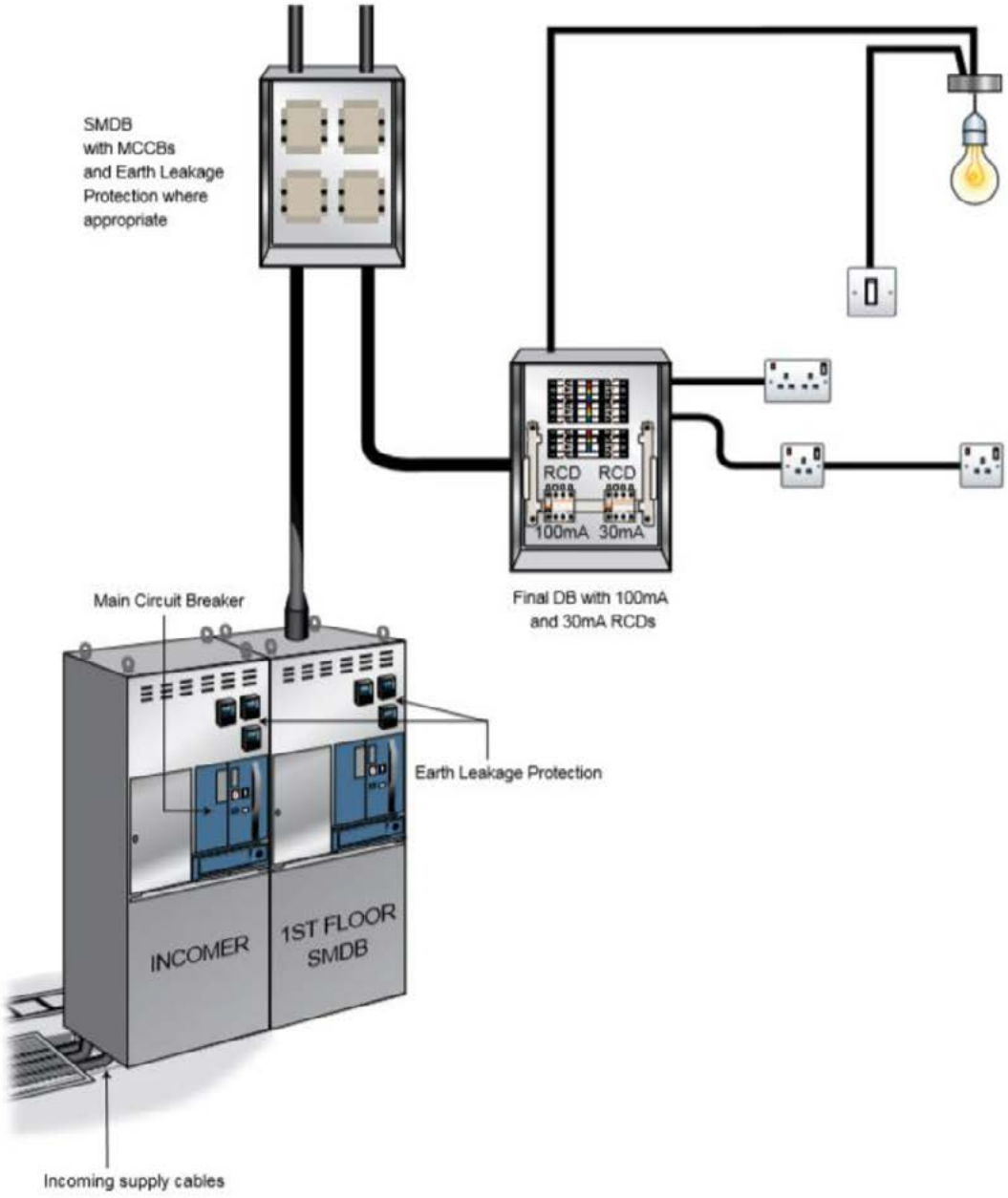


Note 1: *type S RCDs provide time delayed operation in order to discriminate with RCDs at the Final Distribution Board. Alternatively, for high current applications a MCCB with Earth Leakage Protection may be used.*

Note 2: *a maximum of 30mA RCD protection is required for socket-outlets serving portable Appliances; a maximum of 100mA RCD protection is required for fixed Appliances and Circuits.*

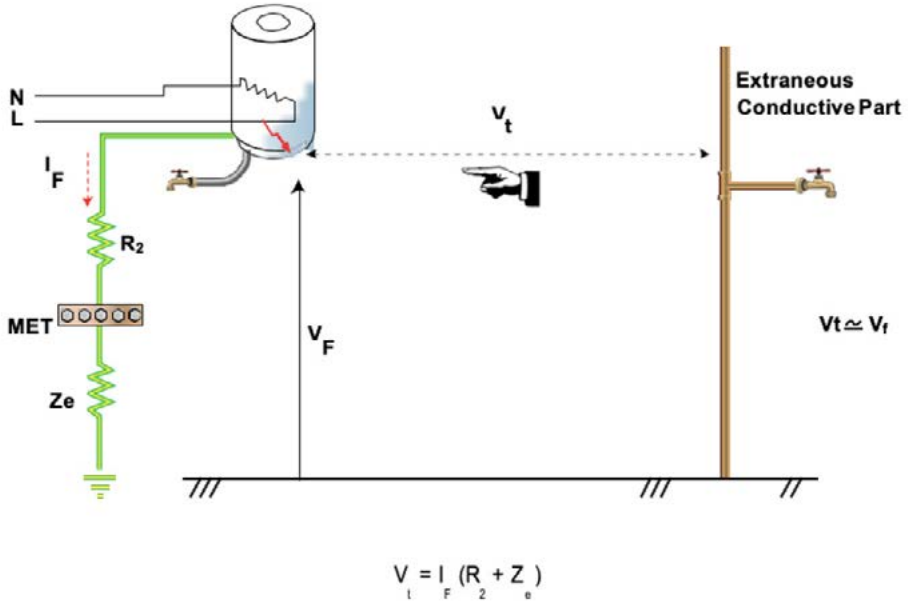
[see Regulation 5.4, clasuses 5.4.5 and 5.4.6]

G4.(f) ELP system supplied from LV switchroom



[see Clauses 5.4.5 and 5.4.6]

G4.(g) Calculation of Touch Voltage (ELP system)



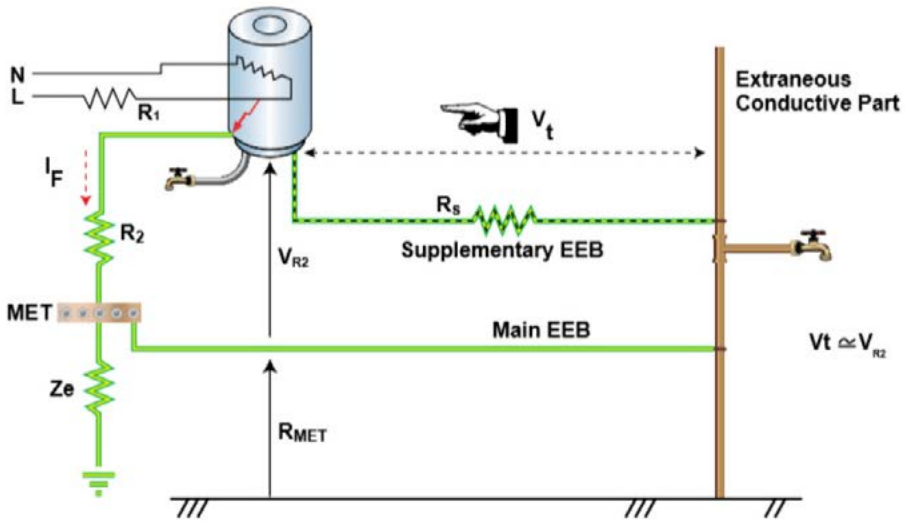
Note 1: *Touch Voltage Vt is approximately equal to the fault Voltage Vf assuming that the Extraneous-Conductive-Part is in good contact with Earth.*

Note 2: *Ze is the resistance of the Earth Electrode (TT system) or the incoming supply Earth Fault Loop Impedance (TN-S) system.*

Note 3: *the illustration shows unbonded Extraneous-Conductive-Parts, such as in an Earth Leakage Protected System (ELPS).*

[see Regulation 5.5]

G4.(h) Calculation of Touch Voltage (EEB system)



Notes:

Without supplementary EEB the Touch Voltage Vt is approximately equal to the Voltage drop across the Circuit Earth Conductor resistance R2 .

To calculate Vt:

$$Vt \simeq V_{R2} = I_F \times R_2 = \frac{U_0}{Z_s} \times R_2$$

Where:

U_0 = supply Voltage to Earth

Z_s = total Earth Fault Loop Impedance

Example:

For an Appliance supplied by an MCB (type C) of nominal rating 16A, the maximum Earth Fault Loop Impedance to give a 0.4 Sec disconnection time, given under Appendix A5(h) is 1.5 Ohms. R2 is measured as 0.9 Ohms.

