

SULTANATE OF OMAN



هيئة تنظيم الكهرباء - عمان
AUTHORITY FOR ELECTRICITY REGULATION, OMAN

AUTHORITY FOR ELECTRICITY REGULATION

STANDARD OES-4

Electrical Installations in Buildings

Third Edition

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INTRODUCTION

This third edition of the REGULATIONS FOR ELECTRICAL INSTALLATIONS in the SULTANATE OF OMAN, takes into account, as far as possible, the latest practices and installation methods meeting the approval of the Authority for Electricity Regulation, Oman.

It is essential that all contractors and wiremen study and abide by the Regulations as laid down in this publication, and in particular the section on safety.

The Regulations contained herein come into effect on 1st January 2020.

NOTE: Some of the material in the Requirements for Electrical Installations BS 7671 (formerly IEE Wiring Regulations), IEC, Kuwait Bahrain, Abu Dhabi standards has been adapted as appropriate and applicable to the sultanate. This is hereby acknowledged.

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1 GENERAL

1.1 SCOPE

These Regulations apply to electrical installations such as those of: -

- a. Residential and domestic premises
- b. Commercial premises
- c. Public premises
- d. Industrial premises
- e. Agricultural and horticultural premises
- f. Prefabricated buildings
- g. Construction sites
- h. Temporary installations including exhibitions and fairs
- i. Mobile and transportable installations including caravans and motor caravans

The Regulations cover:-

- a. Circuits supplied at nominal voltages up to and including 415/240 V a.c, 50 Hz
- b. Any wiring not specifically covered by the specification for appliances
- c. Fixed wiring for telecommunications, signalling, control (excluding internal wiring of apparatus).

1.2 COMPLIANCE WITH REGULATIONS

Compliance with these Regulations is essential to ensure safety of life, plant, equipment and buildings especially from the hazards of fire, electrical shocks and mishaps in the utilization of electricity in and around buildings and shall be enforced accordingly.

NOTES:

1. *The requirements as set out in Sections 1 and 2 of these Regulations present uniform mandatory minimum requirements which must be complied with to provide a safe electrical installation. Subsequent sections provide more prescriptive "deemed to comply" requirements to achieve compliance with these fundamental principles for more common electrical installation types. Where a specific electrical installation type is not addressed through the more prescriptive sections, these mandatory requirements must still be complied with. Where any installation type cannot comply with the prescriptive requirements, the Designer must document how the fundamental principles have been satisfied and include such information in the Completion Certificate.*
2. *Where an installation type or technical requirement is not covered by these Regulations, IEC 60364 and/or BS 7671 may be used as a guideline or specification, with prior approval from the Distribution Company and the Authority. For the avoidance of doubt, all domestic and residential installations shall comply with the prescriptive methods provided throughout these Regulations.*

1.2.1 PRECEDENCE

In the case of any conflict of requirements, the following order of precedence of documents and standards applies:

- a. Oman Sector Law
- b. Oman Distribution Code
- c. OES 4, Regulations For Electrical Installations In the Sultanate of Oman (these Regulations)

- d. Other Oman Electrical Standards (OES)
- e. International Electro technical Commission (I.E.C.) Standards (except for where BS and BS EN standards are directly referenced in these Regulations)
- f. British Standards (BS)
- g. Other Internationally accepted Standards.

NOTE: A list of the referenced IEC and BS and standards referenced in these Regulations which covers more common equipment has been provided in Appendix VII

1.3 ELECTRICAL DESIGN

All electrical design work shall be carried out by a Designer and consider all relevant design basis information including complying with the requirements as set out in Section 2.2.

1.3.1 DOCUMENTATION AND SUBMISSION OF DESIGN

Design documentation shall be prepared and submitted to the relevant Distribution Company before commencement of any electrical work, large or small, new or additions, and work shall start only after due approval of the Distribution Company. Design documentation shall include the following:

- a. Single Line Diagram including all equipment ratings
- b. Site and equipment layout drawings
- c. Equipment sizing, cable sizing and load calculations including total connected load and maximum demand (i.e. if different where the use of diversity is deemed appropriate).

All work shall be carried out in accordance with the approved design and drawings.

NOTES:

1. *For simple installations such as single dwelling domestic installations with single consumer units, drawings may not be required provided the equivalent design basis information can be achieved in a schedule or table and there is no possibility of confusion for those accessing or operating the equipment.*
2. *Non-domestic, commercial and industrial installations may also require additional design documentation including schematic and wiring diagrams subject to the complexity of the installation and the decision of the Distribution Company.*

1.4 INSTALLATION WORK

For the erection of the electrical installation, good workmanship by suitably qualified and competent personnel shall be provided. The works shall be carried out in a neat and workmanlike manner to meet the requirements of these Regulations.

All electrical installation works shall be carried out by or under the direct supervision of a Licensed Electrician.

1.5 INSPECTION

All installation work will be subject to inspection and testing by an electrical inspector from the relevant Distribution Company and will be connected to the power supply only after the work is checked and approved by the Distribution Company. This inspection in no way relieves the Designer, Installer and Tester of any of their obligations and specifically of the Tester to carry out all mandatory inspection and testing activities in accordance with Section 13.

1.6 DEFINITIONS

Accessory

Any device, other than lighting fitting, associated with the wiring and current using appliances of an installation, e.g. a switch, a fuse, a plug, a socket-outlet, a lamp holder or ceiling rose.

a.c

Alternating Current

Ambient temperature

The temperature of the surrounding medium under normal conditions, at a situation in which apparatus and cables are installed or going to be installed, including the effect of any artificial heating used in the building or any local source of heat.

Apparatus

Electrical apparatus, including all machines, equipment and fittings, in which conductors are used or of which they form a part.

Appliance

Any device which utilises electricity for a particular purpose, excluding a lighting fitting or an independent motor.

Authority

Authority for Electricity Regulation, Oman.

Bonded (as applied to items of metal work)

Connected together electrically, not normally for the purpose of carrying current but to ensure a common potential.

Bus-bar trunking

A fully enclosed system comprising of rigid conductors, rigidly separated by insulating materials within a duct, trunk or similar enclosure (also referred to as busduct or busway) which shall be fully type tested, installed in accordance with manufacturer's recommendations and be designed and installed fully in compliance with BS EN 61439-6.

Bunched

Cables are said to be 'bunched' when two or more are contained within a single conduit, or trunking or, if not enclosed, are not separated from each other.

Cable Trunking

A fabricated casing for cables normally of rectangular cross section of which one side is removable or hinged to allow cables to be laid therein.

Channel (for cables)

A groove cut or formed in part of a building and intended to receive one or more cables, the groove having removable or hinged covers to allow cables to be laid therein.

Circuit-breaker

A mechanical device for making and breaking a circuit both under normal conditions and under abnormal conditions, such as those of an overload or short-circuit, the circuit being, broken automatically.

Circuit-conductor

A current-carrying conductor forming part of a circuit or final sub-circuit, but excluding the earth-continuity conductor.

Conductor (of a core or cable)

The conducting portion, consisting of a single wire or of a group of wires in contact with each other.

Consumer's installation

Wiring and apparatus situated upon consumer's premises and controlled or installed by him, excluding all equipment of the Distribution Company.

Consumer's terminals

The point in the consumers installation at which the incoming supply of energy is delivered to that installation.

Consumer units

A particular type of distribution board typically used in domestic installations.

Core (of a cable)

The conductor with its insulation but not including any other covering for mechanical or other protection.

d.c

Direct Current

DCRP

Distribution Code Review Panel

Dead

At earth potential and disconnected from any live system.

Designer

A Professionally Qualified Engineer or a Licensed Electrician with sufficient relevant practical skills and experience for the nature of electrical work undertaken.

Distribution board

An assembly of parts, including main isolator, circuit-breaker, one or more fuses or circuit-breaker, arranged for the distribution of electrical energy to final sub-Circuits or other distribution boards.

Distribution Company

A company or body holding a distribution licence issued by the Authority pursuant to Royal Decree 78/2004 (as amended).

Duct (for cables)

A closed passage-way formed underground or in a structure and intended to receive one or more cables which may be drawn in.

Earth-continuity conductor

The conductor connecting the consumers earthing terminal to those parts of an installation which are required to be earthed. It may be a dedicated single core insulated cable or may be in whole or part the metal sheath and/or armouring of a cable, earth-continuity conductor of a cable or flexible core incorporating such a conductor.

Earth electrode

Copper rod providing an effective connection with the general mass of the earth.

Earthing lead

The final conductor by which the connection to each electrode is made.

ELV

Extra Low Voltage- (*refer to Voltage*)

Fault

A circuit condition in which current flows through an unintended path.

FBA

Factory Built Assembly

Final sub-circuit

An outgoing circuit connected to a distribution board and intended to supply electrical energy to current-using apparatus, either directly or through socket outlets.

Flame proof

Applied to apparatus to denote that the containing case or other enclosure will withstand without injury any explosion of prescribed flammable gas that may occur within it under practical condition of operation within the rating of the apparatus and will prevent transmission of flame such as will ignite any prescribed flammable gas that may be present in the surrounding atmosphere.

Flammable

A flammable material is one capable of being easily ignited.

Flexible cord

A flexible cable in which the cross-sectional area of each conductor does not exceed 4 mm²

Fuse

A device for opening a circuit by means of a fuse-element designed to melt when an excessive current flows. It consists of a fuse-base and fuse-link. The fuse-link shall be of the cartridge type. For the purpose of these Regulations the current rating of a fuse is a current, less than the minimum fusing current, that the fuse will carry continuously without deterioration.

Fuse-element

That part of a fuse which is designed to melt and thus open a circuit.

H.P

Horse Power -1 H.P is equivalent to 746 Watts

IP

Ingress Protection, which refers to an equipment rating in accordance with IEC 60529

Installer

Licensed Electrician with sufficient relevant practical skills and experience for the nature of electrical work undertaken carrying out the certification of the installation.

Insulation

A suitable non-conducting material enclosing, surrounding or supporting a conductor.

Intrinsically safe

1. As applied to a circuit or installation, denotes that any electrical sparking that may occur in normal working conditions will be contained, and incapable of causing an ignition of flammable gas or vapour.
2. As applied to apparatus, denotes that it is so constructed that when installed and operated any electrical sparking that may occur in normal working, either in the apparatus or in the circuit associated therewith, is incapable of causing an ignition of the prescribed flammable gas or vapour.

Isolator

A mechanical device capable of opening or closing a circuit under conditions of no load or negligible current.

LED

Light Emitting Diode

Licensed Electrician

Electrician who has been assessed and approved by the relevant Distribution Company or approved licensing authority body.

Live

In relation to a conductor, it means that under working conditions a potential difference of voltage exists between the conductor and earth.

MICC

Mineral Insulated Copper Conductor

Neutral conductor

The neutral conductor of a 3-phase 4-wire system or the conductor of a single phase installation which is earthed at the source of the supply.

Non-combustible

A non-combustible material is one which is not capable of undergoing combustion and satisfies the performance requirements specified in the non-combustibility test of BS 476 - Fire tests on building materials and structures, Part 4 - Non-combustibility test for materials.

OES

Oman Electrical Standards

Overload

Overcurrent when a circuit is in normal service and electrically sound.

Overcurrent

A current in excess of the rated value of electrical equipment.

Plug

A device intended for connection to flexible cord or flexible cable which can be engaged manually with a socket outlet.

Point (in Wiring)

Any termination of the fixed wiring intended for the attachment of lighting fitting or of a device for connecting to the supply, a current-using appliance.

Professionally Qualified Engineer

A person who holds a power electrical engineering specialisation qualification.

PELV

Protected Extra-Low Voltage, an ELV system such that a single fault can not result in an electrical shock but is not electrically separated.

PV

Photovoltaic

P.V.C. (as insulation or sheath of cable)

Polyvinylchloride compound complying with BS 6004, BS 6231 and IEC 60811.

RCBO

Residual Current Circuit-breaker with integral overcurrent protection.

RCCB

Residual Current Circuit-breaker without integral overcurrent protection.

RCD

Residual Current Device. A protection device which operates when a residual earth leakage current occurs in excess of the specified value. Both RCCBs and RCBOs are classified as RCDs. RCDs provide the same functionality as the previous obsolete term Earth Leakage Circuit Breaker (ELCB) which previously related to both voltage and current operated devices.

Resistance area (for an earth electrode only)

The area of ground (around an earth electrode) within which a voltage gradient measurable with ordinary commercial instruments exists when the electrode is being tested.

Separated extra-low voltage

SELV-an ELV that is electrically separated from earth and other systems such that a single fault cannot result in an electrical shock.

Shock current

A current passing through the body of a human or animal and having characteristics likely to cause dangerous pathophysiological effects.

Short-circuit Current

An overcurrent fault current resulting from a fault with negligible impedance (which is therefore referred to as a short-circuit).

Socket-outlet

A device with protected current carrying contacts intended to be mounted in a fixed position and permanently connected to the fixed wiring of the installation, to enable the connection to it of a flexible cord or flexible cable by means of a plug.

Space factor

The ratio (expressed as a percentage) of the sum of the effective overall cross-sectional areas of cables forming a bunch to the internal cross-sectional area of the conduit, pipe, duct, trunking, or channel in which they are installed.

Spur

A branch cable connected to a ring circuit.

Stationary appliance

An appliance intended to be fixed to a supporting surface, or used in only one place.

Switch

A mechanical device for making and breaking, non-automatically, circuit carrying current not greatly in excess of the rated normal current.

Switch-linked

A switch the blades of which are so arranged as to make or break all poles simultaneously or in a definite sequence.

Switch-board

An assembly of switchgear with or without instruments.

Switch gear

Apparatus for controlling electrical distribution or for controlling or protecting electrical circuits, machinery and current using apparatus.

Tester

Licensed Electrician with sufficient relevant practical skills and experience for the nature of the electrical work undertaken and carrying out the testing, inspection and certification of the installation.

Voltage

The voltage by which an installation is designated. The following ranges of nominal voltage (R.M.S. value for a.c) are defined:-

- **ELV.** Not exceeding 50 V a.c or 120 V ripple free d.c whether between conductors or to earth.
- **Low Voltage.** Normally exceeding extra-low voltage but not exceeding 1000 volts a.c or 1500 volts d.c between conductors or 600 a.c volts or 900 volts d.c between conductors and earth.
- **High Voltage.** Voltage exceeding Low Voltage (not addressed in these Regulations)

XLPE (insulation of cable)

Cross linked polyethylene complying with BS EN. 5467/ IEC 60811.

2 FUNDAMENTAL PRINCIPLES

2.1 REQUIREMENTS FOR SAFETY

In electrical installations, risks to persons exist from several factors including:

- Shock currents
- Excessive temperature likely to cause burns, fires and other injurious effects
- Eye damage, exposure to excessive pressure or toxic gasses from arcing or burning
- Ignition of an explosive atmosphere.

All aspects of an electrical installation shall be designed, installed and tested to protect persons from the above risks.

2.1.1 BASIC PROTECTION AGAINST DIRECT CONTACT

Persons and livestock shall be protected against dangers that may arise from contact with live parts of the installation in normal service by a minimum of one of the following methods:

- The use of basic protection measures to prevent contact including insulation, barriers or enclosures
- Limiting the value and duration of current which can pass through a body to a value lower than the shock current.

The use of an RCD is not an acceptable sole means of basic protection.

2.1.2 FAULT PROTECTION AGAINST INDIRECT CONTACT

Persons and livestock shall be protected against dangers that may arise from contact with exposed metal parts during a fault by a minimum of one of the following methods:

- Preventing a fault current from passing through the body of any person or any livestock through the use of double or reinforced insulation class equipment. This method shall not be used where damage to the insulation may be reasonably expected due to the nature of the installation
- Limiting the value and duration of fault current which can pass through a body to a value lower than the shock current
- Automatic disconnection of the supply on the occurrence of a fault likely to cause a current to flow through a body in contact with exposed metal parts, where the value of the current is equal to or greater than the shock current.

The use of earth bonding in accordance with Section 2.9 to create a sufficiently low earth fault-loop impedance and the use of RCDs (not exceeding 30 mA) to operate in the required disconnection time in accordance with Section 4.2.8 is an acceptable form of fault protection against indirect contact.

2.1.3 PROTECTION AGAINST THERMAL EFFECTS FROM NORMAL OPERATION, OVERCURRENT AND EARTH FAULT CURRENT

The electrical installation shall be so arranged that there is no risk of ignition of flammable materials due to high temperature or electric arc. Also, during normal operation of the electrical equipment, there shall be no risk of persons or livestock suffering burns.

Persons and livestock shall be protected against injury and property shall be protected against damage due to excessive temperatures or electromechanical stresses caused by overcurrents (including overload, earth faults and short-circuits) likely to arise in live conductive parts by:

- Automatic disconnection on the occurrence of overcurrent before the overcurrent attains a dangerous value taking in to account its duration

- Limiting the maximum overcurrent to a safe value and duration.

Conductors other than live conductors and any other parts intended to carry a fault-current shall be capable of carrying that current without assuming excessive temperature.

For individual sub-circuit protection, RCBO devices with earth leakage trip ratings of 30 mA or less provide combined fault protection against indirect contact and thermal effects from earth leakage, overcurrent and short-circuits.

2.1.4 PROTECTION AGAINST ABNORMAL VOLTAGES

Persons or livestock shall be protected against injury and property shall be protected against any harmful effects of a fault between live parts of circuits supplied at different voltages.

Persons or livestock shall be protected against injury and property shall be protected against damage from any excessive voltage likely to arise due to other causes such as atmospheric phenomena, switching voltage.

2.2 DESIGN AND SUITABILITY OF EQUIPMENT

Every item of electrical equipment (including materials, appliances and accessories) and apparatus shall fulfil the following basic requirements:

- a. Shall be the best of their respective kinds and shall comply with the latest relevant IEC standards or British Standards (BS)
- b. Shall have suitable electrical supply characteristics in accordance with Section 3.2
- c. Shall be suitable with respect to maximum steady voltage likely to be applied as well as overvoltage and under-voltage likely to occur
- d. Shall be suitable with respect to the maximum steady current or maximum demand which it is to carry in normal service (under the climatic conditions of the Sultanate as per Section 3.1) noting that where appropriate, diversity may be taken into consideration for certain electrical installations in accordance with Appendix VIII
- e. Shall be suitable with respect to the current likely to be carried in abnormal conditions for the period during which it may be expected to flow taking into account protective equipment operating times
- f. Shall be suitable for the duty demanded of the equipment taking in to account the load factor and the climatic conditions of the Sultanate and in accordance with Section 3.1;
- g. Shall be approved by DCRP or equivalent authority body (where applicable processes exist)
- h. Shall be compatible with other equipment so that during normal operation, no harmful effects to other equipment shall arise. Such considerations shall include power factor, voltage fluctuation, harmonics and electromagnetic interference
- i. Shall be appropriate to external influences, the situation in which it is to be used and its mode of installation shall take account of the conditions likely to be encountered including mechanical damage, flora, fauna, site conditions as per Section 3.1, water ingress and dampness in accordance with Section 12.1
- j. Shall suit the intended use regarding fire-resistance, fire-retarding and non-propagation (including minimum fire survival times), explosion protection and safety services requirements where used in hazardous and flammable areas
- k. Shall suit the intended use for explosive atmospheres through the use of flame proof enclosures, intrinsically safe apparatus and other requirements as called for in complying with BS EN 60079.