Hence:

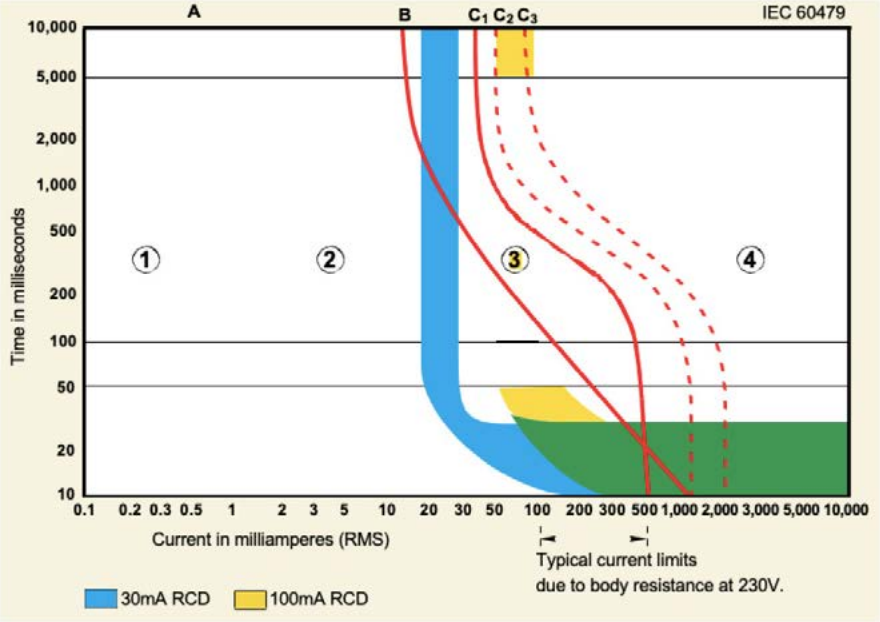
$$Vt = \frac{230}{1.5} \times R_2 = 138\ V$$

If the measured Earth Fault Loop Impedance is higher than 1.5 Ohms, the time-current characteristic of the MCB will need to be checked to see if a disconnection time of 0.4 Sec can be achieved (the Touch Voltage will be higher), otherwise RCD protection will be required. If supplementary bonding is applied then the Touch Voltage is dramatically reduced (the Voltage drop equates to the current passing through the supplementary bonding times the resistance of the supplementary bonding Rs).

G5.(a) RCD operating characteristics and electric shock

These Regulations include a compulsory requirement for provision of Earth Leakage Protection (ELP) on all Final Circuits where Appliances may be used by any persons. This is normally achieved with RCD devices complying with BS EN 61008 and BS IEC 1008 which must operate within 200ms at their residual current rating (tripping current) and within 40ms at 5 times their residual current rating. RCDs must not operate at below 50% of their residual current rating. RCD devices with a residual operating current of 30mA or less may be used for supplementary protection against Direct Contact, whilst devices rated above this value provide protection against Indirect Contact only (see Clause 5.3.2).

ELP devices do not protect against electric shock between phase conductors or between phase and neutral nor do they provide any overload protection. The response of the human body depends on the time and magnitude of current that may pass at the time of an electric shock incident. The 'low risk' and 'high risk' range of current against time is illustrated below, along with the operating times of typical RCD devices (from IEC 60479).



Response of human body vs. RCD charcateristics:

Zone 1: usually no reaction

Zone 2: shock sensation, but usually no harmful effects

Zone 3: likelihood of muscular contraction, and temporary cardiac arrest without ventricular fibrillation

Zone 4: in addition to the effects of zone 3, the probability of ventricular fibrillation is increased by 5% for curve C2 and 50% for curve C3; harmful effects such as cardiac arrest, breathing arrest and burns are likely to occur

G5.(b) Typical values of body resistance and physiological effects

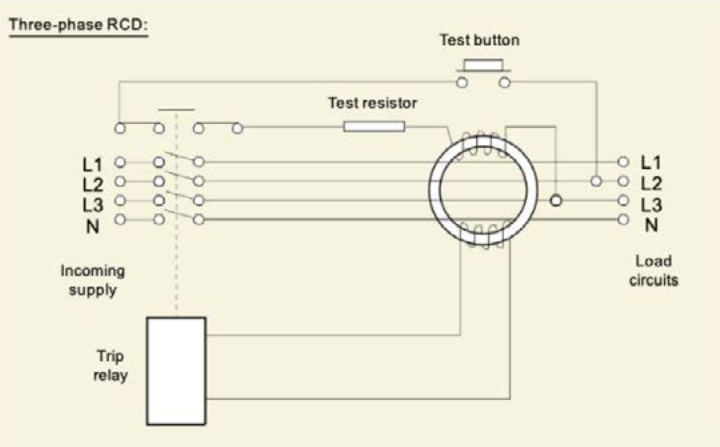
(Human resistance for various skin contact conditions (k Ohms		
Touch area	Dry	Wet
Finger touch	1,000 – 40	15 – 4
Hand hold on wire	50 – 15	6 – 3
Hand hold on pipe	3 – 1	1.5 – 0.5
Palm touch	8 – 3	2 – 1
Internal body resistance (including skin) = 0.2 – 1 k Ohms		

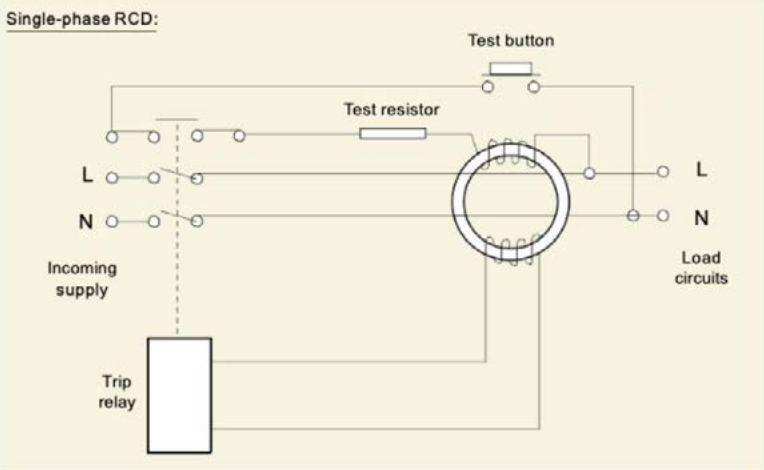
Electric current (1 second contact)	Physiological effect	Voltage required to produce the current with assumed body resistance:	
		100 k Ohms (dry finger)	1 k Ohms (wet hand)
1mA	Threshold of feeling, tingling sensation	100V	1V
5mA	Accepted as maximum harm-less current	500V	5V
10-20mA	Beginning of sustained mus-cular contraction (“Can’t let go” (current	1000V	10V
100-300mA	Ventricular fibrillation, fatal if continued. Respiratory function continues	10000V	100V

G5.(c) RCD operating principles

RCD devices measure the vector sum of currents passing through the phase and neutral conductors in a circuit, via a magnetic coil and electronic amplifier. The device will trip if these are out of balance by more than the residual operating current, in accordance with the manufacturer's time-current performance curve. See Guidance Note G5(a).

older type of voltage-operated earth leakage devices (ELCB) are not permitted (Clause 5.4.2) since they operate by detecting fault voltage and require a connection between a Main Earth Conductor and an Earth Electrode; these devices are therefore vulnerable to maloperation due to parallel earth paths.



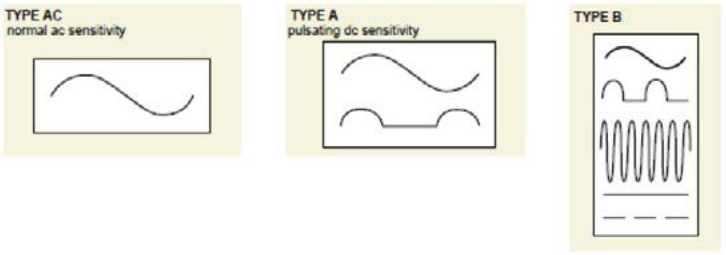


G5.(d) Types of RCDs

Because of the use of semiconductor devices in an Electrical Installation there may be situations when an earth fault current is not purely sinusoidal but contains a DC or 'chopped' waveform. This may de- sensitise or disable standard AC operated RCDs. Special devices are available which are designed to continue to function for non-sinusoidal supply waveforms, complying with IEC 1008, IEC 1009 (indicated by the symbols shown below).

For RCD devices installed at a Main Distribution Boards, time delayed operation is usually required to avoid tripping when a fault occurs in a Final Circuit (the FDB RCD should trip first). Time delayed RCD devices are labelled 'S type'.

For type B RCDs, they are able to provide protection in case of alternating residual sinusoidal currents up to 1000 Hz, pulsating direct residual currents and smooth direct residual currents. Refer to BS EN 62423 for more details.



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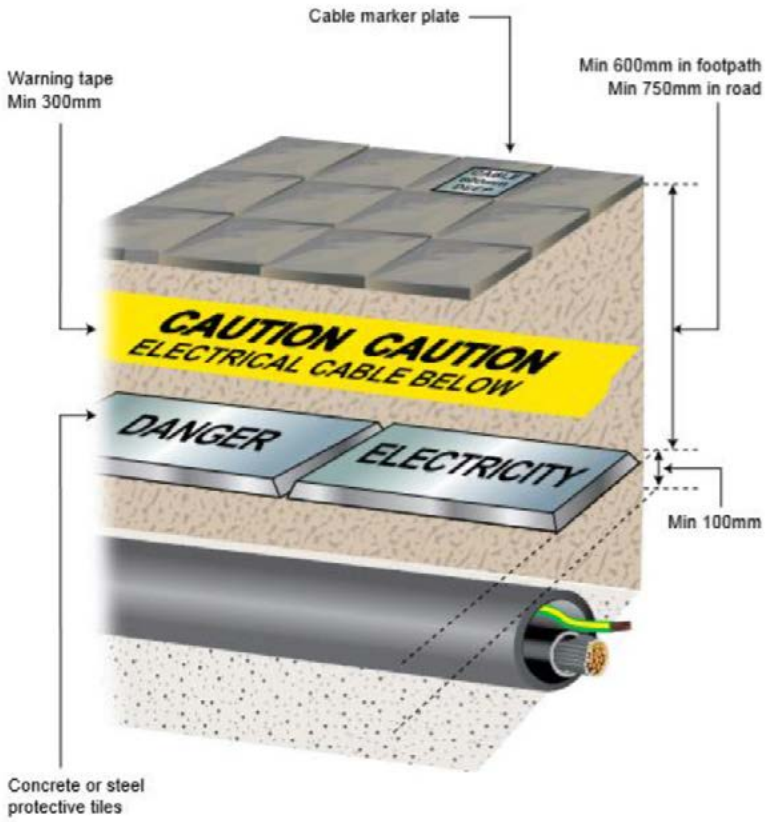
G5.(e) Sources of tripping of RCDs

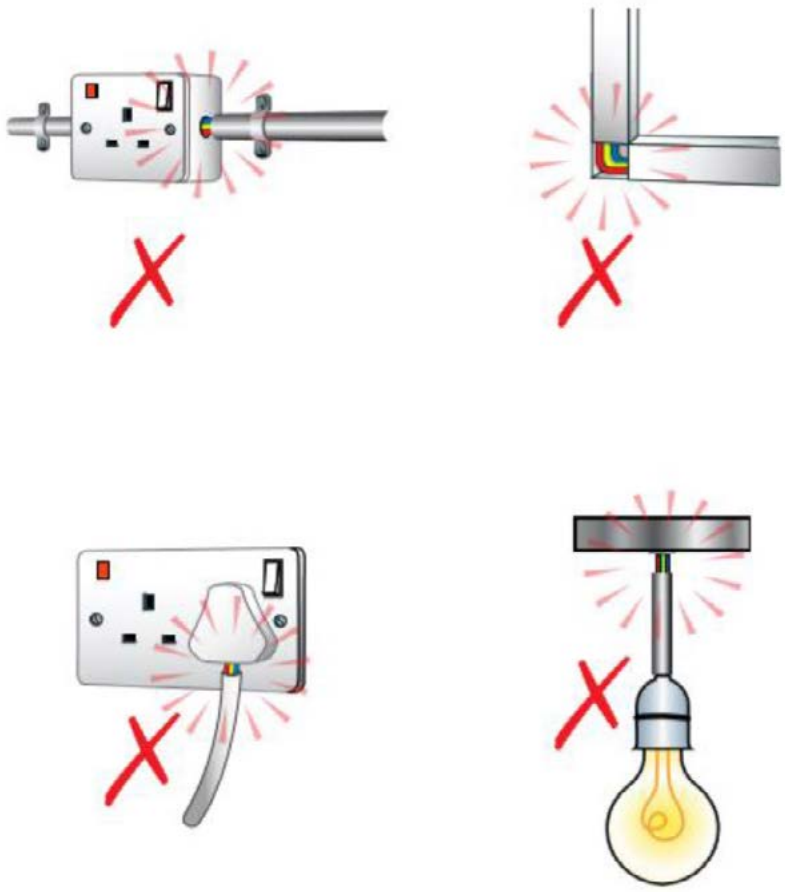
Type of fault	Reason
Downstream of RCD	- Direct Contact by persons - Indirect Contact (during earth fault) - Incorrect discrimination with upstream and downstream devices (e.g. - between MDB and FDB) - Loose connections - Crossed neutral connections on split busbar distribution board - Neutral to earth fault - High Earth Conductor currents (e.g. IT equipment, filters, etc) - Moisture in Circuit conductors (especially joints in MICC cables) - Moisture in Appliances (e.g. cooker heating element) - Double pole switching (capacitive effects) - Transient voltages caused by large inductive loads (e.g. industrial motors) - Damaged Circuits (e.g. nails in walls)
Upstream of RCD	Loose connections Mains borne disturbances (e.g. surges, lightning, harmonics, transients from overhead lines) Disturbing loads (e.g. machinery, lift motor, etc)

G6. Protection of buried cables



[see Clause 7.5.8]

G7.(a) Exposed unsheathed cables at termination points

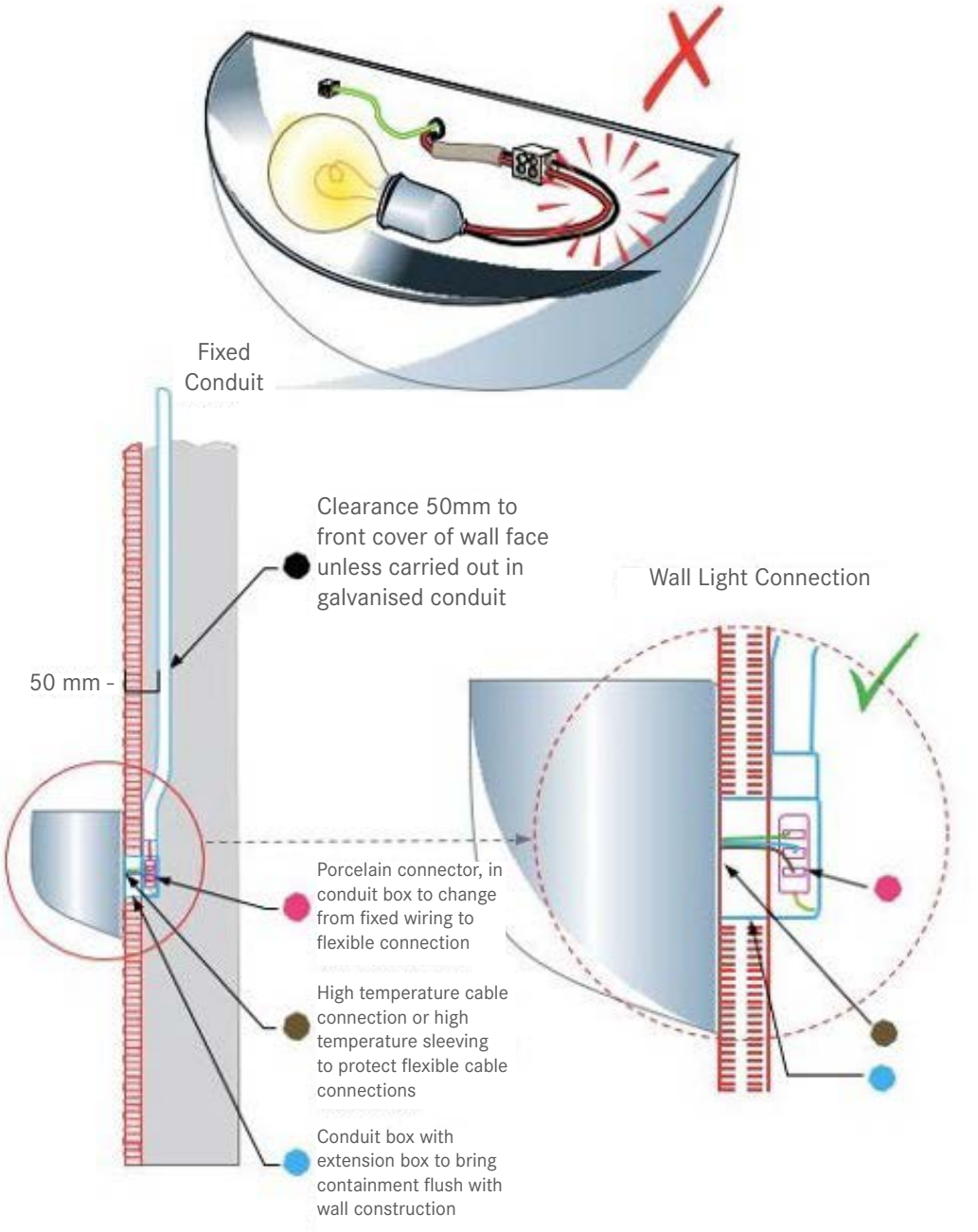


[see Clauses 7.4.8 and 7.5.12]

G7.(b) Protection of high temperature connections

Heat resistant sleeve required for high temperature connections

[see clause 7.5.17]