No apparatus, unless suitably protected shall be installed in a position where it is exposed to water, oil, steam or vapour, or to risk of mechanical damage.

NOTE: *These Regulations provide minimum requirements for electrical installations generally but, in certain cases and for certain installation types including emergency lighting, firefighting, safety services or life safety plant, fire detection and alarming, telecommunication systems and lift circuits, the relevant international standards should be referred to for additional requirements over and above those called for in these Regulations.*

2.3 CONDUCTOR SIZE

The cross section of all electrical conductors shall be determined according to:

- a. Their admissible maximum temperature in the climatic conditions of the Sultanate of Oman as per Section 3
- b. The admissible voltage drop
- c. The electromechanical stresses and thermal effects likely to occur due to short-circuits
- d. Other mechanical stresses to which the conductors may be exposed.

All electrical conductors shall be adequately insulated or otherwise protected to prevent danger.

2.4 PROTECTIVE EQUIPMENT

The characteristics of protective equipment shall be determined with respect to their function which may be, e.g. protection against the effects of:

- Overcurrent (overload, short-circuit);
- Earth fault current
- Overvoltage which shall be provided in accordance with Section 9.18
- Under-voltage and no-voltage which shall be provided where the loss or drop and subsequent restoration of voltage might cause danger to persons or property
- Single phasing.

The protective devices shall operate at values of current (including load, fault and breaking current), voltage and time which are suitably related to the characteristics of the circuits and the possibilities of danger.

Every electrical circuit and sub-circuit shall be protected against overcurrent by circuit breakers/cartridge type fuses of appropriate breaking capacity to automatically disconnect the circuit at current values related to the rating of the circuit.

No fuse or circuit breaker other than linked circuit breaker or switch shall be inserted in a conductor connected with earth.

Every single-pole switch shall be inserted in the live conductor only. Any switch connected in a conductor connected with earth, shall be a linked switch and shall be arranged to break also all the live conductors.

Devices affording overcurrent protection include:

- Fuses fitted with fuse-links complying with BS HD 60269-3
- Miniature and moulded-case circuit-breaker complying with BS EN 60898
- Circuit breakers with adjustable settings selected with appropriate clearance times taking into account the time-current characteristics of the circuit breaker in accordance with the

manufacturer's documentation and which are installed in a manner to prevent inadvertent adjustment of the settings or tampering.

2.4.1 OVERLOAD PROTECTION

Overload (excess-current) protection shall be provided for all electrical equipment and satisfy the following conditions:

- a. The nominal current of the overload protection device must be larger than the maximum demand current of the circuit. For adjustable devices, the nominal current is the current setting selected
- b. The continuous current rating of the conductor must be greater than the nominal current of the protection device. For fuses, the nominal rating shall not exceed 90% of the continuous conductor rating
- c. Operating time of circuit breakers shall be within one hour for circuit breakers up to 63 A and two hours for circuit breakers greater than 63 A at 1.45 times the continuous current rating of the conductor
- d. Operating time of fuses shall be within one hour for fuses up to 63 A, two hours for fuses greater than 63 A, but less than 160 A, three hours for fuses greater than 160 A, but less than 400 A and four hours for fuses greater than 400 A at 1.6 times the continuous current rating of the conductor or as otherwise outlined.

NOTE: *On the basis that MCBs and fuses are being used which comply with the relevant equipment standards and are sized to satisfy conditions a. and b., the clearance times as called for in conditions c. and d. will be deemed to be satisfied due to the characteristics of the fuses and MCBs.*

2.4.2 SHORT-CIRCUIT PROTECTION

Short-circuit protection shall be provided for all electrical equipment against both the electromechanical stresses and thermal effects for peak prospective fault current and the I^2t let-through energy characteristics.

2.5 DIVISION, ISOLATION AND RELIABILITY OF THE INSTALLATIONS

All electrical installations shall be divided into appropriate circuits and select appropriate protective equipment to maximise reliability and avoid hazards and minimise inconvenience and nuisance tripping in the event of a fault.

All lighting circuits should not be connected on the same 30 mA RCD and must use different RCD circuits for multi-storey installations or installations consisting of more than one lighting circuit.

Socket connected circuits should also be connected to different RCD circuits for multi-storey installations and not more than three sub-circuits should be connected to the same RCD.

The selection of loads connected to RCDs shall also reduce the possibility of unwanted tripping of RCDs due to safe levels of leakage current produced by equipment as part of normal operation.

RCDs shall be installed at the most downstream switchboard where the protected final sub-circuit originates.

Safety services such as wired smoke detector shall be independent of other circuits and where possible should not trip due to earth leakage current of other devices.

Where, in case of danger, there is necessity for immediate interruption of supply, an interrupting device shall be installed in such a way that it can be easily recognized and effectively and rapidly operated.

Disconnecting devices shall be provided so as to permit disconnection of the electrical installation, circuits or individual items of apparatus as required for maintenance, testing, fault detection or repair.

2.5.1 PROTECTION COORDINATION, DISCRIMINATION AND BACK-UP

The electrical installation shall be designed with protection devices selected with appropriate coordination with respect to discrimination and back-up protection (where required).

Discrimination (also known as selectivity) should be provided to the maximum extent possible and practical for all protective devices in terms of fault operating characteristics so that the most downstream device operates and upstream devices do not over the entire range of expected fault currents (or selected faults in the case of partial selectivity).

Backup protection shall be provided where the most downstream device has insufficient short-circuit ratings such that the operation of the upstream device is required to prevent excessive stress on the downstream device with respect to fault and I^2t energy let-through characteristics

Manufactures data should be used regarding time/current characteristics of protection devices for determination of coordination.

2.6 EQUIPMENT LAYOUT

The electrical equipment shall be arranged so as to afford as may be necessary:

- Sufficient space for the initial installation and later replacement of individual items of electrical equipment
- Accessibility for operation, testing, inspection, maintenance and repair
- Compliance with Section 5.1.1.

2.7 IDENTIFICATION OF CONDUCTORS

Phase, neutral and protective conductors shall be identifiable at least at their terminations by colouring or other means. These conductors in insulated wires, cords and cables shall be identifiable by colouring or other means throughout their length.

2.8 CONNECTIONS AND TERMINATIONS

Connections between conductors and between conductors and other electrical equipment shall be made in such a way that safe and reliable contact is ensured. Bi-metallic connectors/lugs/sockets shall be used for connections between conductors and terminations of dissimilar metals (e.g. copper and aluminium).

2.9 EARTH BONDING

All metal work other than current carrying parts liable to be charged with electricity, if the insulation of a conductor or live part should become defective, should be effectively bonded and connected to earth to ensure immediate electrical discharge without danger.

In normally damp or wet situations, where electrical apparatus is present, exposed metal parts of other services (such as gas, water, pipes, sinks, baths) shall be bonded and effectively connected with the earth continuity conductor of the electrical installation.

2.10 TESTS ON COMPLETION

On completion of an installation or an extension or major alterations to an installation, tests should be made with appropriate instruments to verify as far as practicable that the requirements of these Regulations have been met and the installation is safe for connection to supply.

The installation shall be subject to inspection and approval by the Distribution Company before connection to supply.

3 GENERAL REQUIREMENTS

3.1 SITE CONDITIONS

The following Site conditions would apply for purposes of design and selection of equipment and materials.

Mean annual rainfall	100 mm
Max. 24 hour rain fall	80 mm
Max. ambient temperature	50 °C
Min. ambient temperature	5 °C
Mean daily temperature	30 °C
Max. temperature of metal surfaces in direct sunlight	80 °C
Relative humidity - Maximum	100
Annual average	40
Height above sea level	0-2000 m
Max. wind pressure (flat surfaces, ground level)	100 kg/m ² (130 km/hr)
Daily average wind speed	4-5 m/sec

Dust and sand storms can occur at any time in coastal regions, the atmosphere is humid, saline and corrosive.

The current ratings of all electrical equipment, cables, conductors and the capacity of conduits and trunking for wires and/or cables, shall take in to account the above site conditions.

Tables 7 to 18 (Appendix IV) attached to these Regulations give the site current ratings for cables and wires and the maximum number of cables/wires that can be installed in conduits/ trunking.

3.2 CHARACTERISTICS OF MAINS SUPPLY

All equipment and materials shall be suitable in all respects for operation on the mains supply, the characteristics of which are as follows:-

Rated service voltage (3 phase 4 wire)	415/240 V ± 6%
Neutral	Solidly earthed
Frequency	50 Hz
Design fault level	40 kA
Fault duration	1 sec

NOTE: It should be noted that where reference standards including but not limited to BS 7671 and IEC 60364 make reference to a nominal voltage of 400/230 V, it shall be replaced with the above rated service voltage as appropriate.

3.3 VOLTAGE DROP

The voltage drop from the consumer's origin of the installation to any load point in the installation shall not exceed the following values of the rated service voltage when all the conductors in the installation are carrying the maximum current.

Lighting circuits:	3%
All other circuits:	4%

A greater voltage drop may be accepted if the Designer can demonstrate equipment has been designed and selected to operate at a lower voltage and if approved by the relevant Distribution Company.

3.4 IDENTIFICATION, LABELLING AND SIGNAGE

Labels or other suitable means of identifications shall be in Arabic and/or English and shall be provided to all the final sub-circuits in distribution boards and feeders in sub main distribution boards and switchboards at respective protection devices and isolators for equipment.

All labels, rating and name plates shall use non deteriorating materials. Signage using paper are not acceptable.

All labels shall be engraved material (white back surface with black writing). Outdoor materials shall be weatherproof.

All equipment nameplates shall be in accordance with the relevant IEC/BS standard of the equipment but as a minimum shall include:

- Identification reference/manufacturer type
- Serial number
- Rated voltage, frequency and current
- Number of phases.

Labels or other suitable means of identification shall be provided to indicate the purpose of switchgear and control gear, unless there is no possibility of confusion (i.e. one consumer unit in a domestic installation).

Labelling shall be provided immediately adjacent to each means of isolation to permit rapid identification of the circuit or group of circuits thereby controlled.

Load distribution schedules, shall be provided at each distribution board and be of a durable quality.

Any switch rooms or electrical equipment rooms shall be suitably labelled to give information on the electricity source and supply parameters, authorised personnel access and contact details and any special precautions to be taken. Minimum warning signage on switchrooms/electrical equipment rooms shall include a sign on all doors as per below (or similar):

“Danger-THIS AREA MUST BE KEPT CLEAR AT ALL TIMES. ACCESS TO ELECTRICAL EQUIPMENT ROOM”

Where parts of an installation are accessible or visible to the general public they shall be labelled with a warning: “WARNING LIVE - 240/415 VOLTS -DANGER DO NOT TOUCH” or similar wording unless the equipment is part of normal use.

NOTE: *Minimum switch room signage need not apply to locations of consumer units in domestic installations.*

4 EQUIPMENT SELECTION

4.1 CONDUCTORS AND CABLES

4.1.1 NONFLEXIBLE CABLES

Nonflexible cables for use in fixed wiring installation of buildings shall, for general purposes and in normal situations, be PVC insulated stranded copper conductor cables complying with BS 6004. The minimum size of conductor shall be 1.5 mm² (7/0.50 mm).

In flammable/explosive situations the cables shall be mineral insulated (or other compliant flame retardant material with equivalent fire survival times) and copper sheathed complying with BS EN 60332/7629/60702/6387. The minimum size shall be 1.5 mm² copper.

Cabling for the supply for firefighting, safety services or life safety plant shall also be mineral insulated (or other compliant flame retardant material complying with BS 8519 including the relevant the minimum fire survival times).

4.1.2 FLEXIBLE CABLES AND CORDS

Flexible cables and cords for use in electrical installations shall be PVC insulated and sheathed with stranded copper conductors complying with BS EN 6004/50525/60332/6231 IEC 60245. The minimum size of conductor shall be 1 mm².

Cables for connection between ceiling rose and lamp holder for pendant type light fittings and for enclosed luminaire shall be heat resistant silicone rubber insulated with stranded copper conductor complying with BS EN 50525. Minimum size of conductor shall be 1 mm².

Cables for lifts shall be braided rubber insulated travelling cables complying with BS EN 50214.

4.1.3 UNDERGROUND CABLES

Underground cables for use in electrical installations shall be in accordance with Standard OES 2.

4.1.4 OVERHEAD LINE CONDUCTORS

Overhead line conductors for use in electrical installations shall meet the requirements in Standard OES 3.

4.2 LOW VOLTAGE SWITCHGEAR AND CONTROL GEAR

LV switchgear shall be factory built assembly (FBA), metal clad, totally enclosed, cubicle or box type complying with BS EN 61439, BS EN 60947 and generally as illustrated in Figs. 1 & 2 (Appendix V). All current carrying components of the switchgear shall be of copper.

Switchgear bus bars and connections shall conform BS EN 61439 and BS EN 60947. The minimum creepage distance of insulators shall be 30 mm to earth and 50 mm between phases. The minimum clearance in air shall be 20 mm between any phase and earth and 25 mm between phases. The phase bus-bar, neutral bar and earth bar shall be colour identified in accordance with Section 6.19. The neutral bar shall be of the same cross-section as the phase bus-bars and the earth bar a minimum cross-section of 100 mm².

The current ratings for all equipment, components and busbar in the FBAs under BS/IEC standard conditions shall in general be reduced by 20% to take account of the site conditions (Section 3.1) if installed in well ventilated locations.

This derating shall apply to all protective equipment and consumer units covered by the below sub-Sections. A higher degree of derating should be considered, if improperly ventilated conditions exist.

Protection of persons against electric shock shall be obtained by:

- Barriers and/or enclosures
- Opening of cover or door with insulated key or special tool
- Interlocking of door with supply disconnecter
- Internal barrier/shutter shielding of live parts when door is open
- Insulated operating handles or knob.

Specifically, live parts shall be protected from direct contact by being installed inside an enclosure which provides at least IP 2X and IP 4X for horizontal top surfaces that are readily accessible unless the voltage does not exceed ELV.

FBAs shall have minimum degrees of protection IP 31 for indoor installations and IP 54 for outdoor installations in accordance with IEC 60529 noting that some outdoor installations may require higher degrees of protection to ensure they are appropriate to external influences in accordance with Section 2.2.

Equipment installed in explosive atmosphere shall comply in addition with the series BS EN 60079 and in particular BS EN 60079-14.

4.2.1 ARC FAULT PROTECTION

All switchgear with a rating in excess of 800 A shall have arc fault protection provided by internal separation with a minimum level of Form 3B in accordance with BS EN 61439-2.

4.2.2 AIR BREAK SWITCHES AND FUSE SWITCHES

Air break switches and fuse-switches/switch-fuse units shall comply with BS EN 60947-3. The equipment shall be rated for "uninterrupted duty" and normally of utilisation category AC 22 for mixed resistive and inductive loads. For switching of purely motor load or other highly inductive loads, category AC 23 shall apply.

Fuses used in the switch and fuse units shall be high rupturing capacity cartridge type to BS HD/IEC 60269-3.

The use of re-wireable fuses is not permissible.

4.2.3 CIRCUIT BREAKERS

Circuit-breakers shall comply with BS EN/IEC 60947 -2, and designed and manufactured for uninterrupted duty.

Circuit-breakers shall be moulded case air break type.

4.2.4 FUSE BOARDS

Single and three phase distribution fuse boards with ratings not exceeding 200 A for individual outgoing circuits shall be factory built assemblies complying with BS EN 61439.

4.2.5 MINIATURE CIRCUIT-BREAKER BOARDS

Single phase and three phase miniature circuit-breaker (MCB) distribution boards for ratings not exceeding 200 A per phase for incoming circuit and 100 A for individual outgoing circuits shall be factory built assemblies complying with BS EN 61439. An integral isolator shall be included for isolating incoming supply.

4.2.6 MINIATURE CIRCUIT-BREAKERS

Miniature circuit-breakers (MCBs) (which are essentially devices for the protection of sub-circuits) shall comply with BS EN 60898 having a short-circuit capacity of 10 kA.

Circuit-breaker terminals shall be fitted with contacts having adequate and durable facings of silver or materials not subject to progressive deterioration. Insulating materials of the circuit-breakers shall as a minimum be 120 °C class E of BS EN 60085.

Circuit-breakers shall be designed and manufactured to reference calibration temperature 45 °C (average); circuit-breakers shall be capable of carrying continuously, without tripping, their rated current at an ambient temperature up to 50 °C which is the site maximum ambient temperature.

4.2.7 CONSUMER UNITS

Consumer units for installation in consumer's premises for single phase service connection for loads up to 100 A shall be factory built assemblies complying with BS EN 61439. This includes the selected components incorporated such as MCBs, RCDs and fuses (only permitted for non-domestic or commercial installation) which shall be declared suitable and fully co-ordinated with the consumer unit by the equipment manufacturer. All consumer units shall be made of non-combustible materials.

Consumer units shall incorporate means for isolation of mains supply in the form of double pole switch and an assembly of MCBs and RCDs for individual sub-circuits.

4.2.8 USE OF RCDS

RCDs conforming to BS EN 61008 shall be used for additional protection with continuous current ratings up to and including 125 A and tripping current ratings in accordance with Section 8. Clearance times shall be a maximum of 40 ms at five times the tripping current.

4.3 SWITCHES FOR USE IN WIRING INSTALLATIONS

Switches used in wiring installations shall conform to BS EN 60669. For outdoor and industrial use, switches shall be metal clad and watertight to degree of protection IP 65.

4.4 PLUGS AND SOCKET-OUTLETS

Plugs and socket outlets for domestic and similar general use shall conform to BS 1363 with fuse links conforming to BS 1362.

Plugs, socket outlets, cable couplers and appliance couplers for industrial applications shall comply with BS EN 60309.

4.5 LIGHTING EQUIPMENT, LUMINAIRES AND ACCESSORIES

4.5.1 LUMINAIRES

Luminaires shall be designed and installed in accordance with BS EN 60598 in sufficient quantities and locations to ensure compliance with illuminance levels provided in Appendix II.

All domestic luminaires intended for connection a socket must be pre-fitted with an approved BS EN 1363 compliant socket.

All underwater luminaries shall comply with BS EN 60598 and Section 12.1.

4.5.2 LED LIGHTING

LED installations shall comply with BS EN 62031 in addition to all other requirements.

4.5.3 CEILING ROSES

Ceiling roses for use with single or multiple pendant lighting fittings in circuits with nominal voltage not exceeding 250 V and current rating not exceeding 5 A shall be in accordance with the requirements of BS 67.

4.5.4 LAMP HOLDERS AND STARTER HOLDERS

Lamp holders and starter holders shall be so designed and constructed that in normal use their performance is reliable and without danger to the user or surroundings.