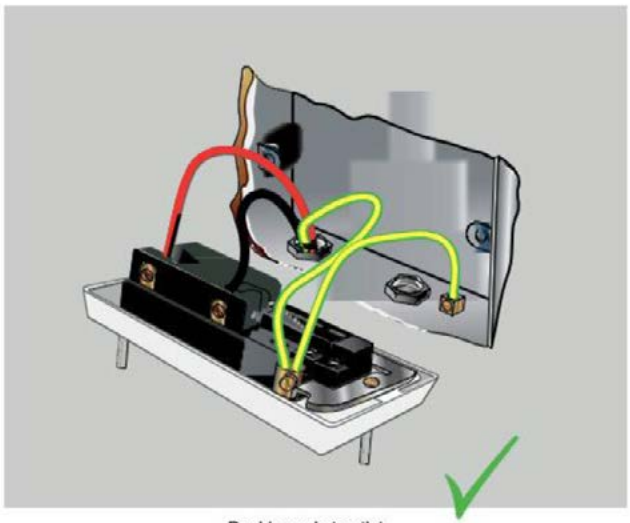


G7.(c) Weather protected outdoor socket-outlets

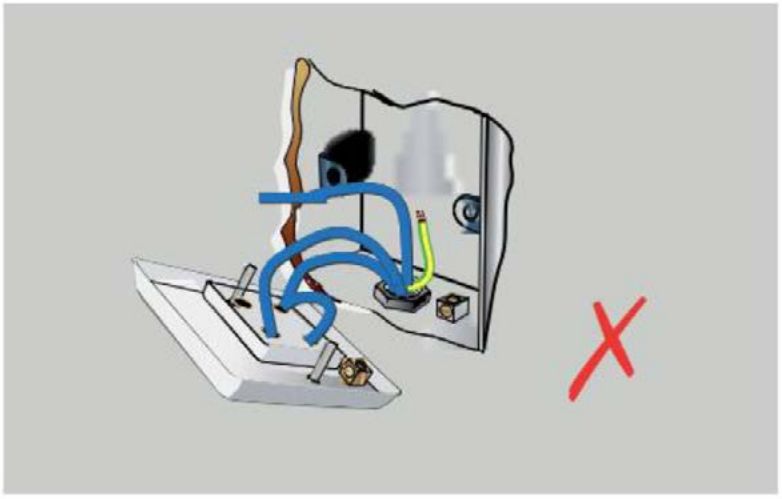
IP55 weather protected socket outlet with 30mA RCD

[see Clauses 7.1.14, 9.4.1(b), 9.5.1(b), 9.6.2(i)]

G7.(d) Earth tails in Accessories and connection boxes

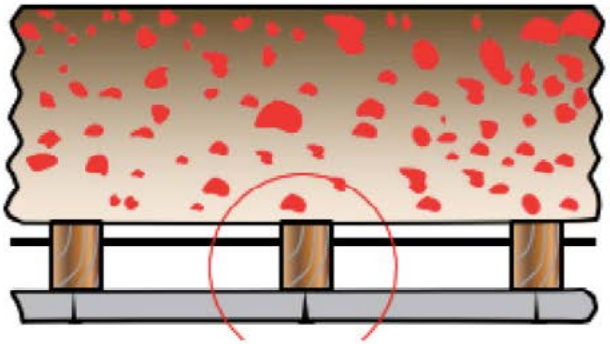


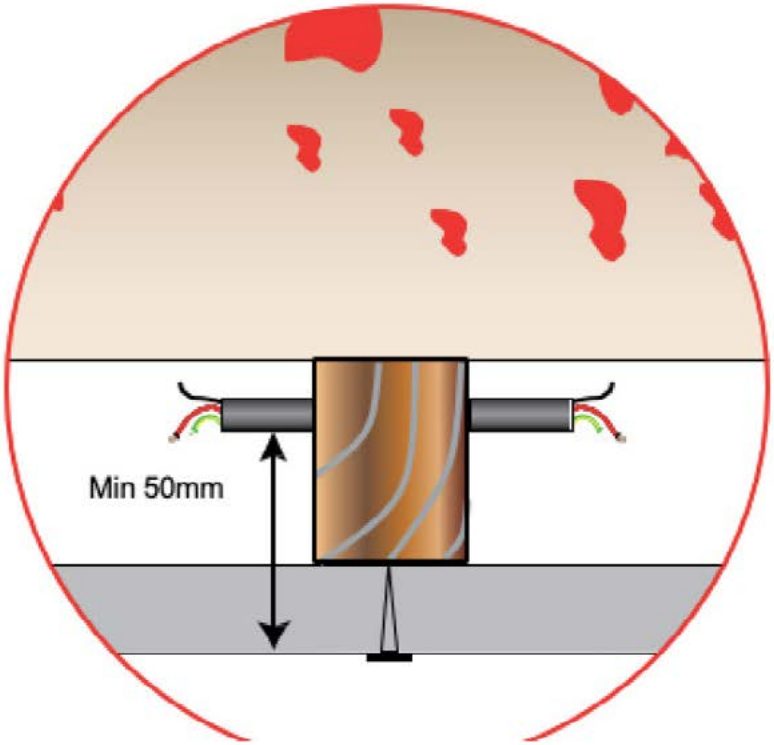
Double socket-outlet



[see Clause 6.6.4]

G7.(e) Minimum depth of buried plastic conduit

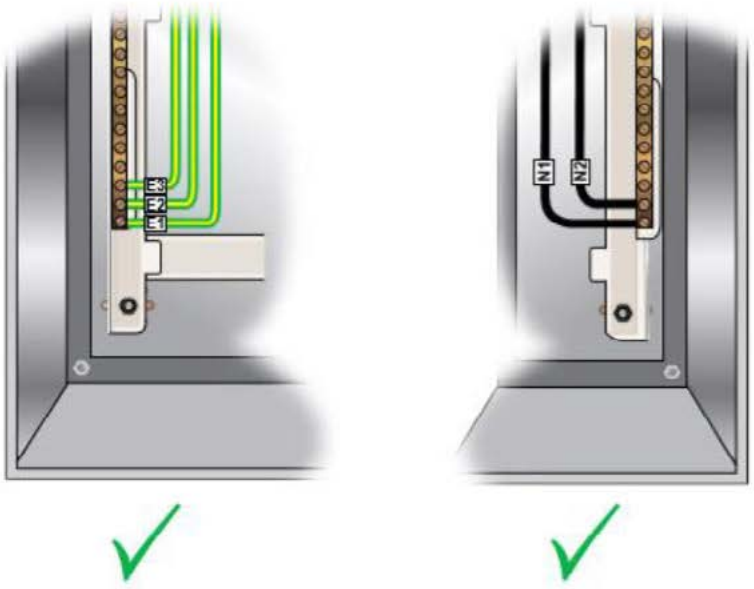




Buried plastic conduits in walls or ceilings must be min 50mm depth or metal conduit must be used (see Clause 7.4.6)

G7.(f) Circuit identification numbers on Accessories and Earth Conductors

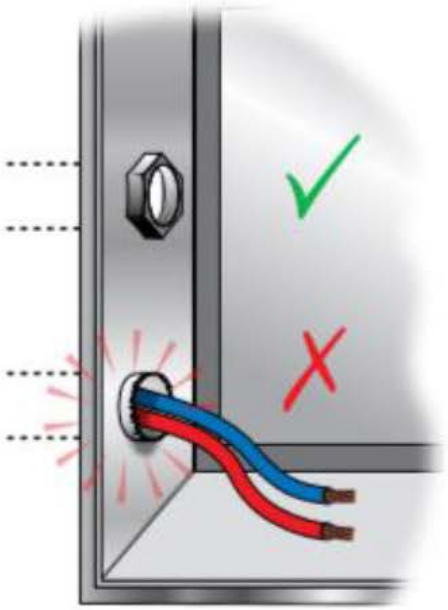
(Circuit identification numbers,
See clause 3.6.4,3.6.5)

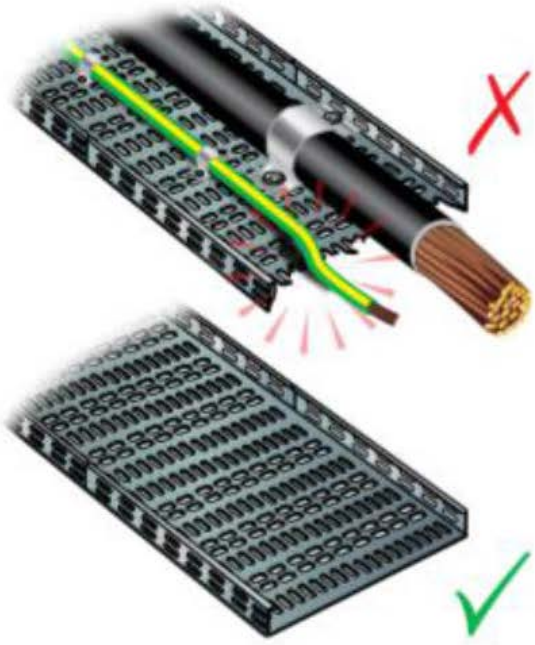


Note: *phase and neutral conductors should be in the same sequence.*

[see Clause 6.5.3]

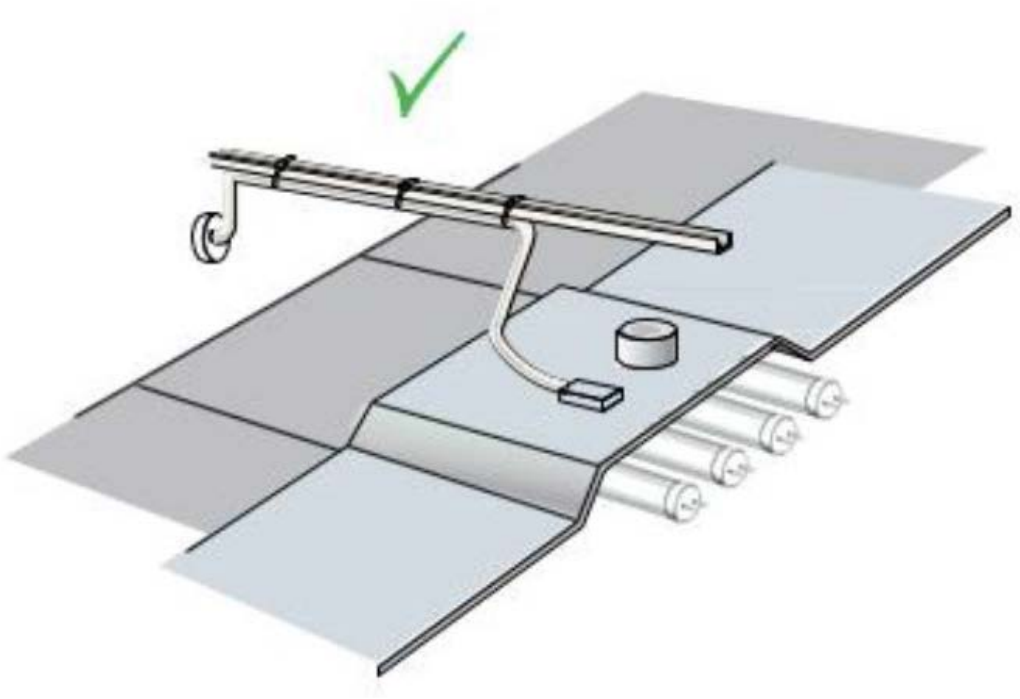
7.(g) Missing grommets and sharp edges on Cable Tray





[see Clause 7.4.8]

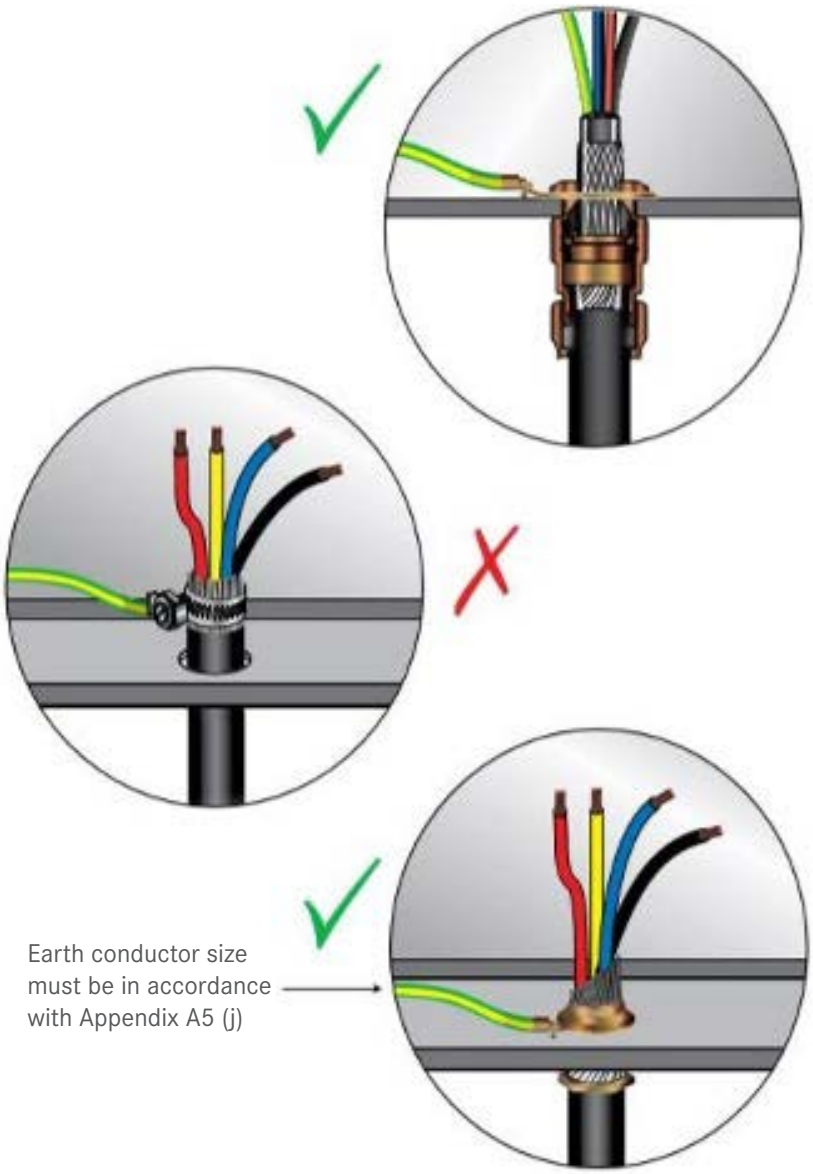
G7.(h) Cables in ceiling-voids



[see Clauses 7.3.8 and 7.5.15]

(flexible connections to be limited to 3m in length and securely fixed; ‘plug & fit’ connection systems may be used after the main supply connection)

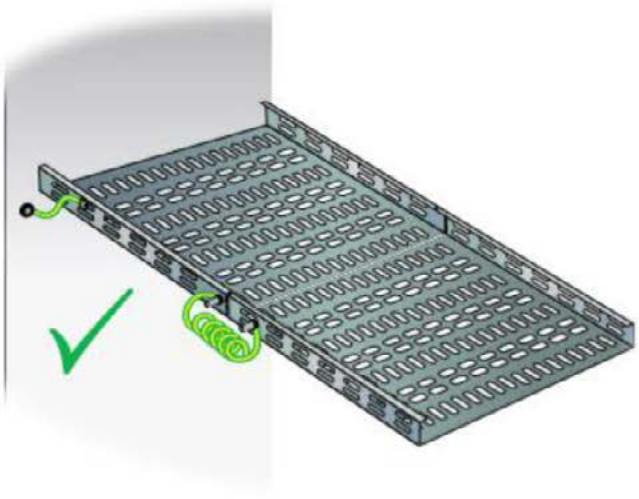
G7.(i) Cable glands for Earthing of armoured cable

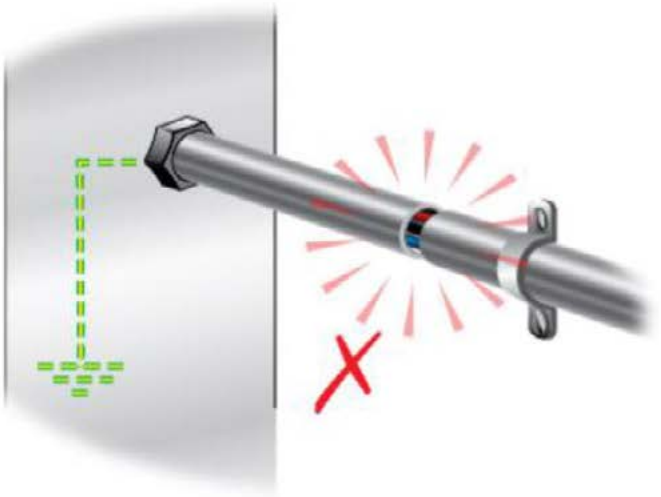


[see Clause 7.5.18]

Note: *all glands should be mechanically and electrically sound, secured and tightened using the appropriate tools.*

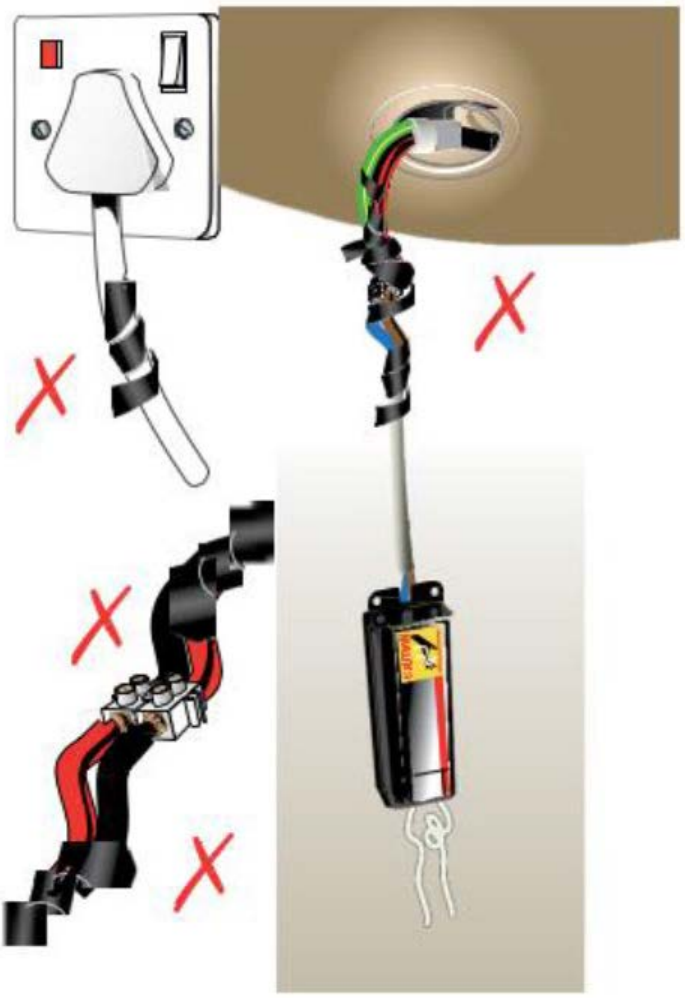
G7.(j) Earth continuity connections across Cable Tray and conduit





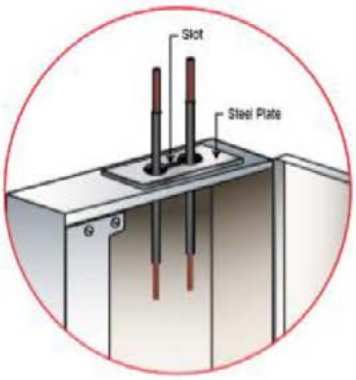
[see Clauses 6.6.1 and 7.4.4]