Lamp holders and starter holders shall comply with the following standards:

- BS EN 61184: Part 1 Bayonet lamp holders, for use with tungsten filament lamps to BS EN 60432: Part I having caps to BS EN 60061
- BS EN 61184/BS EN IEC 60238: Edison screw lamp holders for use indoors or outdoors in residential as well as in industrial installations
- BS EN 61184/60400; Built in lamp holders and starter holders for tubular fluorescent lamps intended for use in a.c. circuits not exceeding 250 V
- BS EN 60838; Miscellaneous lampholders
- BS EN 62722-2-1; Luminaire performance. Particular requirements for LED luminaires.

4.5.5 DISCHARGE LAMPS

All lighting fittings with discharge lamps, mercury vapor, sodium vapor, fluorescent tubes, for use in the Sultanate shall incorporate capacitors, to obtain a power factor of 0.9 or better which shall comply with BS EN 61048 and BS EN 61049.

4.5.6 STREET FURNITURE AND STREET LOCATED EQUIPMENT

All street furniture and street located equipment shall be protected in accordance with Section 8.8. The structures shall be provided with protective earthing and bonding in accordance with Section 2.9.

4.6 COOKER CONTROL UNIT

Cooker control unit shall comply with BS 4177 comprising main switch with 30 A rating, an auxiliary switch 13 A rating and a 13 A socket-outlet to BS 1363. Larger ratings may be used (where required for high consumption cookers) provided sufficient overload protection is provided.

4.7 ELECTRIC SHAVER SUPPLY UNIT

Electric shaver fixed supply units containing double wound transformers having separate input and earth free output windings and 110 V output socket for the supply of electric dry shavers, shall comply with BS EN 61558.

The unit shall be designed and constructed to provide adequate protection against electrical hazards.

The socket outlet shall be suitable for two pin reversible plugs to BS 4573. The rated output shall not be less than 20 VA and not more than 50 VA.

4.8 PVC CONDUITS AND FITTINGS

PVC conduits and fittings for use in building electrical installations shall be from high Impact rigid PVC complying with BS 4607 and BS EN 61386 suitable for use at ambient temperature up to 50 °C. The material shall not soften or suffer structural degradation at a temperature of 70 °C and shall be non-hygroscopic, fire retardant.

4.9 STEEL CONDUITS AND FITTINGS

Steel conduits and fittings for use in building electrical installations shall comply with BS 4568. Parts 1 & 2 of heavy gauge steel hot dip galvanized inside and outside, screwed type.

4.10 BOXES FOR ACCESSORIES

Boxes for the enclosure of electrical accessories in electrical wiring installations of buildings shall meet the requirements of BS 4662.

Boxes shall incorporate means for their effective earthing.

4.11 AIR CONDITIONING EQUIPMENT

All central air-conditioning plant, window type air conditioners, and split-type air conditioning units for use in the Sultanate shall incorporate integral means for power factor correction where required to obtain a power factor of 0.9 or better and shall be fitted with a manual-reset under-voltage device to trip on power failure unless exempted by the relevant Distribution Company.

5 SERVICE CONNECTION AND CONSUMER'S INSTALLATION

5.1 GENERAL

Power supply from Distribution Companies shall be governed by the terms, conditions, fees and tariffs stipulated in their respective distribution licenses, royal decree Nos 78/2004, the Distribution Code and directions issued by the Authority from time to time.

Consumers shall, before commencement of building construction, solicit advice and guidance as to type and category of service connection and availability of power supply from the concerned Distribution Company.

Power supply to a building or premises shall be either from the Distribution Company's low voltage network or from a distribution substation installed within the building or premises.

5.1.1 MAIN SWITCHBOARD GENERAL ARRANGEMENT AND LOCATION

All installations shall comply with the minimum layout and spacing requirements as per Section 5.2.7, and be approved by the relevant Distribution Company prior to installation. The Consumer shall provide a main switchboard at the Consumer's Terminal which has sufficient allocation for the installation and termination of the Distribution Company's equipment. The main switchboard shall be provided with a viewing panel with a minimum IP 54 rating so that the Distribution Company's personnel can record meter readings without opening the main switchboard. Protection against electric shock shall be provided against all live parts of the main switchboard by the method "internal barrier/shutter shielding of live parts when door is open" in accordance with Section 4.2 which shall also include circuit-breaker shrouding.

The main switchboard shall be installed in an area or location that is readily accessible to Distribution Company staff and other authorised persons, particularly in an emergency, and located in a safe and accessible position. For the avoidance of doubt, the main switchboard for a multi-tenancy installation shall not be installed in a single tenant's premise.

5.1.2 SERVICE CONNECTION FOR LOAD NOT EXCEEDING 400 KVA

Power supply to a building or premises with a total connected load not exceeding 400 kVA shall comply with the following categories and minimum conductor sizing requirements:-

a. Category 1: Load not exceeding 25 kVA

Single phase service connection comprising:

- 3 Overhead line aluminium conductors XLPE covered 35 mm² (subject to the Distribution Company's approval)

Or

2 core underground cable XLPE/PVC/SWA/PVC copper 35 mm²

- Single phase and neutral cutout 100 A
- Single phase kWh meter 20-100 A.

b. Category 2: Load from 25 kVA to 75 kVA

Three phase service connection comprising:

- 4 core underground cable XLPE/PVC/SWA/PVC copper 25/35 mm²
- Three phase four wire kWh meter 50 A/ 100 A
- Three phase and neutral cutout 100 A.

c. Category 3: Load from 75 kVA to 400 kVA

Three phase service connection comprising:

i. For single consumer installation:

- 4 core underground cable XLPE/PVC/SWA/PVC copper 70 to 240 mm² (as appropriate)
- 200/5, 300/5 or 400/5 A current transformers with associated kWh meter
- Means for isolation of main incoming supply.

ii. For multi-consumer installation, the means for isolation of main incoming supply shall still be provided; the required number of three phase and neutral 100 A cutouts and three phase 4 wire 50 A/100 A kWh meters shall be grouped together and installed either on the ground floor, or in each floor of multi-story buildings, where rising mains are adopted. In all cases, kWh meters should be accessible for meter reading personnel.

d. Category 4: Three phase connection for loads not exceeding 25 kVA

A three phase connection may be permitted for loads below 25 kVA where requested by the consumer and subject to the Distribution Company's approval.

5.1.3 SERVICE CONNECTION FOR LOAD EXCEEDING 400 KVA

In cases where the total connected load exceeds 400 kVA, provision should be made for an indoor distribution substation in the consumer's premises in accordance with relevant OES 36 -User Notes of Guidance. The relevant Distribution Company may grant permission, on receipt of a connection application, for exemption from these requirements.

NOTE: While OES 36, OES 36-User Notes of Guidance and associated drawings refer to a single 1000 kVA transformer design, all principles including those regarding minimum spacing requirements between equipment and layout shall apply for installations exceeding 400 kVA. Switch room dimensions shown in OES 36-User Notes of Guidance and associated drawings need not apply for installations below 1000 kVA provided the equipment spacing can be satisfied.

5.1.4 SERVICE CONNECTION TO DETACHED BUILDINGS

Normally a single service connection shall be provided for supply to a building or premises. In cases where a consumer's installation comprises of an installation in two or more detached/semidetached buildings, or distinct and separate parts of buildings, two or more service connections may be permitted (in accordance to decisions, directives or determinations by the Authority). In all such cases, each supply shall cater to distinct and independent installation, and separate and independent means of isolation shall be provided to isolate each installation.

5.1.5 LOAD BALANCING

In all cases where three phase supply is available, the load shall be balanced between the phases as far as practical.

5.2 CONSUMER'S INSTALLATION

5.2.1 CONTROL OF INCOMING SUPPLY

Incoming supply to the consumer's installation shall be adequately controlled by switchgear readily accessible to the consumer which shall incorporate:

- A means of isolation
- A means of overcurrent (short-circuit and overload) protection
- A means of earth leakage protection.

5.2.2 MEANS OF ISOLATION

The means of Isolation shall comprise a load break switch or circuit-breaker arranged to disconnect the live conductors only, with an Isolating link inserted in the neutral conductor, the Isolating link being either securely fixed by bolts or screws or arranged to be in contact before the switch or circuit-breaker can be closed. Where a circuit-breaker is used as a means of supply isolation, an additional off-load isolator shall be provided as a means of Isolating the supply for maintenance of switchgear.

Where consumer installation comprises installation in two or more detached buildings, separate means of Isolation shall be provided in each detached building.

5.2.3 OVERCURRENT PROTECTION

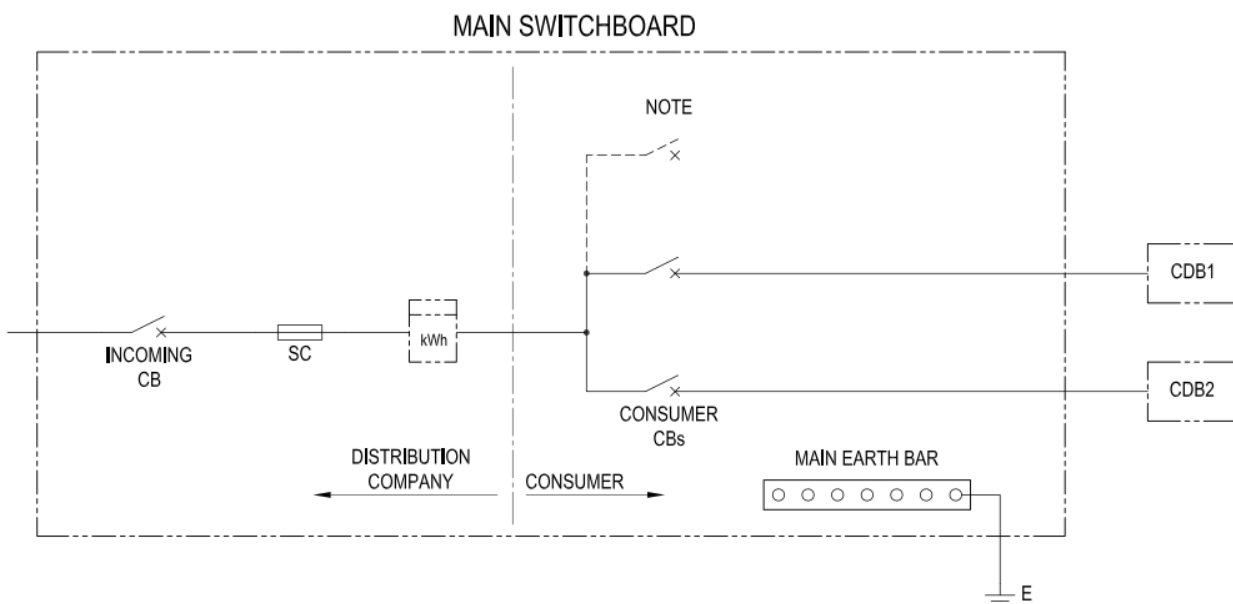
The means of overcurrent protection shall be in the form of cartridge fuse link (class P or Q1 for BS 1362 or BS HD 60269-3) inserted in each live conductor or a circuit-breaker selected to provide overcurrent protection in accordance with Section 2.4.

5.2.4 EARTH LEAKAGE PROTECTION

The means of earth leakage protection shall comprise of RCDs with maximum operating currents in accordance with Section 8. The consumer's earthing terminal shall be connected to a suitable earth electrode provided by the consumer.

5.2.5 SEQUENCE OF PROTECTIVE DEVICES: SINGLE CONSUMER INSTALLATION

An example of the sequence of protective devices to meet the requirements of Section 5.2.1 is shown in the diagram below:



NOTE: Consumer CBs to be installed to be installed for every CDB.

SC	SERVICE CUTOOUT (Distribution Company)
KWH	KILOWATT HOUR METER (Distribution Company)
CB	CONSUMER'S MAIN CIRCUIT-BREAKER
RCD	CONSUMER'S RCD
CDB	CONSUMER'S DISTRIBUTION BOARD
E	CONSUMER'S EARTH ELECTRODE

Figure 1: Typical connection and sequence of protective devices for a single-consumer main switchboard

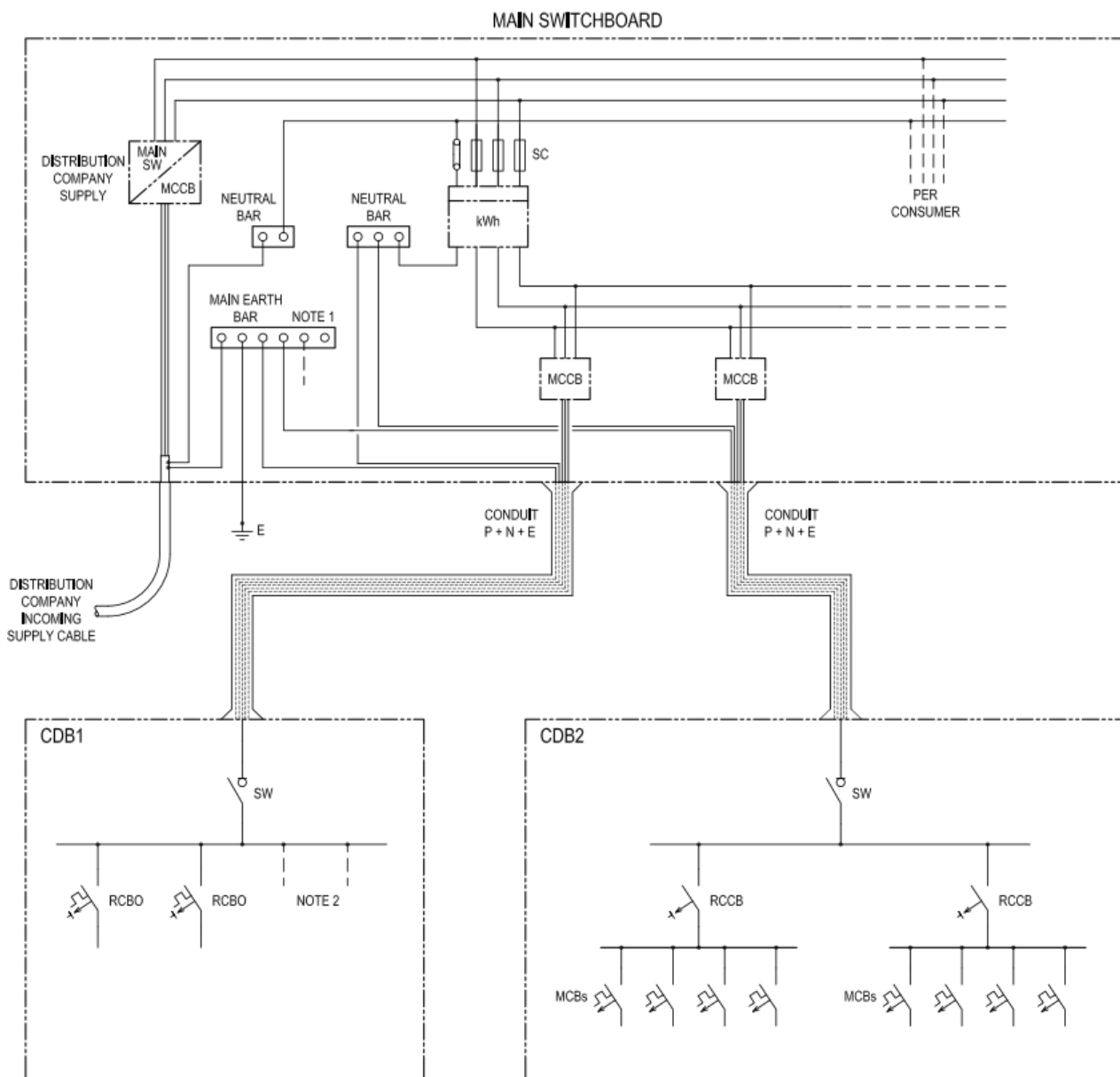
5.2.6 SEQUENCE OF PROTECTIVE DEVICES: MULTI-CONSUMER INSTALLATION

In a multi-consumer building there shall be a main load break switch or circuit-breaker as the means for isolation of main incoming supply.

The service cutouts and kilowatt hour meters of all consumers shall be grouped together and installed on the main electrical board of the building or a board adjacent to the main board, (Section 5.1.2c).

Each individual consumer's equipment for isolation, overcurrent and earth leakage protection shall, however, be installed inside the consumer's block/apartment fully under the control of the consumer.

The diagram below illustrates an example of a compliant arrangement:



NOTES:

1. Distribution Company incoming cable earth sheath, consumer earth electrode, all protective earthing/bonding and earths supplied to CDBs to be terminated onto the main earth bar.
2. Per sub-circuit

Figure 2: Typical connection and sequence of protective devices for a multi-consumer main switchboard and consumer distribution boards

5.2.7 LOCATION OF SWITCH AND CONTROL GEAR

Consumer's main-switch/switchboard, distribution board, sub-distribution boards shall all be installed in locations to which access is available and unobstructed at all times to be safely operated, maintained and adjusted. A minimum space of 1500 mm or 600 mm with switchdoors in any position and with switchgear in a fully racked out position (whichever is greater) shall be provided in the front and 600 mm on the sides, to permit safe operation, inspection and repairs. In a single story domestic installation, this front spacing may be reduced to 600 mm. Cubicle type switchboards with rear access doors shall have, in addition, a minimum space of 1000 mm in the rear. Adequate level of illumination shall be provided to facilitate safe operation at all times.

Switches, isolators, circuit-breakers shall be mounted so that the relative operating handles, toggles, control switches, control knobs, push buttons are at a minimum height of 1250 mm from finished floor level.

Switchgear and distribution control equipment shall not be installed in damp or wet locations, in bathrooms, toilets, above sinks, or below any staircase.

All switchgear shall be located in areas with sufficient exit facilities to enable a person to leave the vicinity of the switchgear under emergency conditions. Additionally the switchgear location shall minimise as far as practical the impact of any smoke generated from a fault in the switchboard affecting egress from the building.

Every switch or circuit-breaker shall be labelled to indicate the apparatus or circuit it controls.

NOTE: *Emergency egress requirements are not mandatory in single domestic installations.*

5.2.8 SEGREGATION OF SUPPLY AND CONSUMER'S CABLES

Incoming supply cable or cables to the consumer's main board shall be totally segregated from the consumer's cables. If the supply cables are laid in trench, that trench shall be used only for those cables.