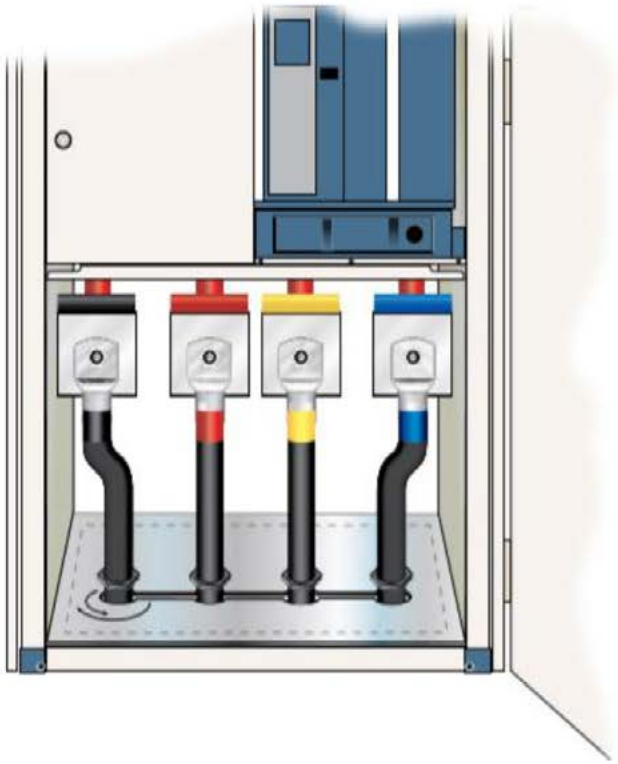
G7.(k) Prohibited terminal blocks and taped connections



[see Clause 7.5.16]

G7.(I) Slotting of steel gland plates for single core cables

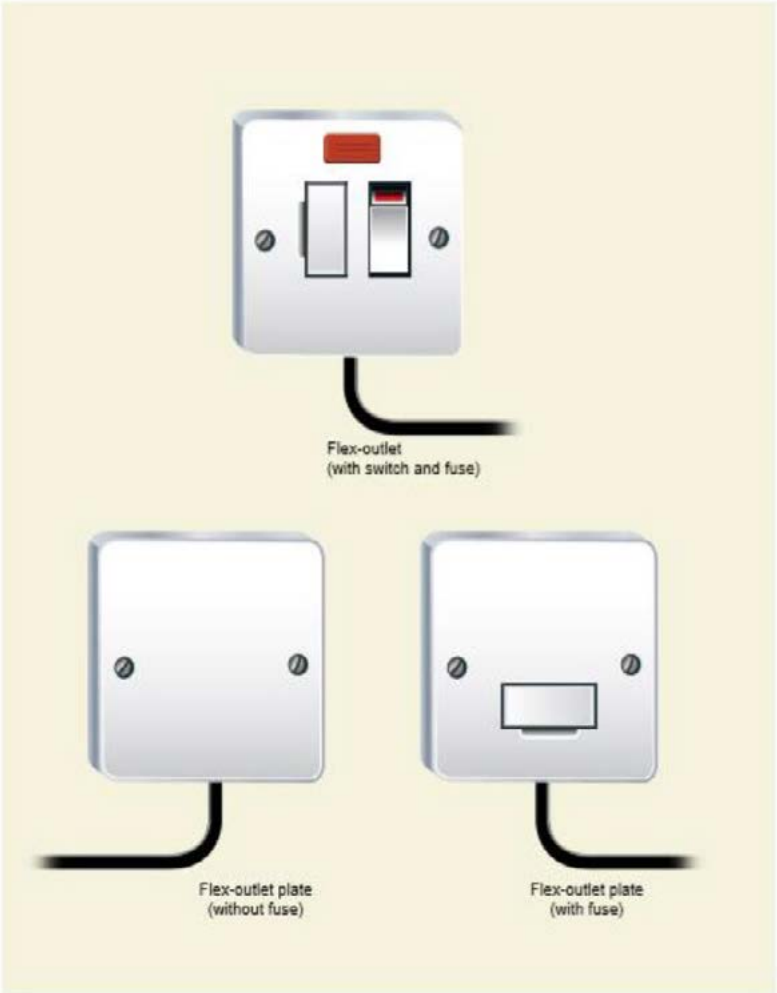




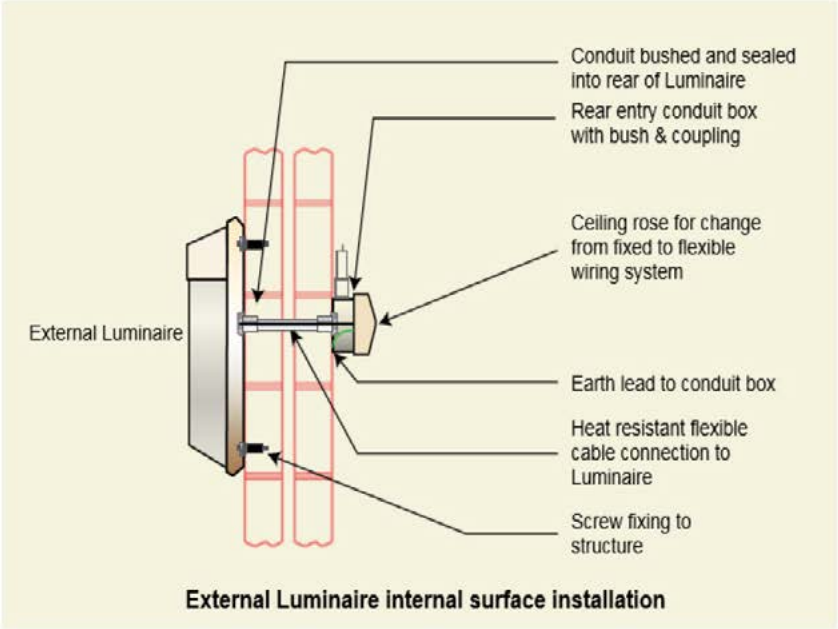
Note: *single core cables in a steel enclosure will cause electromagnetic currents in the steel and possible overheating. This can be avoided by ensuring that a non ferromagnetic material is used around the cables (e.g. brass or aluminium plate) or slots are cut in the steel between the phase conductors.*

[see Clause 7.5.11]