5.2.9 CONSUMER'S EARTHING SYSTEM

An independent, separate earthing system shall be installed and maintained by the consumer. This shall comprise the following:-

- Earth electrode of 15 mm diameter copper earth rod set with driving pin and head driven to a minimum depth of 3 m. This shall be installed as near to the consumer's main board as possible inside earth pit with inspection cover as per fig. 3(Appendix V). The earth electrode shall include a corrosion resistant terminal clamp;
- PVC insulated stranded copper earth conductor (35 mm² copper for single consumer installation and 70 mm² copper for multi-consumer installation) with crimped terminal lugs, shall be connected between the earth electrode and the consumer's main earthing terminal or bar;
- PVC insulated-earth continuity conductor of every outgoing circuit from the consumer's main board shall be connected to the main earthing terminal;

- The resistance of the consumer's earthing system to the general mass of earth shall not exceed 50 Ω . To achieve this value in areas of high soil resistivity, additional earth electrodes with a minimum spacing of 3 m, shall be installed;
- Consumer's earth electrode resistance shall be measured in accordance with the methods described in Section 13.7
- All metal work, exposed conductive parts and enclosures, in the consumer's installation (other than live conductors and current carrying parts) shall be connected with PVC insulated earth-continuity conductor to the main earthing terminal;
- The consumer's earthing system shall be connected to the Distribution Company earthing system (incoming mains cable armour/protective earth-continuity conductor i.e. fifth wire of the distribution system connected to the transformer neutral/star point) where practical
- The neutral conductor shall remain insulated throughout the installation and shall not at any point be connected to the earthing system.

NOTES:

1. *The Oman earthing system differs from those defined in IEC 60364 and also used by BS 7671. The Oman system includes the following characteristics:*
 - *Consumer installation earth electrodes*
 - *Separate neutral and protective conductors throughout the system*
 - *The distribution system is directly connected to earth at the neutral point of the supply transformer. This earth reference is provided to the consumer from the Distribution Company via the incoming cable earth sheath or armour which is connected to the consumer's main earthing terminal*
2. *The use of any other system of earthing shall not be used unless approved by the Distribution Company.*

5.2.10 CONNECTION OF SWITCH AND CONTROL GEAR

Switches, circuit-breakers, fuses, thermostats and similar control devices shall be connected in live (phase) conductors only, a bolted or screwed link being connected in the neutral conductor. If a switch or circuit-breaker includes an isolating neutral link, it shall be arranged to make before and open after the live (phase) poles.

5.2.11 PROTECTION OF INDIVIDUAL CIRCUITS

Every circuit in the installation shall be protected against overcurrent (overload and short-circuit) by a cartridge fuse or circuit-breaker at the origin of the circuit, namely, consumer's switchboard, distribution board, sub-distribution board or consumer unit. The cartridge fuse or circuit-breaker shall afford overload protection to the lowest rated conductor in the circuit.

Every plug connected to a socket-outlet shall be fused to afford overload protection to the relative appliance circuit.

5.2.12 SEGREGATION OF PHASE CIRCUITS

More than one phase of supply shall not be brought into a multi-gang switch box.

All socket-outlets and all lighting points in a room shall be connected to the same phase.

5.2.13 CONNECTION OF NEUTRAL CONDUCTORS IN DISTRIBUTION BOARDS

The neutral conductors of the final sub circuits shall be connected at the distribution board in the same order as that in which the live conductors are connected to the fuses or circuit-breakers.

5.2.14 COOKING APPLIANCES

Every stationary cooking appliance in domestic premises shall be controlled by a cooker control switch to BS 4177 separate from the appliance and installed within 2 m of the appliance. It shall be connected to a separate final sub-circuit from the distribution board. Cooking appliance shall incorporate an integral earthing terminal.

5.2.15 CONTROL OF WATER HEATERS

Water heater up to 3 kW shall be controlled by a 20 A double pole switch, final connection to the heater being made from a flex outlet plate mounted adjacent to the heater.

The control switch for heater installed in a kitchen, may be located in the kitchen. But for heater installed in a bathroom or toilet it shall be installed immediately outside the bathroom.

Water heaters shall be connected to a separate final sub circuit from the distribution board.

Water heaters shall incorporate an integral earthing terminal adjacent to the phase and neutral terminals.

All terminals shall be housed in suitable recess with a splash proof removable cover.

5.2.16 CONTROL OF AIR CONDITIONING UNIT /PLANT

Every room air conditioning unit shall be controlled by a double pole switch with flex outlet mounted adjacent to the unit. The switch shall have a rating of 20 A for unit with cooling capacity up to 24000 BTU and 45 A for larger units. The switch shall be connected to a separate final sub circuit from the distribution board.

Supply to central air conditioning plant shall be from the consumer's main board and controlled by separate fuse-switches or circuit-breakers forming part of the main board.

5.2.17 LOAD ON LIGHTING CIRCUITS

The loading on lighting circuits in domestic installations shall not exceed 1500 W per final sub-circuit.

5.2.18 SOCKET-OUTLETS IN DOMESTIC AND COMMERCIAL INSTALLATIONS

In domestic and commercial installations, only double pole switched socket-outlets 13 A 3 pin flat type to BS 1363 shall be used.

A radial final sub-circuit may be installed to serve a maximum of six socket-outlets in rooms other than kitchen and controlled by a 20 A circuit-breaker in the distribution board.

A ring final circuit formed by looping into every socket on the ring all three conductors (phase, neutral and earth continuity) commencing and returning to the same way in the distribution board,

may serve a maximum of 10 socket-outlets in rooms other than kitchen, no spurs shall be connected to a ring circuit. A ring circuit shall be controlled by a 30 A circuit-breaker.

A kitchen shall have its own ring final sub-circuit for socket-outlets; no socket-outlets in other rooms shall be connected to it. The ring may serve a maximum of six socket-outlets in the kitchen and controlled by a 30 A Circuit-breaker. If additional socket outlets are required, a second ring shall be installed.

No socket-outlet shall be mounted within 2 m of any tap, sink or basin in a kitchen.

No socket-outlet other than shaver socket-outlet to BS EN 61558 shall be installed in a bathroom.

5.2.19 SOCKET-OUTLETS IN INDUSTRIAL AND OTHER NON-DOMESTIC INSTALLATIONS

For industrial and non-domestic applications, switched socket-outlets to BS 196 shall be used in single phase circuits with current ratings up to 30 A and to BS 433/IEC 309 for single phase circuits above 30 A and for three phase circuits of all current ratings.

Radial and ring sub-circuits for socket-outlets used for hand tools, hand lamps and other portable machinery shall be operated from single phase 110 V supply obtained from safety isolating transformer to BS EN 61558.

Socket-outlets and plugs shall be colour coded as follows:

For three phase 415 V a.c. circuits red

For single phase 240 V a.c. circuits blue

For single phase 110 V a.c. circuits yellow

5.2.20 LIGHTING SWITCHES

Local switches for lighting points and for appliances not connected to socket-outlets shall have a minimum current rating of 5 A. For outdoor and industrial use, switches shall be metalclad and water-tight.

Switches for control of discharge lighting shall have a current rating of not less than twice the steady state continuous current of the circuit.

All local switches shall be mounted in readily accessible positions with the dollies at minimum height of 1250 mm from finished floor level.

In kitchens and in situations, other than bathrooms, where water is regularly used no switch shall be mounted within 2 m of any tap, basin, sink if this is not possible, ceiling mounted insulating cord operated switches shall be used.

In bathrooms and toilets, switches shall be of the ceiling mounted insulating cord operated type. If wall mounted switches are used for control of lighting and exhaust fans, same shall be located in an accessible position outside the bathroom or toilet and immediately adjacent to the door. Special wall mounted switch for control of supply to water heater shall be similarly mounted.

Switches for lighting and fans inside a room shall be mounted inside the room on the side of the door nearest to the door-catch, handle knob or lock approximately 150 mm from the door frame.

5.3 MAIN CABLE ENTRY

High impact rigid PVC duct shall be provided in the building for entry of underground service cable:

- 100 mm inside diameter for service connection under categories 1 and 2 (as defined in Section 5)
- 150 mm inside diameter for service connection under category 3 (as defined in Section 5).

5.4 MAINS SUPPLY FOR MOTORS

Mains supply is available at 415/240 V 3 phase 4 wire 50 Hz and this supply will be permitted for single phase motors up to 5 H.P., and 3 phase motors up to 150 H.P. Where a large number of motors above 150 H.P. are proposed, the advice of the Distribution Company shall be sought on availing bulk supply at 11000 V 3 phase 50 Hz.

5.5 CONTROL AND PROTECTION FOR MOTORS

Motors of 25 H.P. and above shall be provided with earth leakage and unbalanced current protection.

Starters shall be provided with overload relays of the thermal type with automatic compensation for variation in ambient temperature between 5 °C and 50 °C.

All motors shall be provided with an isolator. Switch or switch-fuse for isolating the motor from the supply during periods of inspection or maintenance. Such means of isolation shall effectively interrupt the supply on all live conductors; it may be integral with the control gear or may be separate but shall be in the vicinity of the control gear. An emergency stop push-button shall be incorporated in the control gear.

Where starter operating circuits and ancillary apparatus are energized by any auxiliary circuit other than the main circuit to the motor, the isolator shall include ancillary contacts to effectively cut off the supply to the auxiliary circuit.

All starters, switches, isolators or push-buttons shall be clearly labelled in Arabic and English stating which machine they control and the function of the various buttons. Words likely to cause confusion (e.g. Open, close, shut) should not be used on any switch, starter. START, STOP shall be used.

A clear schematic diagram shall be firmly fixed inside the lid or cover of each starter, controller or control gear.

Motors and their control gear shall be located in well ventilated situations with adequate space for operation, inspection and maintenance.

All single phase air conditioning units and motors above 0.5 H.P. shall be provided with capacitors or other approved means for maintaining a minimum power factor of 0.9 throughout the normal working range of the units or motors or as otherwise agreed by the Distribution Company. All required capacitor banks shall comply with BS EN 61921 and BS EN 60831 as applicable.

All three phase motors over 3 H.P. and all single phase motors above 1 H.P. shall be provided with current limiting starting equipment to effectively keep the starting current within the following limits:

- Single phase motor 20 A or twice full load current whichever is the larger
- Three phase motor 30 A or twice full load current whichever is the larger.

Such starting equipment may employ any of the following types:

- Star-Delta
- Primary-Resistance
- Auto-Transformer

- Inverter based technology including variable speed/frequency drives.

All motors over one H.P. shall be provided with means of automatic disconnection from the supply in the event of:

- Failure of the supply
- Serious drop in voltage
- Flow of excess current.

6 INSTALLATION OF CONDUCTORS AND CABLES

6.1 PERMISSIBLE VOLTAGE DROP

The maximum voltage drop from the consumer's incoming supply terminals to any point in the installation shall not exceed the limits as set out in Section 3.3.

6.2 CURRENT RATINGS

Current ratings for single core and multicore cables to be adopted for use in consumer's installation are set out in Table 8, Table 9, Table 10 and Table 11 (Appendix IV). The current carried by the cables at any time shall not exceed the specified ratings.

6.3 PARALLEL OPERATION

Cables shall not be operated in parallel (ie: separate circuits). Where two or more incoming cables are connected to bus bars in a common switch board, bus-section isolators/breakers interlocked with feeder Isolators or breakers shall be provided to inhibit parallel operation. Where conductors above 4 mm² are permanently connected in parallel (with no means of isolation one without the other and joint at each end), the total current carrying capacity may be determined by taking the sum of the individual conductors provided the grouping does not impact the cooling of the conductors. Similarly, voltage drop calculations may take parallel conductors into account.

6.4 PROTECTION AGAINST DAMAGE

All conductors and cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal condition of service.

Where cables pass through holes in metalwork, rubber or plastic grommets or bushes shall be provided or the edges lined with soft material to prevent abrasion of the cables.

6.5 METHODS OF INSTALLATION

The following methods of installation shall apply to cables in consumer's fixed Installation.

- a. Multicore cables XLPE insulated PVC sheathed single steel wire armoured PVC served overall (XLPE/PVC/SWA/PVC) to BS 5467 may be installed as follows:-
 - Directly buried in ground
 - Laid in concrete trenches with removable cover, preferably on trays or cleated to walls at close intervals
 - Mounted on trays and cleated at close intervals in cable shafts
 - Drawn through ducts.

- b. Single core PVC insulated cable to BS 6004 shall only be run in conduit or trunking;
- c. PVC insulated and PVC sheathed cables with earth-continuity conductor, flat twin and earth or 3 core, to BS 6004, may be run on metallic saddles and clips mounted on walls or within metallic partitions in situations not liable to metallic damage. Otherwise, the cables shall be protected by enclosure in conduit or trunking;
- d. Mineral insulated cables (or other compliant flame retardant material with equivalent fire survival times) shall be installed in flammable explosive situations where flame-proof installations are necessary and in situations where high temperatures are encountered. If the atmosphere is also corrosive, the MICC (or other compliant flame retardant material) cable shall be further protected with PVC converting over the copper sheath. MICC cables shall be run on copper saddles and cleats mounted on walls at close intervals.

6.6 CABLES FOR LIFT

Cable shall not be installed in a lift (or hoist) shaft unless they form part of the lift installation and shall comply with BS EN 81.

Cables for lift installation other than travelling cables, in such a shaft shall be:

- Armored, or
- MICC, or
- Enclosed in metal conduits.

6.7 CABLE SUPPORTS

Every cable installed in or on a building shall be supported by one of the following methods, with supports so arranged that there is no mechanical strain on any cable termination.

- a. Multicore armored and sheathed cables, two core and earth sheathed cables, and MICC cables may be supported by clips at spacing's not exceeding the appropriate value stated in Table 13 (Appendix IV)
- b. Multicore armored and sheathed cables in horizontal runs may rest on trays or in dry and smooth concrete trench without fixing
- c. Non-sheathed cables shall be supported and enclosed in conduits or in trunking without further fixing of cables, provided that vertical runs do not exceed 5 m in length. Intermediate supports for cables shall be provided if the vertical run in any situation exceeds 5 m
- d. Sheathed cables without armour may be supported and enclosed in conduits provided vertical runs do not exceed 5 m in length.

6.8 RADIUS OF BEND

The internal radius of bend for cable in fixed wiring shall not be less than the appropriate value stated in Table 13 (Appendix IV).

6.9 CABLE TERMINATIONS

All terminations of cable conductors and bare conductors shall be mechanically and electrically sound and shall be made by means of a terminal or compression type socket and shall not impose any mechanical strain on the terminal or socket.

At all terminations, the cable insulation shall be neatly stripped without making the conductor strands. The conductor shall be tightly twisted and doubled back before being clamped with

pinching screws or studs. Where two or more cables are looped in to the same terminal, their conductors shall be tightly twisted together before being inserted in to the terminal. Bare conductor shall not be allowed to project beyond insulated shrouding of a live terminal.

Where aluminium conductors are connected to copper terminals or bus bars, compression type bi-metallic lugs with copper palm and aluminium barrel shall be used.

Cable glands for multicore cables (insulated and armored) shall be of brass compression type to BS 6121 with earth tag and PVC shroud.

The ends of mineral-insulated copper sheathed cables shall be protected from moisture by proper seal, the insulation being thoroughly dry before the sealing material is applied. Terminations shall comply with BS EN 60702.

Where cables are to be connected to bare conductors or bus-bars, it shall be verified that their type of insulation and/or sheath is suitable for the maximum operating temperature of the bare conductors or busbars. The insulation and/or sheath of the cables shall be removed for a distance of 150 mm from the connection and replaced if necessary by suitable heat resisting insulation.

6.10 JOINTS

No joints shall be permitted on any cable runs in consumer's fixed installation except MICC cables installed on surface where the length of run exceeds nominal coil length.

6.11 PROTECTION AGAINST FIRE

Where cables, conduits, ducts, or trunking pass through floor, wall, partitions or ceilings, the surrounding hole shall be made good with cement or a proprietary transit system to the full thickness of the floor, wall, etc. to inhibit spread of fire or smoke.

6.12 EARTH-CONTINUITY CONDUCTOR

Throughout the consumer's electrical installation, an earth-continuity conductor coloured green/yellow shall be provided and connected to the consumer's main earthing terminal in the distribution board. The size of the earth-continuity conductor shall be in accordance with Table 14 (Appendix IV).

6.13 DISTRIBUTION SYSTEM IN MULTI-STOREY BUILDINGS OR AREAS WHERE A PARTICULAR RISK OF FIRE EXISTS

In a multi-story building or location with a particularly high risk of fire or fire-propagation exist, one of the following distribution systems shall be adopted:-

- a. Supplies direct from the main board to individual consumer distribution boards, comprising single core PVC insulated cables which shall be fire retardant and non-flame propagating in accordance with BS EN 60332/ 61034 and installed in separate BS EN 61386 compliant conduit for each consumer
- b. Sub-main multicore cables (XLPE/PVC/SWA/PVC from the main board to the sub-main board on each floor, with supply cables from this sub-main board to individual consumer distribution boards installed in conduits, which shall be fire retardant and non-flame propagating in accordance with BS EN 60332/61034) a separate BS EN 61386 compliant conduit being used for each consumer

- c. Any cabling for multi-story installations with high density occupation, difficult evacuation conditions or in escape routes shall use Low Smoke, Zero Halogen (LS0H) sheathed cables in accordance with BS EN 60754
- d. Busbar trunking systems including rising main systems, duct or shaft with a combined tap-off unit and sub-main board at each floor. The entire rising main system shall be factory made, fully compliant under the fire conditions of BS EN 61439-6 and especially assembled for the purpose with adequate strength to withstand short-circuit forces and necessary provisions for thermal expansion and contraction. Rising main systems shall comprise the following where it passes through floors:
 - Copper conductors or busbars in unbroken lengths
 - Internal fire barriers.

The floor around the rising main shall be raised by a minimum of 100 mm to prevent any water draining in the floor.

Supply cables from the sub-main board to individual consumer distribution boards shall be installed in conduits, a separate conduit being used for each consumer.

The current rating of each rising main system shall not exceed 400 A.

Installation locations and the accommodation of building services in ducts shall comply with BS EN 8313 and any applicable building Codes or regulations.

6.14 CONSUMER'S UNDERGROUND WIRING

Consumer's wiring installed underground for distribution between a building and a point of utilization not attached to it (e.g. another building) shall be in the form of XLPE insulated PVC sheathed single galvanized steel wire armoured cable (XLPE/PVC/SWA/PVC) drawn in duct or laid direct in ground.

The installation shall in general conform to standard OES 2.

6.15 CONSUMER'S OVERHEAD WIRING

Consumer's overhead wiring for distribution between a building and a point of utilization not attached to it (e.g. another building) shall be in the form of overhead lines having conductors of hard drawn aluminium or copper covered with XLPE insulation, installed on insulators with wood pole supports.

The installation shall in general conform to standard OES 3.

6.16 CABLES IN STEEL CONDUITS, TRUNKING OR DUCTS

Cables of a.c circuits installed in steel conduits, trunking or duct shall be so bunched that the cables of all phases and the neutral conductor are contained in the same conduit, trunking or duct. This shall also apply to bare conductors enclosed in steel trunking, duct or shaft.

Where conductors pass through steel casing of any equipment or apparatus, or building steel structural, all phase conductors and the neutral associated with each circuit shall pass through the hole or aperture.

Where circuits from distribution boards are bunched at the start of the runs and then separated they shall not be brought back into a common conduit.

Circuits from distinct sources of supply (e.g. from different distribution boards) shall not be bunched in a common conduit.

6.17 SEGREGATION OF LOW VOLTAGE AND EXTRA-LOW VOLTAGE CIRCUITS

Low voltage and extra-low voltage circuits shall be segregated according to their respective functions to prevent electrical and/ or physical contact and to avoid any detrimental effects and each shall be installed in its own separate conduit. Segregation shall be provided for the following circuits:-

- a. a.c. circuits for general purpose (lighting, sock-outlets, etc.)
- b. Fire alarm circuits
- c. Radio
- d. Television
- e. Telecommunications cabling
- f. Sound distribution
- g. Burglar alarm
- h. Bell and call circuits
- i. Data cabling.

Where multicore cables are used the cores of each of the above circuits shall be contained in separate distinct easily identifiable cables.

Fire alarm circuits may preferably be wired in mineral insulated copper sheathed cable (or other materials complying with BS 8519 including the relevant the minimum fire survival times) with overall PVC covering of 'red' Colour in and on a building and in multicore armoured cable with overall PVC covering laid underground between buildings.

The terminations, switches, push-buttons, socket-outlets, cord-outlets for each of the above circuits shall be distinct and easily identifiable.

NOTES:

1. *The above segregation requirements do not ensure circuits such as telecommunications, data transfer or other sensitive electronic equipment will be sufficiently protected from the effects of electrical interference. Wiring systems shall be selected and installed to minimize of electromagnetic interference which may include wiring or enclosures which shield magnetic fields.*
2. *Extra-low voltage circuits (except for fire alarm circuits or other life safety systems) may be run together on trays or installed in a common trunking or duct, but not in common conduit.*
3. *Effective segregation may also be achieved by the use of independently sheathed cables, barriers of fire-resisting material, double insulation, distance or if all cables or each conductor of a multi-core cable is insulated for the highest voltage present.*
4. *Wiring supply for fire-fighting, safety services or life safety plant may require additional segregation.*

6.18 FLEXIBLE CORDS AND CABLES

Current ratings for flexible cords and cables are set out in Table 7 (Appendix IV). Where apparatus requires to be earthed, flexible with earth core shall be used.

Where flexible cables and cords are exposed to the risk of mechanical damage, they shall as a minimum be sheathed with PVC or rubber and where necessary shall be armoured, the armour not being used as sole means of providing earth-continuity.

Flexible cords and cables shall be connected to plugs, ceiling roses and movable apparatus with the BROWN core to phase, BLUE core to neutral and GREEN/YELLOW core to earth terminal of accessory or frame of the apparatus.

In situations where high temperatures are encountered, flexible cables and cords shall be insulated with silicone rubber and appropriately rated in accordance with BS EN 50525-2-41.

Where a flexible cord supports or partially supports a luminaire, the maximum mass supported by the cord shall not exceed the values given in Table 7 (Appendix IV).

Flexible cords shall not be used as fixed wiring.

6.19 COLOUR IDENTIFICATION OF CABLE CORES

Additional consideration and care should be taken where UK/European imported electrical appliances, equipment and accessories are used containing internal wiring using the colours prescribed in IEC 60364/BS 7671 to ensure the correct cables are used and terminated for their intended functions. Typical European colouring schemes are provided below to assist with coordination:

- a. Colour identification of insulated cable cores for fixed installation and of sleeve, band or disc for bare conductors shall be as stated in the sections below under “Oman/OES 4 Colouring”.

Cable Function Colouring	Oman/OES 4 Colouring	European
Earthing conductor	Green and Yellow	Green and yellow
Phase of a.c single phase circuit	Red	Brown
Neutral of a.c	Black	Blue
Phase R of 3 phase a.c circuit	Red	Brown
Phase Y of 3 phase a.c Circuit	Yellow	Black
Phase B of 3 phase a.c Circuit	Blue	Grey
Positive of d.c 2 wire	Red	Brown (if floating)
Negative of d.c 2 wire	Black	Grey (if floating)

- b. Colour identification of flexible cables and flexible cords shall be as follows under “Oman/OES 4 Colouring”:

Cable Function Colouring	Oman/OES 4 Colouring	European
Live	Brown	Brown
Neutral	Blue	Blue
Earthing	Green and yellow	Green and Yellow

NOTES:

1. *European colouring for positive of d.c may also be blue for positive earthed circuit.*
2. *European colouring for negative of d.c may also blue for negative earthed circuit.*

7 INSTALLATION OF CONDUITS, TRUNKING AND TRAYS

7.1 INSTALLATION OF CONDUITS

The conduits for each circuit shall be completely installed before any cable is drawn in.

Conduits shall be securely fixed and where they are liable to mechanical damage they shall be adequately protected.

Provision for the safe and easy drawing in of cables shall be made by use of inspection fittings, draw boxes. Provisions shall be such that cables can be drawn-in or replaced without the cables being damaged or the conduct dismantled.

All runs of conduits shall be truly vertical or horizontal.

7.2 CONDUIT SUPPORTS

Where conduits are installed on the surface of building fabric they shall be supported into a fixed position by means of purpose made supports (including suitably spaced steel or copper clips, saddles or clamps) suitable to prevent damage to the conduit or any associated cables from all external influences and which shall not be liable to premature collapse in the event of a fire.

Supports shall be provided at a maximum spacing of 1500 mm for galvanized steel conduit and 1200 mm for high impact PVC conduit.

7.3 SMOOTH FINISH OF CONDUITS

The boxes of all conduits shall be smooth and free from projection which may injure cables or obstruct their drawing in. Ends of conduits shall be so reamed and when they terminate at boxes, trunking and accessories not fitted with spout entries, shall be so bushed as to obviate abrasion of cables.

7.4 RADIUS OF BENDS

The radius of every conduct bend shall not be less than 2.5 times the outside diameter of the conduit.

7.5 GALVANISED STEEL CONDUITS

Galvanized steel conduit system shall be earthed and connected to the earth-continuity conductor. All Joints shall be made mechanically and electrically continuous by screwing. The conduct shall not, however, be used as an earth-continuity conductor; and a separate earth-continuity cable shall be drawn into the conduct for every final sub-circuit.

Galvanized steel conduits or equivalent flame retardant non-metallic conduits (provided they are installed at height of no less than 50 mm above the false ceiling to avoid mechanical damage in compliance with requirements as specified in BS 7671) shall be used in the space between a roof and suspended false ceiling, in situations subject to fire risk and in surface mounted industrial installations. PVC conduits shall not be used for such applications.

Galvanized steel conduits shall not be used under floor tiles of buildings or in concealed wiring systems embedded in walls or floors. PVC conduits shall be used for all such applications.

7.6 PVC CONDUITS AND FITTINGS

PVC conduits and fittings shall be of the unthreaded type. All Joints shall be made with vinyl cement and entries of all conduit fittings shall be designed such that reliable water tight Joints can be obtained.

Surface mounted PVC conduit systems shall be so supported as to allow for longitudinal expansion and contraction. A cement that shall remain in adhesive plasticized state shall be used for expansion couplers.

7.7 FLEXIBLE CONDUITS

Flexible conduits shall only be used for the final connection of motors and other equipment subject to vibration or adjustment of position.

PVC flexible conduits and fittings shall comply with BS 4607/61386. Metallic flexible conduits and fittings shall comply with BS EN 61386 and shall preferably be provided with an outer sheath of PVC.

Flexible metal conduct shall not be used as the sole means of providing earth-continuity and a separate earth-continuity cable shall be provided.

Where necessary, flexible conduit shall be adequately supported and/or protected.

In damp or wet situations flexible conduits shall be watertight and remain impervious to ingress of water or moisture.

The ends of flexible conduit shall be securely anchored to fixed conduit and/or equipment entries by purpose made flexible conduit adaptors.

7.8 CONDUIT SIZES

Conduits shall be limited to the following sizes:

16 mm, 20 mm, 25 mm, 32 mm and 50 mm.

7.9 CABLE TRUNKING

Cable trunking may be employed for housing single core PVC cables at special situations where due to space limitations it is not possible to install conduits.

Trunking shall be constructed of galvanized steel or non-combustible insulating material with removable covers. Trunking and its accessories shall be manufactured from substantial sections to provide adequate strength and rigidity. All sharp edges, burrs and other projections shall be removed and the trunking finished smooth to prevent-injury to cables.

Trunking shall be completely installed before drawing in cables. Every entry to finished trunking shall be so placed as to prevent the ingress of water. All removable covers shall be securely fixed after wiring is completed.

Tables 10 & 11 (Appendix IV) show the number of PVC cables that can be accommodated in different sizes of trunking.

7.10 CABLE TRAYS

Trays for supporting cables are recommended for use in warehouses, industrial buildings, plant and equipment rooms, cable trenches, shafts in commercial and residential buildings. All cable tray and ladders shall comply with BS EN 61537. A cable tray system shall form a rigid structural system and be constructed of galvanized steel, stainless steel, aluminium or any other material that satisfies the tests under fire conditions in BS EN 61537 and is tested and classified as non-flame propagating. Ladders, troughs, channels or perforated or solid bottom trays may be used.

Cable trays shall have sides of adequate dimensions. All fittings, bends, tees, supports, fittings and accessions shall be of substantial sections and of the same quality as the trays themselves.

Cables shall be fastened securely by purpose made clips, cleats, saddles or by stainless steel cable ties or straps. The number of multicore cables that may be installed in a perforated or solid bottom trays shall be such that the space factors given in Table 18 (Appendix IV) are not exceeded.

8 EARTHING AND EARTH LEAKAGE PROTECTION

8.1 CONSUMER'S EARTHING INSTALLATION

Consumer's earthing installation shall be provided in accordance with Section 5.2.9, with earth electrode and main earth lead connected between the electrode and the consumer's main earthing terminal.

8.2 EARTH-CONTINUITY CONDUCTOR

Throughout the consumer's installation an earth-continuity PVC cable coloured green and yellow shall be provided and connected to the main earthing terminal. The size of the earth-continuity cable shall be as stated in Table 14 (Appendix IV).

8.3 EARTHING TERMINAL OF SOCKET-OUTLETS

The earth-continuity cable of the final sub-circuit shall be connected to the earth terminal of the galvanized steel box for the socket-outlet.

8.4 EARTHING TERMINAL OF LIGHTING POINTS

Every lighting point shall include an earth terminal, which may be a terminal in a metal box. (similarly every switch position shall include an earth terminal). The earth-continuity cable of the final sub-circuit shall be connected to the earth terminal.

8.5 RESISTANCE OF EARTH-CONTINUITY CONDUCTOR

The resistance from any point of the earth-continuity conductor to the main earth electrode shall not exceed 0.50 Ω .

8.6 BONDING OF METAL WORK

All metal work of the consumer's installation (other than current carrying parts) including cable armour, metal conduits, ducts, trunking, cable trays, metal accessory boxes, exposed metal work of consumer's appliance, apparatus and equipment like air conditioning units, washing machines, electrical, cookers, water heaters, electric type-writers, copying machines, motors, lift machinery shall be connected to the earth-continuity conductor. The connection of each piece of equipment to the main earth-continuity conductor shall be by a separate branch. Series method of earthing one piece of apparatus to another shall not be permitted except in the case of socket-outlets, lighting points and lighting switch point connected to a sub main circuit.

8.7 NEUTRAL CONDUCTOR

The neutral conductor shall not be earthed at any point within the consumer's premises.

8.8 ADDITIONAL PROTECTION BY RCDS

Each and every consumer's installation shall have additional protection on the incoming side of the consumer's main distribution board through the use of RCDs of the required continuous current ratings and operating currents to minimise nuisance trips in accordance with Section 2.5. Single incomer designs using RCBOs on all final sub-circuits may be permitted or split load type consumer units having dual or three RCD incomer designs are also acceptable.

The following equipment and appliances shall be supplied by a dedicated circuit protected by a RCD (unless protection is provided by upstream incomer RCDs) with the following rated operating currents to afford maximum protection against shock.

Table 1: Additional Protection by RCDs

Installation and Equipment Type	Maximum Operating Current
Under water lighting	10 mA
Day-care and kindergarten for children under 5 years	10 mA
Education and training facilities	30 mA
Socket-outlet and apparatus circuits	30 mA
Individual domestic, residential or multi-storey installations	30 mA
Industrial and commercial installations	30 mA
Cooker (socket connected)	30 mA
Circuit supplying luminaires and lighting	30 mA
Street lighting and furniture	30 mA
Indoor Floor and ceiling heating units	30 mA

Portable or transportable equipment	30 mA
All final sub-circuits on a construction and building sites	30 mA
All final sub circuits of agricultural and horticultural installations	30 mA
All other damp and wet conditions as per Section 12.1	30 mA
All mobile installations at least every socket outlet supply	30 mA
Electric vehicle charging stations at every charging point	30 mA Type B
Agricultural and horticultural installations-main circuit	100 mA
Temporary electrical installations	100 mA type S (i.e. with delay to minimise nuisance trips)

NOTES:

1. *Portable equipment used in construction shall also have additional requirements as per Section 10.*
2. *For electric vehicle charging points, type A RCDs may also be used in conjunction with appropriate equipment that can detect and disconnect for d.c fault current above 6 mA.*

8.8.1 LOCATION OF RCDS

In electrical installations with multiple distribution boards (such as a main switchboard and individual consumer units), RCDs shall be installed where the final sub-circuit originates.

9 INSTALLATION OF ACCESSORIES AND APPARATUS

9.1 VOLTAGE RATING

All apparatus shall be rated for a voltage of a.c 415/240 V 50 cycles.

9.2 CURRENT RATING

All apparatus shall be rated for a current not less than the maximum steady current likely to flow through it, taking into account the site service conditions (Section 3.1).

9.3 TERMINAL MARKINGS AND EARTH MONITORING

The terminal markings and disposition of the contacts of single phase switched socket- outlet to BS 1363 for use in domestic installations are shown in Figure 6 (Appendix V).

Figure 7 (Appendix V) shows the markings and disposition of the contacts of single phase industrial socket-outlet to BS EN 60309.

Figure 8 (Appendix V) shows the markings and disposition of 3 phase and earth terminals of socket-outlet to BS EN 60309.

Figure 9 (Appendix V) shows the markings and disposition of 3 phase, neutral and earth terminals of socket-outlet to BS EN 60309.

Socket outlets and corresponding plugs shall be wired and connected according to the above reference Figures in Appendix V.

In industrial situations, to eliminate the danger that may be caused due to damage to earthing conductor of a flexible cable connected to portable and transportable equipment RCD protection shall be provided in accordance with Section 8.8. Additional earth or insulation monitoring equipment is also permitted in addition to RCD protection.

9.4 LIGHTING SWITCHES

Local lighting switches shall be of minimum 5 A capacity. In domestic installation, the switches shall have all insulated tops and dollies. For outdoor use, switches shall be metal clad watertight.

Switches used to control discharge lighting circuits shall have a current rating of not less than twice the steady current that it is required to carry.

Wall-mounted switches must not be installed in and damp or wet areas as per section 12.1. Cord-pull switches may be used or wall-mounted switches mounted outside the rooms may be used.

In areas not defined as damp or wet areas but which contain a sink or a source of water, e.g. kitchens, wall-mounted switches shall be located at least 2 m from the sink or other source of water.

9.5 CEILING ROSES

Ceiling roses shall be of the three or four terminal type with terminals clearly marked or cast into ceiling rose materials as follows:

Three terminal type	L (Line), N (Neutral), E (Earth)
Four terminal type	L (Line), Loop-in, N (Neutral), E (Earth)

Ceiling roses shall be securely fixed to building structure or circular galvanized steel box to BS 4662, and shall not hang on or strain any fixed wiring. Flexibles shall be securely anchored so that no pull from them can be transmitted to the conductor connections.

9.6 LAMP HOLDERS

Bayonet cap lamp holders for general purposes shall be all insulated type to BS 52 section 5 and bear the marking BS 52 A for situations where the lamp-holder does not attain a temperature exceeding 135 °C, where the lamp holder IS installed inside an enclosed luminaire, heat resisting type complying with section 7 of BS 52 and marked BS 2H shall be used.

The centre contact of Edison type screw lamp holders shall be connected to the neutral conductor.

9.7 PENDANT LIGHTING

Heat resisting flexible core, minimum size 1.0 mm² silicone rubber insulated, shall be used for connection between ceiling rose and lamp holder for pendant type light fittings or for enclosed luminaire.

9.8 MOUNTING HEIGHTS OF ACCESSORIES

The mounting heights of lighting accessories commonly used in electrical installations shall be as follows:

Lighting switch	1250 mm above fixed floor level
Ceiling fan regulator	1250 mm above fixed floor level
20 A D.P. switch for water heater or A/c units	1250 mm above fixed floor level
Shaver socket-outlets	1250 mm above fixed floor level
13 A switched socket-outlet for general purpose	450 mm above fixed floor level
13 A switched socket-outlet in kitchen	250 mm above work top
Cooker control unit	1600 mm above fixed floor level
Cooker low level connection outlet	1000 mm above fixed floor level

9.9 PROTECTION OF CONSUMER'S SUB-CIRCUITS

All final sub-circuits in consumer's domestic & commercial installation shall be controlled and protected by MCBs or RCBOs. Fuses (cartridge or rewirable) are not permitted for such application.

MCB's or cartridge fuses may be used in industrial installations.

It is recommended that all individual sub-circuits be protected by combination RCBO breakers, (earth leakage, overcurrent and short-circuit) with earth leakage trip rating of 30 mA.

9.10 EXTRA-LOW VOLTAGE APPARATUS

Electric bells and other extra low voltage apparatus shall be supplied through double wound safety isolating transformers with cartridge fuse or M.C.B. in the secondary circuit. The metal enclosures of such apparatus and one side of the extra-low voltage circuit shall be earthed.

Extra-low voltage wiring shall be earned out with PVC cable of 1.0 mm² stranded copper. Segregation of low voltage and extra-low voltage circuits shall be in accordance with Section 6.17.

9.11 ACCESSORY BOXES

Where conduits are run on surface, all branch switches, switched socket-outlets, ceiling roses, etc. shall be mounted on galvanized steel boxes to BS 4662 especially designed for surface mounting.

Where conduits are embedded in walls and floor slabs all branch switches, switched socket-outlets, ceiling roses, etc. shall be mounted on galvanized steel boxes which shall be installed flush with the plaster.

9.12 AUTO-TRANSFORMER IN CONSUMER'S INSTALLATION

The common terminal of any auto-transformer, used in the consumer's installation shall be connected to the neutral conductor.

9.13 WATER HEATER

Any heater or boiler used in the consumer's installation shall incorporate an automatic device to prevent a dangerous rise in temperature.

9.14 UNDER WATER LIGHTING

All underwater lighting circuits shall be supplied from a SELV operating at voltage not exceeding 12 V a.c or 30 V d.c, comply with BS EN 60598 and be installed to ensure full safety.

Lighting fixtures shall be completely water tight, tested to ensure complete safety in operation and comply with all requirements of Section 12.1.