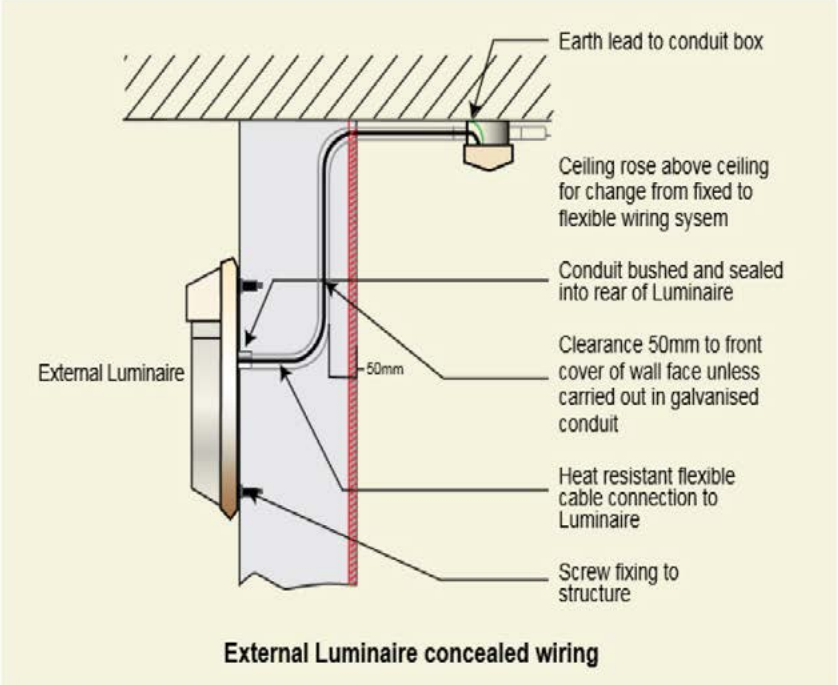
G7.(m) Flex-outlets



G8. Typical lighting Circuit Installation

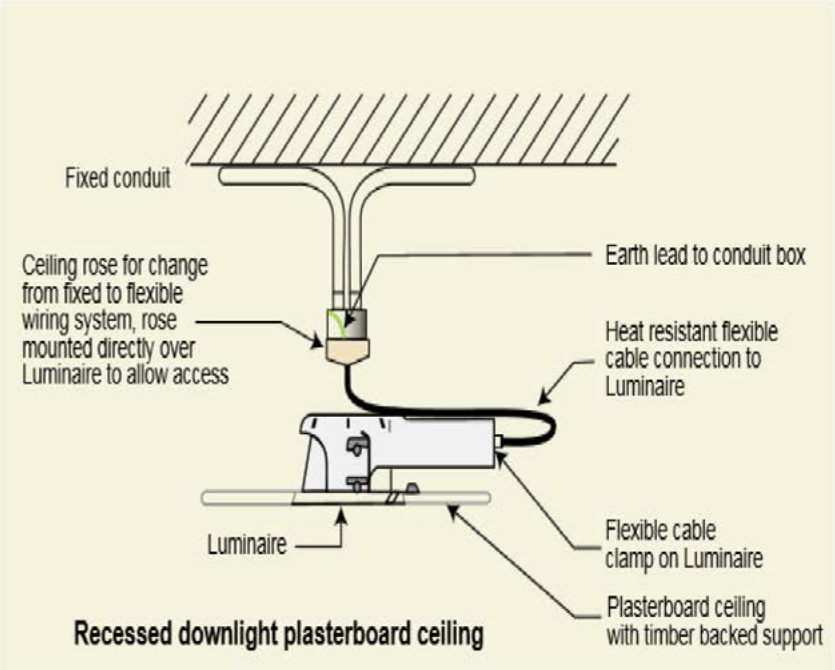


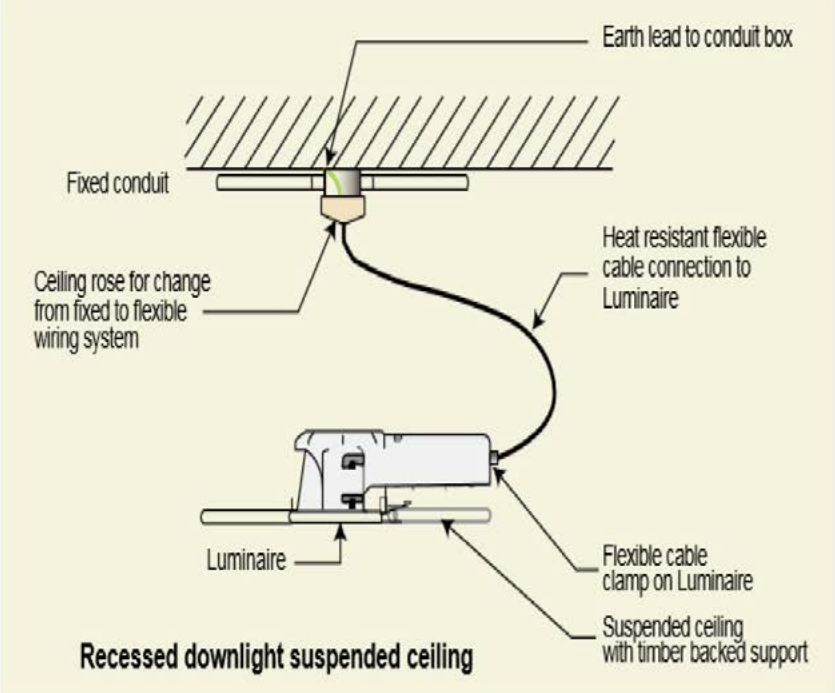
External Luminaire internal surface installation



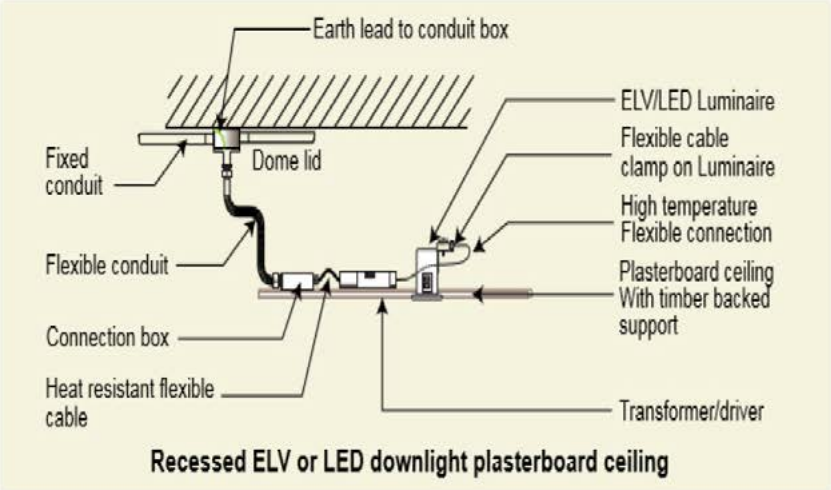
External Luminaire concealed wiring

G8. Continued...

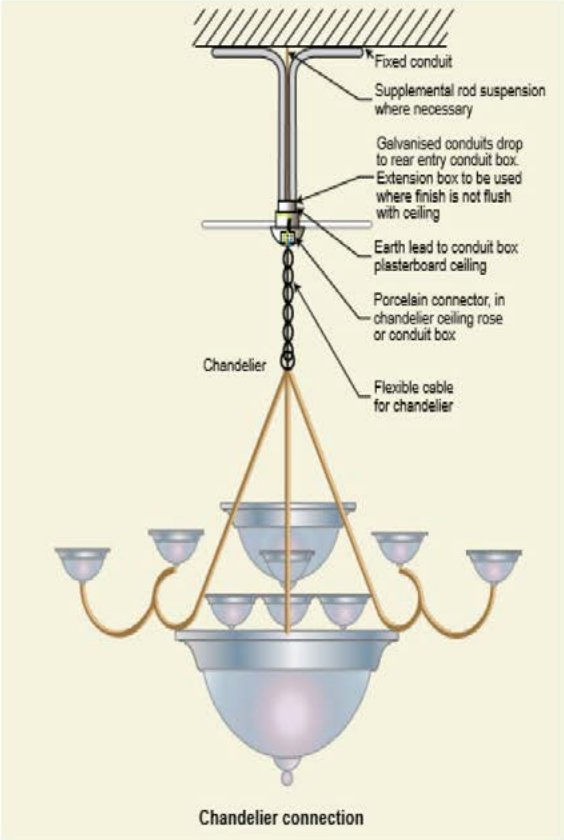




G8. Continued...



Recessed ELV or LED downlight plasterboard ceiling



Chandelier connection

Note 1: *flexible conduits to be fitted with glands at both ends.*

Note 2: *connection box to be complete with conduit inlet and flexible cable clamp outlet.*

Note 3: *connection box to be suitably sized to allow removal through Luminaire aperture*

G9. Isolation and Switching

Note 1: *all pumps in the set are to be provided with isolators.*

Note 2: *remote stop switches or isolator on the control panel does not provide sufficient means of isolation to meet the requirements of the Regulations.*

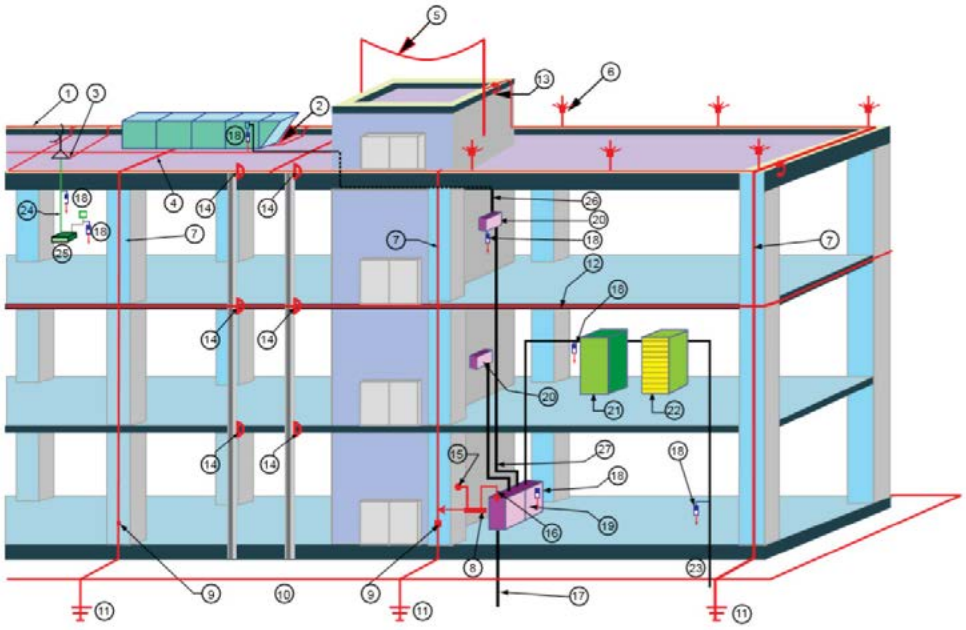
Note 3: *remote stop push button must be located to be easily accessible but without possibility of inadvertent operation.*

Note 4: *all cables and conduits must be adequately supported and fully terminated.*

Note 5: *all isolators must be lockable in the off position.*

Note 6: *all motors must be provided with suitably sized terminal block.*

G10.(a) Typical lightning protection system details



1. Roof tape network
2. Earth Equipotential Bonding to roof mounted electrical equipment
3. Earth Equipotential Bonding to aerial array
4. Meshed type LPS
5. Catenary type LPS
6. Rod (Finial) type LPS
7. Down conductor
8. Earth Equipotential Bonding bar for internal LPS
9. Test point
10. Ring Earth Electrode below ground level
11. Earth Electrode
12. Earth Equipotential Bonding ring (for buildings above 30m, ring provided at 20m intervals of height)
13. Earth Equipotential Bonding to lift shaft
14. Earth Equipotential Bonding to façade steelwork
15. Earth Equipotential Bonding to building steelwork
16. Earth Equipotential Bonding from LV supply to equipotential bonding bar.
17. Incoming supply cable
18. Surge protection device (SPD)
19. MDB
20. DB
21. UPS
22. ICT Equipment
23. Incoming communication and data cables (copper)
24. Satellite aerial cable
25. Satellite Decoder
26. Electrical supply to roof mounted equipment
27. Sub-main cable

G10.(a) Continued...