All metallic parts of the pool structure, including reinforcing steel, metal fittings, metal enclosure for lighting fittings, low voltage transformers, accessories, shall be bonded together and connected securely to the earthing system.

All circuits feeding pool lights and other components shall be protected by an RCD having a trip rating of 10 mA in compliance with Section 12.1 installed on the supply side of L.V. transformer.

9.15 ELEVATORS AND ESCALATORS

Each elevator or escalator shall be protected by a separate circuit-breaker on the main switch-board. In addition, an isolating switch shall be installed on the control board for the lift or escalator for isolating the entire electrical supply to the equipment.

In multi-lift installations, separate sub-main for signals, lights and other equipment common to the group, shall be provided, with separate means for isolation.

Mechanical means shall be provided for bringing down the elevator to the ground floor in case of power supply failure.

A fireman's break glass type switch or similar device shall be installed adjacent to the elevator doors to bring down all the elevators to the ground floor during an emergency.

9.16 STAND-BY GENERATORS

Where it is intended to provided standby generator supply for purpose of maintaining power supply under mains failure conditions, the installation shall ensure that it is impossible to parallel generator supply with the distribution mains supply. Necessary electrical and/or mechanical interlocks shall be provided.

The change-over circuit-breaker or isolator shall have 4 poles (3 phase and neutral) for 3 phase supply and double pole (phase and neutral) to ensure that not only the phases but also the neutrals of the two systems remain separate and distinct.

If the changeover switch is operated by a handle, this handle shall be insulated to a 2.5 kV test voltage. The armour of the generator cable shall not be bonded to the body of the changeover circuit breaker or isolator

Prior to installation of a standby generator set, full details of the equipment with circuit and wiring diagrams shall be submitted to the relevant Distribution Company for scrutiny and specific approval of the Distribution Company obtained in writing before commencing work.

9.17 FESTOON LIGHTING

Festoon lighting system for construction site lighting or decorative lighting shall be factory assembled with PVC insulated twin copper cable having heat resisting, flame retardant polychloroprene (PCP) sheath overall with lamp holder shrouded in insulating material and permanently moulded to the cable sheath.

In spans exceeding 10 m, the lighting cable shall be secured to a catenary of galvanized steel wire with plastic or PVC coated clips or similar means at close intervals to eliminate risk of damage to sheath or insulation.

9.18 LIGHTNING AND OVERVOLTAGE PROTECTION

Protection against direct and indirect lightning strikes and other forms of overvoltage shall be provided in the following instances:

- a. Where an overvoltage event could cause danger to persons or property such as systems using telecommunications conductors
- b. Installations with consequences related to human life including safety services and medical equipment in hospitals
- c. Installations resulting in loss of services including rail, telecommunications, electricity and gas
- d. Loss of cultural heritage such as mosques
- e. Loss of commercial or industrial activity including banks, hotels, industries
- f. Installations with a large number of co-located individuals being affected.

For other installations not highlighted above and where lightning or overvoltage protection is not specified by the consumer, a risk assessment complying with the principles of BS EN 62305 for direct protection and BS 7671 for indirect protection shall be undertaken to determine if overvoltage protection is required. Such standards consider the economic value of the installation, likelihood of a lightning strike (flash density), proximity to other structures and surrounding environment, flammability of external building structure materials, network connection type and presence of upstream protection.

General factors which are likely to justify the installation of overvoltage protection without conducting a risk assessment include the presence one or more of the following factors:

- The installation is in an area where there is high prevalence of lightning or other overvoltage events (such as frequent power disturbances in industrial areas)
- The installation is supplied from a long length of overhead power lines
- The installation is elevated (i.e. on a hill) and/or is isolated with no nearby large structures
- The installation contains sensitive electronic equipment

Where protection against a direct lightning strikes is required, it shall be provided by primary/structural lightning protection (including air terminals, down conductor and earth termination networks) with air terminals locations determined based on the rolling sphere method.

Building lightning protection earthing system shall not under any circumstances be connected to the distribution earthing system or the consumer's earthing system for electrical installation.

A minimum separation of 5 m shall be provided between earth electrodes for electrical installation and building lightning protection.

The down lead for the Lighting protection shall be either XLPE insulated or run on Insulated saddles.

Where overvoltage protection from indirect lightning strikes and other transients is required, it shall be achieved through secondary protection including Surge Protection Devices (SPDs) in accordance with BS 7671.

NOTES:

1. *Additional requirements may apply in hazardous and flammable areas.*
2. *In general, additional overvoltage protection is not a requirement (excluding the above mandatory installation types) for installations with no additional risk to personnel and with one or more of the following cases:*
 - *equipment damage is acceptable*
 - *Non-sensitive or valuable equipment is to be installed in areas where there is low lightning activity or prevalence*
 - *Where a consumer's installation is supplied via an underground LV supply and all consumer's equipment complies with the applicable minimum impulse withstand voltages based on the applicable classification of the equipment in accordance with BS EN 61010.*

10 INSTALLATIONS ON CONSTRUCTION AND BUILDING SITES

10.1 GENERAL

Installations on construction and building sites shall comply with the requirements for permanent installations and in addition with the specific requirements of Sections 10.2– 10.11 below.

10.2 ELECTRICAL APPARATUS AND CABLING

Electrical apparatus and cabling in Site installations may be subject to extreme abuse. The use of equipment and materials which will be suitable for and withstand the onerous duty imposed by construction Site conditions, is essential; correct and sensitive circuit protection, proper earthing arrangements, and frequent inspection and testing are important.

10.3 DISTRIBUTION UNITS

Distribution units for Site supplies shall comply with BS 4363 and incorporate the following basic features:

- Suitability for transport and storage;
- Robustness in construction to resist damage from transportation, rough handling, heavy objects falling and exposure to atmospheric conditions;
- Safety in use.

10.4 PORTABLE APPARATUS AND SITE LIGHTING

A reduced voltage system operating at 110 V through a double wound transformer complying with BS EN 61558 shall be provided for portable and hand-held tools and lamps and for site lighting other than flood lighting.

10.5 SOCKET-OUTLETS

Single phase socket-outlets, plugs and couplers shall comply with BS EN 60309.

Three phase socket-outlets, pins and couplers shall comply with BS EN 60309.

All socket outlets, plugs and couplers shall be splash proof.

10.6 110 V PLUGS AND SOCKETS

Plugs and sockets operating at 110 V are to be identified by the colour yellow. It is essential that this colour is not used for plugs, socket-outlets and couplers operating at other voltages.

10.7 COLOUR CODE FOR ACCESSORIES

Identification colours for accessories shall be as follows:

110 V	Yellow
240 V	Blue
415 V	Red

10.8 REDUCED VOLTAGE SYSTEM

Reduced voltage system operating at 110 V three phase should be obtained from a double wound transformer complying with BS EN 61558 having its star connected secondary winding earthed so that the nominal voltage of the sub-circuit to earth is only $110/\sqrt{3}$ V, i.e. approx. 65 V.

Reduced voltage system operating at 110 V single phase would be obtained from a double wound transformer having the centre tap of the secondary winding earthed so that the nominal voltage of the sub-circuit to earth is only 65 V.

10.9 CABLES

All cables used on construction sites shall have a metal sheath and/or armour which must be continuous and effectively earthed. In the case of flexible or trailing cables such earthed metal sheath and/or armour should be in addition to the earth core in the cable and should not be used as the sole earth-conductor.

Cables shall be armoured having an overall covering of PVC or other thermoplastic heat resisting, oil resisting and flame-retardant (HOFR) sheath overall in accordance with BS EN 50525. Non-flexible cables shall comply with BS 5467 and flexible cables shall comply with BS 6708 with armour and overall covering of HOFR.

Flexible cords should be of the Circular type having a PCP or HOFR sheath.

10.10 LAMP HOLDERS

Types of lamp holders should be selected to ensure that 110 V and 240 V lamps cannot be inadvertently interchanged.

Edison screw lamp holders for operating on 110 V or 240 V supply shall be fitted with shrouds or skirts so that neither the lamp cap nor screw part of the holder can be inadvertently touched when the cap is engaged with the lamp holder screw.

Lamp holders fitted with pin contacts intended to be pressed into tough rubber sheath or PCP sheath cable shall not be used. Festoon lighting system in which the lamp holder is shrouded in insulating material and permanently moulded to the cable sheath, shall be used for illumination of discrete areas.

10.11 MAINTENANCE AND INSPECTION

Site work is, of necessity, in a constant state of change and because of this, the associated electrical installation is subject to risk of damage or misuse. Strict maintenance and frequent checking of control apparatus and protection equipment and the wiring distribution system is therefore essential to promote safety and efficient operation and shall be carried out by competent personnel in accordance with Section 13.11.

11 AGRICULTURAL AND HORTICULTURAL INSTALLATIONS

11.1 GENERAL

This section applies to the specially onerous conditions which are likely to be encountered in agricultural and horticultural installations, including the special risks arising from the presence of livestock, wet corrosive conditions, exposure to mechanical damage, weather and neglect.

All installations shall comply with the requirements for building installation in general and in addition to the specific requirements of Sections 11.2- 11.7.

11.2 LOCATION OF SWITCHGEAR

No switchgear shall be installed within reach of livestock or in any position where access to it may be impeded by livestock, in normal conditions or in panic.

11.3 ISOLATION AND CONTROL

For isolated items of equipment like pump, remote from the main installations, a separate means of control adjacent to the apparatus shall be provided in a readily accessible location.

11.4 PROTECTION OF CABLES

All cables shall be placed out of reach of livestock and clear of all vehicles.

Where additional protection against mechanical damage to cables is required, it shall be provided by non-metallic high impact rigid conduit.

11.5 INSTALLATION OF CABLES

Cables buried underground shall be placed at a minimum depth of 1000 mm and further protected with rigid PVC ducts and PVC warning tape, to avoid any risk of damage by implements used for

purposes of cultivation/irrigation. The routes of all cables shall be clearly marked by cable route markers.

Cables couplers shall not be used in agricultural installations.

In situations accessible to livestock, in and around agricultural buildings, the installation shall as far as practicable be of all insulated construction.

11.6 PROTECTION OF EARTHING LEAD

The earthing lead of an agricultural installation shall be adequately protected against disturbance or damage by livestock or by passing mechanical implements. Where the earthing lead is not enclosed in conduit, it shall be of the armoured type.

11.7 EXTRA-LOW VOLTAGE (ELV)

Considerations should be given to the use of reduced voltages for portable apparatus. Portable lamps or appliances used in damp situations should be operated at a voltage not exceeding 12 V from a 24 V single phase a.c supply derived from a double wound transformer having the center point of its secondary winding connected with earth.

12 SPECIAL INSTALLATIONS OR LOCATIONS

12.1 DAMP AND WET AREAS

12.1.1 GENERAL

Damp and wet areas include areas where moisture is either permanently or intermittently present and would be likely to impact on normal safety precautions called for in these Regulations. Damp and wet areas shall include but not be limited to bathrooms (baths, showers), swimming pools, spas, fountains, saunas and areas in proximity to other fixed water containers or installations.

All electrical equipment to be used in damp, wet or high-humidity situations, shall be designed and installed to be suitable for the conditions that they will be exposed to including appropriate IP ratings (including glanded penetrations/entries), equipment location and RCD protection.

Damp and wet areas are divided into zones based on the distance from the water source. The requirement for electrical systems and apparatus are dependent on the zone where they will be located.

RCD protection shall be provided in accordance with Section 8.8 regardless of which zone the equipment is installed in.

All socket outlets installed in damp and wet areas shall be installed 0.3 m above the floor.

Table 2 defines the extent and spacing of the defined zones within damp and wet areas.

Table 2: Damp and Wet Areas Zone Classification

Installation/Locations	Zone 0 Spacing (m)	Zone 1 Horizontal Spacing (m)	Zone 2 Horizontal Spacing (m)	Zone 3 Horizontal Spacing (m)
Bathroom/shower	The area interior of a bath/shower base	Above baths and shower base	0.6 from Zone 1	2.4 from Zone 2
Swimming Pools and spas	Inside pool	2 from pool and above the pool	1.5 from Zone 1	N/A
Fountains	Inside or directly above fountain	2 from fountain	N/A	N/A
Sauna	N/A	0.5 from moisture source	All other space in room	N/A
Other Fixed Water Containers and damp areas	The area interior to the water container	Above water container	0.6 from Zone 1	2.4 from Zone 2

All electrical equipment installed in damp and wet areas shall comply with the following degrees of protection and installation locations:

Table 3: Damp and Wet Areas Equipment Selection

Equipment	Zone 0	Zone 1	Zone 2	Zone 3
Socket Outlets	Not permitted	Not permitted	A Shaver supply units in accordance with BS EN 61558	Either SELV, PELV or reduced low voltage supplied by and isolation transformer complying with BS EN 61558 supply.
Luminaires, Other electrical equipment	IPX7, specifically designed for use in Zone 0 and SELV or PELV supply from a	IPX4	IPX4; or class II construction (double or reinforced insulation); or SELV or PELV; or recessed into ceiling	No specific IP rating

	source located outside Zone 0			
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NOTES:

1. *No switchboards or distribution board shall be installed in damp or wet areas, kitchens or on the reverse side of bathrooms*
2. *Electricity generation systems shall not be installed in damp or wet locations*
3. *Irrespective of which zone an appliance or luminaire is installed, a minimum IP rating of IP X5 shall be used where a shower with a flexible hose connection or water jets are used*
4. *For the avoidance of doubt, zone and IP requirements apply to water heaters, extractor fans and associated spur fuses where applicable.*
5. *Luminaires installed in Zone 0 shall also comply with Section 9.14.*
6. *Permanent barriers such as screens, doors or enclosures can be used to limit the associated zones spacing for zones 2 and 3. They cannot be used to limit zone 1 (i.e. installing a non X5 rates water heater directly above the shower even if “boxed in”). An example of an acceptable use of barriers to limit zone spacing would be using a permanent barrier shower screen in a bathroom with a fixed shower plumbing connection (i.e. not a flexible hose connection) to permit the use of zone 3 equipment on the other side of the barrier instead of zone 2 equipment.*

12.2 TEMPORARY INSTALLATION-INCLUDING SITE SUPPLY

This section provides requirements for all temporary installations (including exhibitions, shows, fairs, living quarters and other structures associated) that have obtained relevant authorities permissions and have carried out a risk assessment identifying an acceptably low risk to the public. It is not intended to apply to film, video and television sites.

Continuous monitoring should be undertaken on a monthly basis for the duration of the connection.

12.2.1 CONDUCTOR INSTALLATION

Where the temporary installation will involve stakes, pegs or anchors, all underground wiring (including the permanent supply to the site and any underground wiring for the event) shall be installed either in steel conduit, concrete capping or at a burial depth no less than 1 m.

All above ground temporary (i.e. installed for the duration of an event) wiring shall be located so as to not obstruct persons walking in the vicinity or to put under mechanical or excessive thermal stress and have mechanical protection provided including SWA cabling, heavy gauge steel, heavy duty insulating conduits or trafficable cable covers.

Any overhead conductor shall be insulated aerial conductors, and avoid crossing roadways, access ways where cranes and heavy machinery are in use.

12.2.2 PROTECTION AGAINST THERMAL EFFECTS, OVERCURRENT, EARTH LEAKAGE. AND ENVIRONMENTAL FACTORS

RCD protection shall be installed in accordance with Section 8.8 which shall include 30 mA protection for all lighting and detachable connections which include socket outlet connected or extension cord connected appliances.

Where no fire alarms are installed, all cabling shall be fire retardant, non-flame propagating in accordance with BS EN 60332/ 61034 and Low Smoke, Zero Halogen (LS0H) sheathed cables in accordance with BS EN 60754.

Overcurrent protection shall comply with Section 2.4.

Any portable outlet box shall have a minimum IP rating of X4.

12.3 MOBILE INSTALLATIONS- INCLUDING SITE SUPPLY

This section provides additional requirements for all mobile and transportable installations (including caravans, mobile homes, food vending vans, relocatable homes and temporary site offices) and their site supplies.

12.3.1 INCOMING SUPPLY ARRANGEMENTS

All mobile installations be supplied from a minimum IP X4 socket outlet and matching plug complying with BS EN 60309 which shall be able to be connected by unskilled persons. Upstream wiring in the caravan park shall comply with Section 12.3.2. The only exception is where a mobile installation will be permanently installed in a fixed location whereby a permanent terminated connection to either a protective device or junction box shall be permitted. All supply leads and conductors shall not exceed 20 m unless unavoidable.

Tents and non-rigid installations may be connected to an electrical source only where they are securely erected and all electrical equipment is sufficiently protected from rain. All non-rigid mobile installations shall be connected via an outlet box except for where only one appliance is installed in which case a single socket-outlet extension cord connection may be permitted.

12.3.2 CONDUCTOR INSTALLATION

All conductor installation locations shall be selected so as to not obstruct persons walking in the vicinity or to put under mechanical or excessive thermal stress.

Where the installation is likely to involve stakes, pegs or anchors longer than 400 mm, any underground wiring shall be installed either in steel conduit, concrete capping or at a burial depth no less than one meter.

All above ground cabling shall have mechanical protection provided including SWA cabling, heavy gauge steel or heavy duty insulating conduits or trafficable cable covers.

Any overhead conductor shall be insulated aerial conductors, and avoid crossing roadways, access ways where cranes and heavy machinery are in use.

All internal wiring shall have conductor no less than 2.5 mm².

Appropriate mechanical protection shall be provided taking into consideration vibrational strains including the use of cable glands and grommets through all penetrations.

12.3.3 PROTECTION AGAINST THERMAL EFFECTS, OVERCURRENT, EARTH LEAKAGE. AND ENVIRONMENTAL FACTORS

RCD protection shall be installed in accordance with Section 8.8.

Overcurrent protection shall comply with Section 2.4. No fuses shall be permitted.

All appliance connections and inlets subject to moisture (including all outdoor connections) shall be of the socket type with a minimum IP rating of 44.

All outlets shall have an IP rating of IP 44 with or without a connector engaged.

All wiring and electrical appliances (except for ELV equipment related to gas control) shall be installed in any gas cylinder storage compartment or if unavoidable, within 500 mm of the base of the cylinder.

Each socket outlet or protective device shall be installed no higher than 1.5 m above ground/the floor.

12.3.4 PROTECTIVE EARTHING AND BONDING

A protective earthing conductor shall be installed between the mobile installation and the supply source either through the supply lead (in the case of a three pin socket connection) or via a separate mechanically connected conductor.

All structural metal parts internal and external to the mobile structure shall be effectively connected to a common earth.

No earthing electrode shall be installed as part of the mobile installation.

12.3.5 IDENTIFICATION

All mobile installations shall be provided with clear instructions on the electrical supply and connection and periodic inspection requirements.

12.4 SOLAR PV SYSTEMS

All solar PV systems shall be designed and installed in accordance with the requirements of the "Small Scale Grid-Connected Solar PV Systems-Technical Guidelines" issued by the Authority with due reference to "Small Scale Grid-Connected Solar PV Systems: Additional Document on Specific issue on the safety of PV systems" and "Small Scale Grid-Connected Solar PV Systems Connection Guidelines".

12.5 ELECTRIC VEHICLE CHARGING STATIONS

This section provides additional requirements for circuits with the intent on supplying electric vehicles for charging purposes.

12.5.1 GENERAL

All electric vehicle charging equipment shall comply with relevant parts of BS EN 61851.

All plugs, socket-outlets, vehicle connectors and vehicle inlets used shall be BS EN 62196 compliant, BS 1363-2 with appropriate "EV" labelling or BS EN 60309-2 with appropriate interlocking. Any sockets-outlets or connectors that permit charging modes 3 and 4 shall be provided with mechanical interlocks to prevent disconnection while charging is occurring.

Where any charging equipment is built into switchgear, all relevant equipment shall comply with BS EN 61439-7.

12.5.2 PROTECTION AGAINST THERMAL EFFECTS, OVERCURRENT, EARTH LEAKAGE. AND ENVIRONMENTAL FACTORS

Overcurrent protection shall be provided by an individual device at every charging point.

RCD protection shall be installed in accordance with Section 8.8 which shall include protection against d.c faults.

Equipment to be installed in public areas or areas with higher exposure to damage from impact shall be provided with mechanical protection through the use of equipment location (positioned to avoid damage from reasonably foreseeable impacts), protective bollards, barriers or an appropriately rated equipment enclosure for medium impact in accordance with BS EN 62262.

All outdoor installations, installations subject to the presence of water or foreign materials shall use equipment with a minimum IP 44 degree of protection.

12.5.3 PROTECTIVE EARTHING AND BONDING

All new installations shall comply with Sections 8 and 5.2.9.

NOTE: *In the case of making additions or alterations to existing older installations with legacy earthing systems that do not comply with Sections 8 and 5.2.9 (particularly those without an earth electrode or if the neutral and earth conductors are combined), additional protection may be required to automatically disconnect the supply if the voltage between the circuit protective conductor and earth is greater than 70 V. This additional protection may be provided by internal capabilities of the charging equipment.*

13 TESTING AND INSPECTION

13.1 GENERAL

Every installation and every major alteration to an existing installation, shall on completion and before being energized, be inspected and tested to verify compliance with these Regulations.

Test instruments used for such testing should comply with the requirements of BS EN 61557 or an equivalent standard, be fit for the intended purpose and be in a suitable condition for safe and accurate testing. Before carrying out any tests, test instruments should be checked to ensure that they are correctly set, functional and in good condition. Contact probes and leads should be checked for damage to insulated parts, continuity and sound connections.

Testing equipment shall have sufficient accuracy to ensure the installation complies with required values but should not exceed a maximum instrument basic error tolerance of 5%. Examples of methods to confirm accuracy include either one or a combination of the following minimum requirements:

- Calibration test by independent tester at regular intervals but at least every 12 months or earlier if specified by the equipment manufacturer
- Test and record results against a range of resistors of known values (such as a “checkbox”) on at least a monthly basis.

NOTE: Calibration tests only confirm accuracy at the time of the calibration test so more frequent tests against known resistances are recommended.

13.2 VISUAL INSPECTION

A visual inspection shall be carried out to verify if the installation is in accordance with approved drawings and the execution of the work and workmanship and the installation methods adopted meet the requirements of these Regulations.

13.3 COLOUR IDENTIFICATION

It shall be verified that the correct colour identification has been adopted for all wiring and the fuses and switches are connected in the live conductors only and links or linked-switches are connected in the neutral conductor.

13.4 EARTH-CONTINUITY TEST

Earth-continuity test shall be carried out between the consumer's earthing terminal and the remote end of all earth-continuity and equipotential bonding conductors.

The resistance value obtained shall not exceed 0.5 Ω .

NOTE: Earth continuity tests can be carried by using a test lead to connect to the far end of the earth/bonding conductor and all other parts required to be earth one at a time. The test lead must be first zeroed.

13.5 INSULATION RESISTANCE TEST

Insulation resistance test shall be carried out on the installation. For purpose of these tests large installations may be divided into groups each containing 50 outlets. A 500 V d.c test voltage shall be applied.

The insulation resistance to earth shall not be less than 1 MΩ, when measured with all poles and phases of wiring connected together, and switches and fuses all in place. The insulation resistance when measured between all the conductors connected to any one pole or phase of the supply and in turn all conductors connected to each other pole or phase, shall not be less than 1 MΩ.

13.6 CONTINUITY TEST

Test shall be made to verify the continuity of all conductors including the earth-continuity conductor of every ring circuit.

13.7 EARTH ELECTRODE RESISTANCE MEASUREMENT

Earth electrode resistance shall be carried out either by using the method described in Appendix VI or by using a hand held earth ground clamp meter. Where a clamp meter is used, the jaws of the clamp meter shall be placed around the electrode whilst the main earth conductor is still connected in order to measure the loop impedance of the electrode. The measured resistance shall not exceed 50 Ω provided the installation has as a maximum of a 100 mA RCD installed. Additional electrodes shall be provided where necessary to obtain this value.

NOTES:

1. *In good soil conditions, values between 10 and 50 Ω would typically be expected using the clamp meter method.*
2. *If tests are carried out in times when conditions don't represent typical site conditions (including excessively damp soil, the tests shall either have an appropriate safety factor applied to them to cater for seasonal variation or be repeated when conditions are more reflective of typical conditions.*
3. *Without limiting the requirements of Section 8.8 with respect to the used of RCDs, where installations are unable to use an RCD or do not have an earth reference provided by the Distribution Company in accordance with Section 5.2.9, lower earthing resistances may be required to ensure faults resulting in potentially hazardous step and touch potentials are automatically disconnected in a sufficiently fast time and shall be determined and verified accordingly. Acceptable earthing resistance values may be determined using the following condition:*

$Z_s \leq 240 \text{ Vac}/I_a$ where:

Z_s = total earth fault loop impedance (including the earth electrode resistance where no earth reference is provided by the distribution company)

I_a =current causing automatic disconnection within 400 ms (which can be determined using the below)

- *Type A and B MCBs are designed to automatically disconnect within 400 ms at 4X their pickup current*
- *Type C MCBs are designed to automatically disconnect within 400 ms at 7.5 X their pickup current*
- *Type D MCBs are designed to automatically disconnect within 400 ms at 12.5 X their pickup current*

Where equipotential bonding is not provided, clearance times of 200 ms are to be achieved.

4. *In practice, where an earth reference is not provided by the Distribution Company (as in the case of a four wire overhead supply, a single earth electrode system is likely to be inadequate due to its higher resistance and therefore not suitable for a non RCD protected installation.*

13.8 PROTECTION TEST

Tests shall be carried out to verify effective and correct operation of all earth leakage circuit-breakers or RCDs and overcurrent protection of circuit-breakers and fuse-links, and other protective devices.

NOTE: *RCD operating time test are recommended in addition to using the integral test device or “push button”.*

13.9 POLARITY TEST

Tests shall be carried out to verify the correct polarity of all wiring.

13.10 COMPLETION CERTIFICATE

Following the inspection and testing, a completion certificate in the attached format shall be submitted by the electrical contractor to the Distribution Company signed by contractor's Designer, Installer and Tester who have carried out the design, installation and verification of the installation as applicable. The installation will then be further inspected and tested by Distribution Company's electrical inspector and if found satisfactory, the installation will be permitted to be connected to supply. Two signed copies of the completion certificate shall be prepared with one being provided to the Distribution Company and the duplicate signed copy stored in the Main Switchboard.

NOTE: *The Designer, Installer and Tester certification responsibilities need not be carried out by three different signatories provided the signatory is a sufficiently competent person with respect required to qualifications and experience and the actual work carried out. As an example, where design, installation and testing duties are the responsibility of one person, a completion certificate with a single-signature declaration may replace the multiple signatures section of the model form. Alternatively the provided model completion certificate form may still be used with the one competent person populating multiple sections.*

13.11 PERIODIC INSPECTION AND TESTING

The owner or occupier of the premise or installation shall be responsible for the periodic inspection and testing of the electrical installation in accordance with these Regulations and any applicable building Codes or regulations. Tests shall include the following:

- Visual inspections
- Limited testing (where supply interruption can not be tolerated); or
- Full testing (where a supply interruption can be tolerated) which is the recommended method.

The responsible Tester carrying out the periodic inspection and testing shall leave a signed copy of the certificated in Appendix I in the Main Switchboard.

13.11.1 FREQUENCY OF INSPECTION AND TESTING

The maximum interval between inspection times for specific installations shall be as per the following table:

Table 4: Required Periodic Inspection Frequencies

Type of Workplace/Installations	Maximum Period between Inspection & Testing (Years)
Domestic	10 years or change of occupancy if sooner
Residential (flats, accommodation of multiple occupation including halls of residence, workers accommodation etc)	5 years or change of occupancy if sooner
Commercial, educational establishments, hospitals, accommodation, Offices, Shops, laboratories, restaurants, hotels, mosques, majlis and wedding halls	5
Industrial, agricultural, horticultural, cinemas, theatres/public entertainment, leisure complexes (excluding swimming pools), caravans, emergency lighting, Petrol stations	3
Caravan parks, marinas, laundrettes, swimming pools, fire alarms,	1
Construction sites, temporary installations	1 Month

The following inspection and testing activities and frequencies are recommended practices due to these appliances or installations being subject to higher risks of damage:

Table 5: Recommended Periodic Inspection Frequencies

Type of Test/Workplace/Installations	Maximum Period between Inspection & Testing (Years)
Class I/II fixed appliances installed in indoor locations and non-flexed cords (such as offices)	5
Class I/II appliances in residential installations	2
Visual Inspections for all installations, RCD push tests for all installations, Class I/II portable appliances/equipment, cord sets and outlet portable devices for all other installations	1
Class I/II portable appliances, extension cords, cord sets and outlet portable devices installed in workshop or factories, RCD push tests	6 Months
Push button test for Portable RCDs (PRCDs), Class I/II portable appliances for hire equipment	3 Months

NOTES:

1. Requirements under legislation or law for specific installations may call for more frequent or onerous tests which shall be carried out
2. RCD operating time test are strongly recommended every 12 months
3. The above times represent maximum frequencies (ie: longest time between inspection and testing). Certain installations with higher risks may require more frequent inspections.
4. Notwithstanding the maximum periods stated in the tables above, the minimum frequency of the periodic inspection and testing of an installation shall be assessed by taking into account the type of installation, the frequency of its operation and maintenance and any external influences.

Alternatives: Longer periods can be accepted where continuous monitoring regimes and preventative maintenance practices are undertaken.

13.11.2 VISUAL INSPECTION

Visual inspection activities shall include the following activities:

- Check for obvious damage/breakages, wear and deterioration, loose fixings, missing parts (covers, screw) defects including mechanical damage, fuse deterioration or insulation deterioration (any cuts or twists in the outer/inner sheath and cores) insulation discoloration (which may indicate exposure to heat, moisture or chemicals)
- Check for obvious signs of modifications not covered by supplementary completion certificates
- Appropriate labelling and equipment clearances
- Correct enclosures securing such as locks or requiring a tool for access
- Correct equipment spacing/access and no obstructions
- Appropriate IP ratings for equipment in damp areas in accordance with Section 12.1
- Name plate and rating of the equipment is appropriate (including that Appliance ratings don't exceed the circuit protection)
- For portable appliances check cover guards, inlets and exhausts are unobstructed.

NOTE: Stand-alone annual visual inspections need not be carried out by Licensed Electricians

13.11.3 LIMITED TESTING ACTIVITIES

The following inspection and testing activities shall be undertaken for installations that cannot tolerate a disconnection of supply:

- Visual inspection as per Section 13.2
- Conductors appropriately secured and fastened
- Correct RCD protection for the relevant circuit
- Neutral bars with correct insulated fittings
- Correct sizing and termination of earth conductors
- Leakage current test (which can be done by a clamp test device while test circuit is in service)
- Correct function of protective device as per Section 13.8 (for circuits that can tolerate a supply interruption)
- Correct earth connection for fixed Class I appliances
- Polarity tests as per Section 13.6
- Earth conductor resistance test using the clamp method in accordance with Section 13.7.

13.11.4 FULL TESTING ACTIVITIES AND PORTABLE APPLIANCE TESTS

The following inspection and testing activities shall be undertaken for installations that can tolerate a disconnection of supply:

- Visual inspection as per Section 13.2
- Conductors appropriately secured and fastened
- Correct RCD protection for the relevant circuit
- Neutral bars with correct insulated fittings
- Correct sizing and termination of earth conductors
- Leakage current test (which can be done by a clamp test device while test circuit is in service)

- RCD testing
- Correct function of protective device as per Section 13.8 (for circuits that can tolerate a supply interruption)
- Polarity tests as per Section 13.6
- Correct earth connection for fixed Class I appliances
- Continuity of ring and circuit conductors
- Earth conductor resistance tests using the clamp method in accordance with Section 13.7.

NOTE: Careful consideration shall be given to installations that comply with values of the above tests but have reduced substantially from previous test results (where available). This potentially indicates a change in the installation that may warrant modification.

13.11.5 DEFECTS, NON-COMPLIANCE AND UNSATISFACTORY PERIODIC INSPECTIONS

All defects and non-compliances with OES 4 shall be recorded by the Tester in the relevant section of the period inspection certificate and report. Where an installation is found to have a defect or non-compliance which cannot be left as it results in a danger being present and the safety of those using the installation is at risk, the Tester shall make the installation safe on discovery where practical and shall immediately notify the owner or occupier. The installation may be made safe by either repairing, replacing damaged equipment, remedying the defect through other means or isolating the relevant part of the installation and appropriate tagging or labelling as to the reason for isolation.

Such examples of a “danger present” defect may include but not be limited to exposed live parts, arcing equipment or incorrect polarity.

13.11.6 PERIODIC INSPECTION OF INSTALLATIONS CONSTRUCTED TO EARLIER EDITIONS OF OES 4.

All periodic inspections should be carried out to the most current version of OES 4. Where non-compliances are found to the most current version of OES 4 but complied with the OES 4 edition that was current at the time of construction, such non-compliances must be remedied only where they present a material danger and are unsafe or the safety of the installation cannot be verified. Such an example is the use of an obsolete voltage operated style ELCB. While the ELCB may still operate correctly, in practical terms the Tester is unlikely to have the appropriate equipment to test and verify operation and all ELCBs should therefore be replaced with an RCD.

**APPENDIX I-COMPLETION AND PERIODIC INSPECTION CERTIFICATE/REPORTS
(MODEL FORMS)**

Electrical Installation Details					
Installation Address			Client Details		
Description of Premises:	Domestic <input type="checkbox"/>	Commercial <input type="checkbox"/>	Industrial <input type="checkbox"/>	Other <input type="checkbox"/>	
Description of Installation:	New <input type="checkbox"/>	Modification/ Alteration <input type="checkbox"/>	Addition to Existing <input type="checkbox"/>		
EXTENT AND LIMITATIONS OF THE INSPECTION					
Extent of electrical installation covered by this report:					
.....					
.....					
.....					
.....					
.....					
.....					
Designer Details and Declaration					
Details of Designer			Contact Details		
<i>I/we hereby declare that the work completed by myself/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 Oman Electricity Wiring Regulations (OES 4) published by the Authority for Electricity Regulation, Oman</i>					
Qualifications/License No:			Company Details		
Authorisation Signature			Date		
Installer/Construction Details and Declaration					
Details of Installer			Contact Details		
<i>I/we hereby declare that the work completed by myself/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 Oman Electricity Wiring Regulations (OES 4) published by the Authority for Electricity Regulation, Oman</i>					
Qualifications/License No:			Company Details		
Authorisation Signature			Date		
Installation Installed in accordance with drawings?	Yes <input type="checkbox"/>	No <input type="checkbox"/>			
		If no differences:			

	
Installation		Comments:
.....		
Inspection and Testing Details and Declaration		
Details of Tester Contact Details <i>I/we hereby declare that the work completed by myself/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 Oman Electricity Wiring Regulations (OES 4) published by the Authority for Electricity Regulation, Oman</i> Qualifications/License No: Company Details Authorisation Signature Date		
Form A Particulars completed and attached?	Yes <input type="checkbox"/>	N/A <input type="checkbox"/>
Form B Particulars completed and attached?	Yes <input type="checkbox"/>	N/A <input type="checkbox"/>
System Supply and Source Characteristics:		
Incoming supply details Prospective Fault Current Supply Rated Current Main Incoming Protection Devices Service Connection Category Any Loads not protected by RCDs:		
Inspection		Comments:
.....		
Next Inspection not more than: Years/Months (circle appropriate time)		

FORM A (for Completion Certificate)

DESIGNER:									
Test Date:									
Installation Details:									
Circuit. No.	Description	No.	Installed Capacity (kW)	P.F	Maximum Demand (kW)	Phase Connected	kW		Current (A)
							Unit	Total	
	Light Points								
	Air conditioners								
	Fans								
	Single phase motors								
	Three phase motors								
	Water heaters								
	Refrigerators								
	Freezers								
	Cookers								
	Socket outlets								
	Other loads								
Total Installation Maximum Demand					kW	kVA	Current (A)		-
									-
Total Load Phase Balance					Red (kW)	Yellow (kW)	Blue (kW)		-
									-

Tester:

Test Date:

Installation Details

Circuit No/Description	Circuit Rating (A)	Connected Load/Maximum Demand	Colour Identification	Earth Continuity (Ω)	Ring Continuity (Ω)	Insulation Resistance (live/live) (MΩ)	Insulation Resistance (live/Earth) (MΩ)	Polarity	RCD Functional Test	Other Protective Device Functional Test	Earth Electrode Resistance (Ω)	Notes/Comments:

NOTES:

1. Insulation resistance to be done for all phases — with all poles & phases connected together and switches, fuses and breakers all in place. With all conductors on one phase connected together and intern, all conductors connected to each other.

2. Continuity checks to be done for all earth and conductors in ring circuits for socket-outlets

3. Include test equipment details in Notes/Comments

PERIOD INSPECTION CERTIFICATE AND REPORT

Electrical Installation Details

Installation Address Client Details

This certificate covers the following type of inspection (tick one of the below boxes)

- Visual inspection
- Limited Testing
- Full Testing
- Portable Appliance Testing

DETAILS OF THE INSTALLATION Tick boxes as appropriate

Description of Premises:	Domestic <input type="checkbox"/>	Commercial <input type="checkbox"/>	Industrial <input type="checkbox"/>	Other <input type="checkbox"/>
.....				
Estimated age of the Electrical Installation:		 years	
Evidence of Additions or Alterations:			Yes <input type="checkbox"/>	No <input type="checkbox"/>
If "Yes", estimate age: years			
Date of last inspection:	Records available	Yes <input type="checkbox"/>	No <input type="checkbox"/>

EXTENT AND LIMITATIONS OF THE INSPECTION

Extent of electrical installation covered by this report:

.....

.....

.....

.....

Limitations:

.....

.....

.....

Visual	Inspection	Comments:
.....		
.....		
.....		
.....		