Note 1: *a risk assessment evaluating the full requirements of lightning protection systems (LPS) including the impact on electrical and electronic systems (e.g. surge protective devices) is to be carried out by the designer of the Electrical Installation.*

Note 2: *LPS may be provided in three ways, meshed, catenary or rod type. Any or all of the LPS systems shown above may be used depending on the configuration of the Premises. Other methods may be proposed subject to the approval by the Distribution Company.*

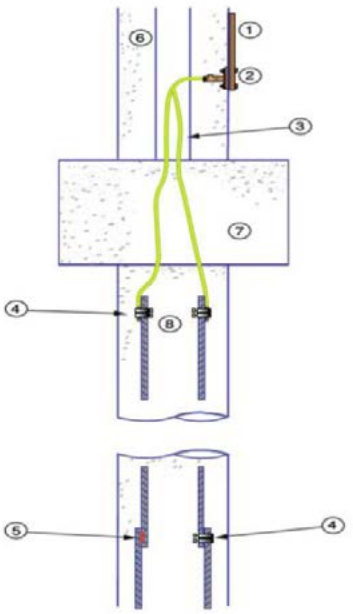
Note 3: *down conductors are to be provided at a spacing interval to meet the lightning protection risk assessment. Typically LPS I & II – 10m, LPS III – 15m and LPS IV – 20m as detailed in BS EN 62305-3.*

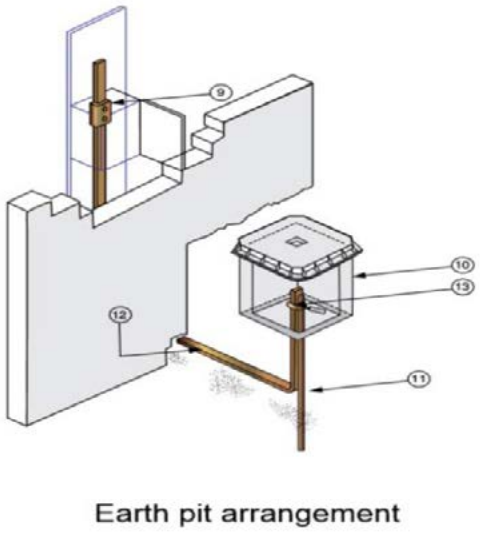
Note 4: *the use of natural components (the building reinforcement bars or structural steel), is not permitted unless approved by the Distribution Company. Down conductors are to be provided with test links either internally or externally in accessible locations at low level. Earth Electrodes should ideally be connected in a ring around the building at ground floor level where practical.*

Note 5: *structural foundations or piles may be used as lightning Earth Electrodes and a typical detailed arrangement is provided in G10(b). For Premises exceeding 30m in height, secondary rings should be provided around the building at a spacing of 20m intervals. Earth Equipotential Bonding is required for Extraneous-Conductive-Parts such as curtain wall framing, lift shaft steelwork, drainage and gutters, parapet copings, exposed equipment, handrails etc.*

Note 6: *surge protection devices (SPDs) are to be provided based on the risk assessment evaluation, but as a minimum should be deployed at the Electricity Intake to the Premises. Equipment that is prone to potential damage from lightning strikes should also be protected.*

G10.(b) Lightning Earth Electrodes





1. Down conductor

2. Test clamp

3. Twin tailed bonding conductors

4. Bolted Earth clamps

5. Welded connection to reinforcement bars

6. Wall construction

7. Pile cap

8. Pile

9. Test clamp with recessed accessible cover

10. Lightning protection Earth pit

11. Earth Electrode

12. Lightning protection tape

13. Corrosion treated connection

Note 1: *when using piles as the lightning protection Earth Electrodes, the planning is to be carried out in conjunction with the design of the structure.*

Note 2: *structural engineer to confirm that piles can be used and that clamping or welding of rods is acceptable. Note 3: where welding is used, minimum length of welds must be 50 mm.*

Note 4: *all LPS works associated with the use of piles is to be inspected prior to pouring of concrete.*

Note 5: *protective cover for tape/cable through ground to Earth Electrode not shown but is to be provided.*

Note 6: *termination at Earth Electrode to be corrosion resistant or be treated for electrolytic action.*

Note 7: *where tape is run surface at low level, mechanical protection is to be provided. Where protection is metallic this is to be bonded to the tape.*

G11. Changes in this Edition (April 2020)

The following is a summary of the key changes incorporated into the Electricity Wiring Regulations (DoE Edition).

1. These Regulations are now issued by DoE in accordance with Law No 11 of 2018.
2. All references to ex RSB were changed to DoE as appropriate.
3. All reference tables in appendices have been updated to capture BS 7671 18th edition as appropriate.
4. EVSE Addendum is now included in the (2020) DoE edition in Part 13.
5. Effective dates of some provisions were updated to capture changes as appropriate.
6. Amended Clause 1.4.5 (of Clause 1.3.5 in 3rd edition).
7. Amended relaxation Clause 1.4.8 (Clause 1.3.8 in 3rd edition) and associated note.
8. Added new Clause 1.4.11 and Clause 1.4.12.
9. Updated regulation 2.5 (Definitions) to include all definitions associated with EVSE Addendum 1
10. The text of Clause 3.1.4 was amended per the suggestion of QCC, this will give Discos some room to approve alternatives.
11. In Clause 3.2.4 added the term designer “the Owner, designer and associated Licensed Contractor..”
12. The text of Clause 3.4.2 was amended, this will give Discos some room to improve processes.
13. Clause 3.5.12 was amended to read “Inspection and testing of Electrical Installations must be carried out by suitably qualified and competent persons with “
14. In Clause 4.2.5, replaced the word hindrance by obstructions.
15. In Clause 7.5.20 replaced the word Live by Phase.
16. Added note 2 to Clause 7.8.15 to allow for the usage of wall mounted MDB and SMDB below 400A at residential villas.
17. Added note to Clause 7.8.17 to specify the Ingress Protection rating of the wall mounted MDB or SMDB below 400A at residential villas to be minimum IP65 unless otherwise specified by the distribution company.
18. Added note (b) with respect to the periodic inspection table of Clause 8.1.5.
19. Introduced new Regulation 9.7 “Roadway Lighting” instead of Street Lighting.
20. Added new Clause 9.7.1 pertaining to Roadway Lighting and amended number of associated Clauses accordingly.

21. In Clause 9.7.2 (Clause 9.7.1 in EWR 3rd Edition) replaced the terms “the street light column” by roadway lighting pole.

22. In Clause 9.8.3, added in accordance with BS EN 50525 to flexible cable.

23. Amended Clause 10.1.3 : The use of capacitor banks in residential villas shall be determined by the distribution company on a case by case basis and hence permitted in accordance with the relevant regulations and shall be installed in the main intake room.

24. Clause 10.2.13 Relevant international standards for capacitors have been updated in the respective table as follows:

Capacitor switching contactors	IEC 60871 and IEC 60831
Detuning reactors	IEC 60076-6 and IEC 60076

25. To ensure consistency and validity of standards, Clause 13.1.17 was updated, e.g. added installation of the In-cable control and protection devices (IC-CPD) for mode 2 charging of electric road vehicles in accordance with IEC 62752

26. Removed reference to IEC-61851-22 from the EVSE respective table associated with Clause 13.1.18, since the same has been withdrawn in Feb 2017 and was replaced by expansion of the scope of IEC 61851-1

27. In new Clause 13.2.5 (previously clause 1.38-Final circuit) replaced Extension cord unit with Cable extension unit.

28. Enforcement procedures (Regulation 15.2) are amended to capture the enforcement powers conferred to DoE pursuant to Law No 11 of 2018.

29. A5(h) Earth Fault Loop Impedance values required for MCBs (at 230 V)- change of values in table, in accordance with BS 7671 18th edition.

30. A6.(d) Time current characteristic of Type D MCBs-chart updated in line with BS 7671 18th Edition.

31. A7(b) Circuit rating and Voltage drop for PVC multi-core cables (non-armoured)- change of values in table, in accordance with BS 7671 18th edition.

32. G2 sample tables have been corrected on the estimation of Connected Load and the use of diversity factors for Final Circuits, SMDBs and MDBs.

33. For improved safety and protectivity, G2 sample table concerning water heaters has been updated to provide radial circuit for each water heater and considered the load 1500W for each, as illustrated below.

Water Heaters: Bathroom & Kitchen	1	WH-1	Single Core	RAD	1.500	0.000	0.000	1.500

34. A1 Glossary of terms and abbreviations-captured AC (alternating current) and DC (direct current) instead of AC and DC respectively and reflected amendment through the document. Also added amended Ze External Earth Fault Loop Impedance “at Intake”.

35. A3 Reference standards have been updated, e.g. BS 6207 has been replaced by BS EN 60702- 3:2016,BS 6500 has been completely withdrawn and included by BS EN 50525, BS 50086 has been withdrawn and replaced by BS EN 61386-23:2004+A11:2010, BS 31 has been withdrawn and replaced by BS EN ISO 80000-12:2013, BS 6701 was removed from General table Earthing part page 93, due to non-relevance, BS 60617 has been completely withdrawn, BS 60446 has been witdrwan and replaced by BS EN 600445:2017, BS 61646 has been withdrawn and now included in BS EN 61215 and updated associated IEC standard, added BS EN 61727, added BS EN 61000, BS 50521 has been replaced by BS EN 62852.

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