Defects, non-compliances requiring urgent action, recommended improvement or further investigation (Tester to specify classification of each defect/non-compliance):

.....

.....

.....

.....

.....

.....

.....

.....

Inspection and Testing Details

Details of Tester

Contact Details

I/we hereby declare that the work completed by myself/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 Oman Electricity Wiring Regulations (OES 4) published by the Authority for Electricity Regulation, Oman

Qualifications/License No:

Company Details

Authorisation Signature

Date

I/We recommend that this installation is further inspected and tested after an interval of not more than years/months, provided that any observations 'requiring urgent attention' are attended to without delay

APPENDIX II-RECOMMENDED ILLUMINATION LEVELS

Table 6: Recommended Illumination Levels



















AREA	LUX	AREA	LUX
GENERAL BUILDING AREAS		OFFICES AND SHOPS	
CIRCULATION AREAS		DRAWING OFFICES	
Corridors, passage ways	100	Drawing Boards	750
Lifts	150	Reference tables and general	500
Stairs	150	Printing Room	300
Escalators	150		
		SHOPS	
ENTRANCES		Conventional with counters	500
Entrance halls, Lobbies waiting rooms	150	Conventional will all displays	500
Enquiry Desks	500	Self-service	500
Gate houses	300	Super-markets	500
KITCHENS		SHOW-ROOMS	
Food Stores	150	Car	500
General	500	General	500
MEDICAL & FIRST AID CENTRES		PUBLIC & EDUCATIONAL BUILDINGS	
Consulting Rooms,		ASSEMBLY AND CONCERT HALLS, CINEMAS AND THEATRES	
Treatment areas	500	Auditorium	100
Medical stores	100	Theatres and concert halls	100
Rest Rooms	150	Cinemas	50
		Multi-purpose	500

OUT-DOORS		Booking offices	300
Entrance and Exits	50	Dressing rooms	300
		Platforms and stages	Special lighting
STAFF RESTAURANTS		Projection rooms	150
Canteens, Cafeterias, Dining Rooms	300		
		LECTURE THEATRES	
STAFF ROOMS		General	300
Changing Room, Cloak Rooms	150	Chalkboard	500
Rest Rooms	150	Demonstration benches	500
Stores	150	Examination halls, seminar rooms, lecture halls	500
		Art Rooms	500
TELECOMMUNICATIONS		Laboratories	500
Cord Switchboard Rooms	500		
Apparatus Rooms	150		
Teleprinter Rooms	500		
CAR PARKS			
Underground	50		
Multi-storey parking floors	50		
Ramps	75		

GOVT. PUBLIC AND EDUCATIONAL BUILDINGS		HOTELS	
LIBRARIES		Entrance Halls	
Shelves, book stack	150	General	75
Study tables	300	Reception, Cashier	300
		Public Rooms	
READING ROOMS		Coffee Bars	150
Newspapers & Magazines	300	Dining Rooms, Restaurants	
Reference libraries	500	General	100
Counters	500	Baggage Rooms	100
Cataloguing & sorting	500	Laundries	300
Binding	500	Cellars	150
Book stores	100	Dining rooms, cash desks	300
		Lounges	100
MUSEUMS AND ART GALLERIES		Writing Rooms	150
Exhibits insensitive to light	300	Cloak Rooms	150
Light sensitive exhibits	150		
Specially light-sensitive exhibits	50	INDOOR SPORTS, GAMES	
		Billiard Rooms	
HOME AND HOTELS		General	100
HOMES		Table	Special
Living Rooms		Boxing ring	
General	50	Top	1000
Casual reading	150	Club	500
Sewing and darning	300	Gymnasium	500
Studies		Swimming pool	
Desk and prolonged reading	300	Top (water level)	500
Bedrooms		Spectator areas	150
General	50	Club Recreational	300
Bedhead	150	Tennis courts	

Kitchens		top	500
Working Area	300	Club	300
Bath Rooms	100	Recreational	150
Halls and landings	150	General	
Stairs	100	Changing rooms, showers, locker	150
Workshops	300		
Garages	50		

APPENDIX III-ELECTRICAL SYMBOLS

SYMBOL	DESCRIPTION
	Distribution Board incorporating MCB's or HRC Fuses.
	Main Switchboard
	M. C. B.
	Fuse
	Main Air Circuit Breaker.
	Isolating Switch
	Link
	Substation Transformer 11000/415 Volt.
	Switch Line (To connect up all outlets controlled by one Switch).
	Circuit Line (To connect up all outlets on the same Circuit).
	Clock outlet Point.
	Surface Trunking
	Cooker Control Unit.
	Low level cooker outlet connection unit.
	Exhaust Fan.
	Ceiling Mounted Fan.
	Ceiling Fan Regulator.
	Underfloor trunking.

SYMBOL**DESCRIPTION**

Telephone outlet for internal calls.



Telephone outlet for external calls.



Coaxial cable outlet for a television aerial.



Bell Push.



Bell (not associated with fire alarms).



Bell Transformer.



Water Heater (K.W. to be stated adjacent to symbol).



Fire Alarm Break Glass Manual Contact.



Fire Alarm Bell.



Fire Alarm Siren.



Fire Alarm automatic smoke detector.



Fire Alarm automatic heat detector.



Fire Alarm main indicator panel.



Earth connection.



Lightning conductor earthing pit.



Time Switch.



Photo Electric Cell.

SYMBOL

DESCRIPTION



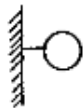
Flourescent tube light fitting ceiling mounted.
 (Fitting reference letter shall be shown in circle and detailed in legend, to give length of fitting and load rating plus the number of fluorescent tubes).



Flourescent tube light fitting — wall mounted.
 (Fitting reference letter shall be shown in circle and detailed in legend, to give length of fitting and load rating plus the number of fluorescent tubes).



Tungsten light fitting — ceiling mounted.
 (Fitting reference letter shall be shown in circle and described in legend, to give load rating of light fitting and number of lamps).



Tungsten light fitting — Wall mounted.
 (Fitting reference shall be shown in circle and described in legend to give load rating of light fitting and number of lamps).



Lighting Switch - 1 Way.



Lighting Switch - 2 Way.



Lighting Switch - Pull cord operated.



Lighting Switch - Key operated.



13 Amp switched socket outlet (domestic).



Industrial Switched Socket Outlet (state single phase or three phase and current rating).



20 Amp. double pole switch with indicator lamp.



20 Amp. double pole Switch.



30 Amp. double pole Switch.



30 Amp. double pole switch with indicator lamp.

NOTE ON THE ABOVE SWITCHES

If a lighting switch is located outside a building and exposed to weather conditions then the switch shall be of the weather proof type and be denoted by the letter "W" adjacent to the switch.

All light switches shall be assumed to be rated at 5 Amps. capacity unless otherwise stated.

APPENDIX IV-TABLES

Table 7: Current Carrying Capacity of Flexible Cords Insulated With Silicone Rubber

S. No.	Size of Cord (mm ²)	Current Rating for Single Phase a.c (A)	Maximum Mass that can be Supported by Twin Flexible cords (Kg)
1	1.0	7	3
2	1.5	11	4
3	2.5	15	5
4	4.0	18	5

Table 8: Current Carrying Capacity of P.V.C. Wires And Cables (Single Core) With Overload Protection

S. No.	Size of Cord (mm ²)	Two cables in One Trunking or Conduit for single Phase a.c (A)	Three of Four cables in One Trunking or Conduit for Three Phase a.c (A)
1	1.5	11	10
2	2.5	15	13
3	4.0	20	17
4	6	25	22
5	10	35	29
6	16	45	39
7	25	59	51
8	35	72	62
9	50	116	96
10	70	139	119
11	120	200	169

Group Rating Factor :

No. of circuits	2	3	4	5	6
Rating Factor	0.8	0.7	0.65	0.6	0.57

Table 9: Current Carrying Capacity of Twin & Multi-Core P.V.C. Insulated Armoured Cables

Cable size in mm ²	Clipped direct to a surface or on a cable tray	
	One two core cable single phase (a.c or d.c A)	One three or four core cable three phase (A)
4.0	22	19
6.0	28	24
10.0	39	33
16.0	51	44

Group Rating Factor :

No. of circuits	2	3	4	5	6
Rating Factor	0.8	0.7	0.65	0.6	0.57

Table 10: Current Carrying Capacity of Multi-Core XLPE Insulated P.V.C. Sheathed Cables Copper Conductors

Cable Size (mm²)	Armoured cable clipped direct to a surface or on a cable tray unenclosed (A)	Armoured cable under ground direct burial ground temperature 35 °C soil resistivity 200 MW/cm per °C (A)
4.0	27	32
6.0	35	38
10.0	48	53
16.0	64	68
25.0	87	89
35.0	106	107
50.0	127	126
70.0	161	155
95.0	197	185
120.0	226	209
150.0	258	232
185.0	280	261
240.0	343	298
300.0	387	329

Group Rating Factor :

No. of circuits	2	3	4	5	6
Rating Factor	0.8	0.7	0.65	0.6	0.57

Table 11: Current Carrying Capacity of Twin & Multi-Core Mineral Insulated Cables

Nominal cross sectional area of conductors (mm ²)	Cables exposed to touch			Cables having overall PVC covering		
	Two core single phase a.c and d.c (A)	One twin cable single phase a.c and d.c (A)	One three core phase (A)	Two core single phase a.c and d.c (A)	One twin cable single phase ac and d.c (A)	One three core phase (A)
1.0	15	12	10	17	13	11
1.5	18	15	12	20	17	14
2.5	25	20	16	27	22	18
40	31	26	22	35	29	25
60	40	33	-	44	37	-
100	54	-	-	60	-	-

Group Rating Factor :

No. of circuits	2	3	4	5	6
Rating Factor	0.8	0.7	0.65	0.6	0.57

Table 12: Spacing of Supports for Cables

Overall dia of cable	Maximum Spacing of Clips, Cleats or Saddles					
	Non-armoured rubber P V C sheathed cables		Armoured cables		Mineral insulated copper sheathed cable with or without PVC covering	
	Horizontal (mm)	Vertical (mm)	Horizontal (mm)	Vertical (mm)	Horizontal (mm)	Vertical (mm)
Not exceeding 10 mm	300	400	-	-	600	800
Exceeding 10 mm but not exceeding 20 mm	300	400	350	450	900	1200
Exceeding 20 mm but not exceeding 40 mm	400	500	450	600	-	-
Exceeding 40 mm	600	800	600	800	-	-

Table 13: Minimum Internal Radii of Bends for Cables in Fixed Wiring

Insulation type	Armored or unarmoured	Overall diameter (mm)	Multiplication factor to be applied to overall diameter of cable to determine minimum internal bending radius
PVC with circular stranded copper conductors		Not exceeding 25 mm	4
		Exceeding 25 mm	6
XLPE multicore with shaped copper conductors	Armored	Any	8
Mineral	Copper sheath with or without PVC covering	Any	6

Table 14: Minimum Sizes of Earth-Continuity Conductors and Bonding Leads

Cross sectional area of largest conductor (mm ²)	Cross sectional area of earth-continuity conductor (mm ²)	Cross sectional area of bonding lead (mm ²)
1.5	1.5	4.0
2.5	2.5	4.0
4.0	4.0	4.0
6.0	4.0	6.0
10.0	6.0	6.0
16.0	6.0	6.0
25.0	16.0	10.0
35.0	16.0	10.0
50.0	25.0	16.0
70.0	35.0	35.0
95.0	50.0	50.0
120.0	50.0	50.0
150. and above	70.0	70.0

Table 15: Capacities of Both Galvanised Metal and High Impact Rigid P.V.C. Conduits

Cable size (mm ²)	Conduit Size									
	16 mm		20 mm		25 mm		32 mm		50 mm	
	A	B	A	B	A	B	A	B	A	B
1.5	5	3	9	6	-	11	-	-	-	-
2.5	4	2	6	4	-	8	-	-	-	-
40	3	2	4	3	8	6	-	-	-	-
6	2	-	3	2	6	4	11	8	-	-
10	-	-	2	-	3	2	6	4	-	10
16	-	-	2	-	3	2	5	3	-	9
25.0	-	-	-	-	2	-	3	2	8	5
35.0	-	-	-	-	-	-	3	-	6	4
50.0	-	-	-	-	-	-	2	-	4	3
70.0	-	-	-	-	-	-	-	-	3	2

A - Maximum number of cables in straight runs without bends,

B - Maximum number of cables in runs with two bends or the equivalent. Where runs include additional bends, tees or other restrictions, the numbers must be appropriately reduced

Table 16: Maximum Number of P.V.C Cables That May be Installed in Surface Mounted Metal or P.V.C Trunking

Trunking Sizes	Cable Sizes										
	1.5	2.5	4.0	6.0	10	16	25.0	35.0	50.0	70.0	95.0
	7/0.5	7/0.67	7/0.85	7/1.04	7/1.35	7/1.70	7/2.14	19/1.53	19/1.78	19/2.14	19/2.52
38 X 38	71	55	39	25	14	12	8	6	5	3	3
50 X 38	92	70	50	34	20	16	10	8	6	5	3
50 X 50	123	90	67	45	28	23	15	11	8	6	5
75 X 50	185	140	101	70	43	34	22	17	12	9	7
75 X 75	278	215	152	105	65	52	34	26	19	15	11
100 X 50	247	190	135	95	58	46	30	23	17	13	10
100 X 75	370	285	203	145	88	70	46	35	26	20	15
100 X 100	494	385	271	190	118	94	62	47	35	26	21
150 X 50	370	285	203	145	87	69	46	34	26	19	15
150 X 75	556	425	304	215	130	104	69	52	38	29	23
150 X 100	741	570	406	285	174	139	92	69	52	39	31
150 X 150	112	850	609	445	270	212	140	105	83	60	47
225 X 100	1112	850	609	440	270	212	140	105	83	60	47

Table 17: Maximum Number of Cables That May be Installed in Underfloor Trunking

Trunking Sizes	Cable Sizes										
	1.5	2.5	4	60	100	16	25	35	50	70	95
	7/0.5	7/0.6	7/0.85	7/1.0	7/1.35	7/1.7	7/2.1	19/1.53	19/1.7	19/2.1	19/2.5
50 X 25	48	38	26	20	13	9	6	4	3	2	2
75 X 25	72	57	39	30	19	14	9	7	5	4	3
100 X 25	96	76	52	41	26	19	12	9	7	5	4
150 X 25	144	115	79	61	39	28	19	14	10	8	6
50 X 38	72	57	39	30	19	14	9	7	5	4	3
75 X 38	108	86	59	46	29	21	14	11	8	6	4
100 X 38	144	115	79	61	39	28	19	14	10	8	6
150 X 38	216	172	118	92	59	43	28	21	16	12	9

Table 18: Number of Cables that may be Installed in Cable Trays

Multi-core and Single Core Cables	
Ventilated Cable Tray	The sum of the diameters of all cables installed shall not exceed 60 percent of the cable tray width and the cables shall be installed in a single layer.
Solid Bottom Cable Tray	The sum of the diameters of all cables installed shall not exceed 50 percent of the cable tray width and the cables shall be installed in a single layer.

APPENDIX V-FIGURES AND DRAWINGS

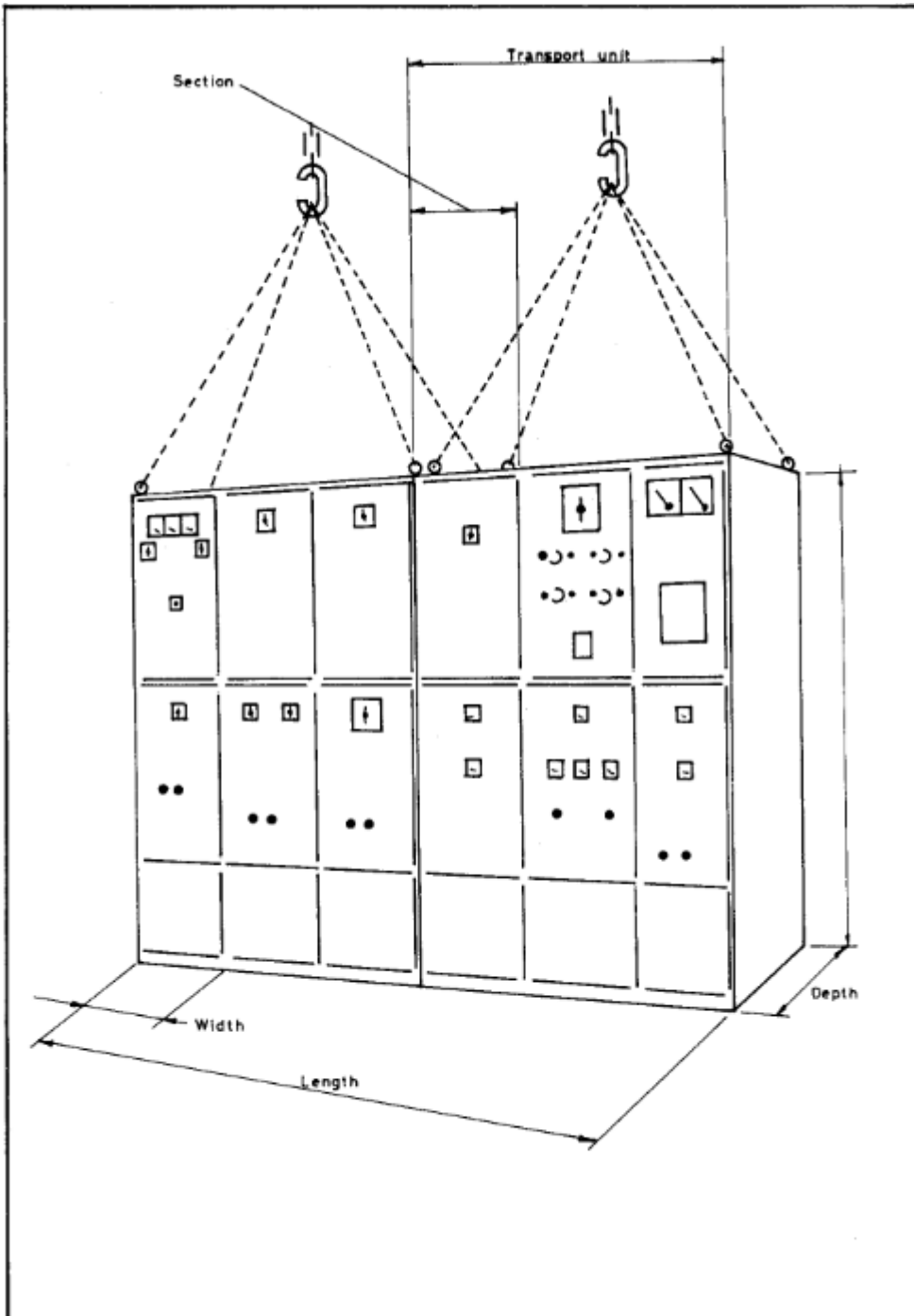


Figure 3: Multi-cubicle type FBA

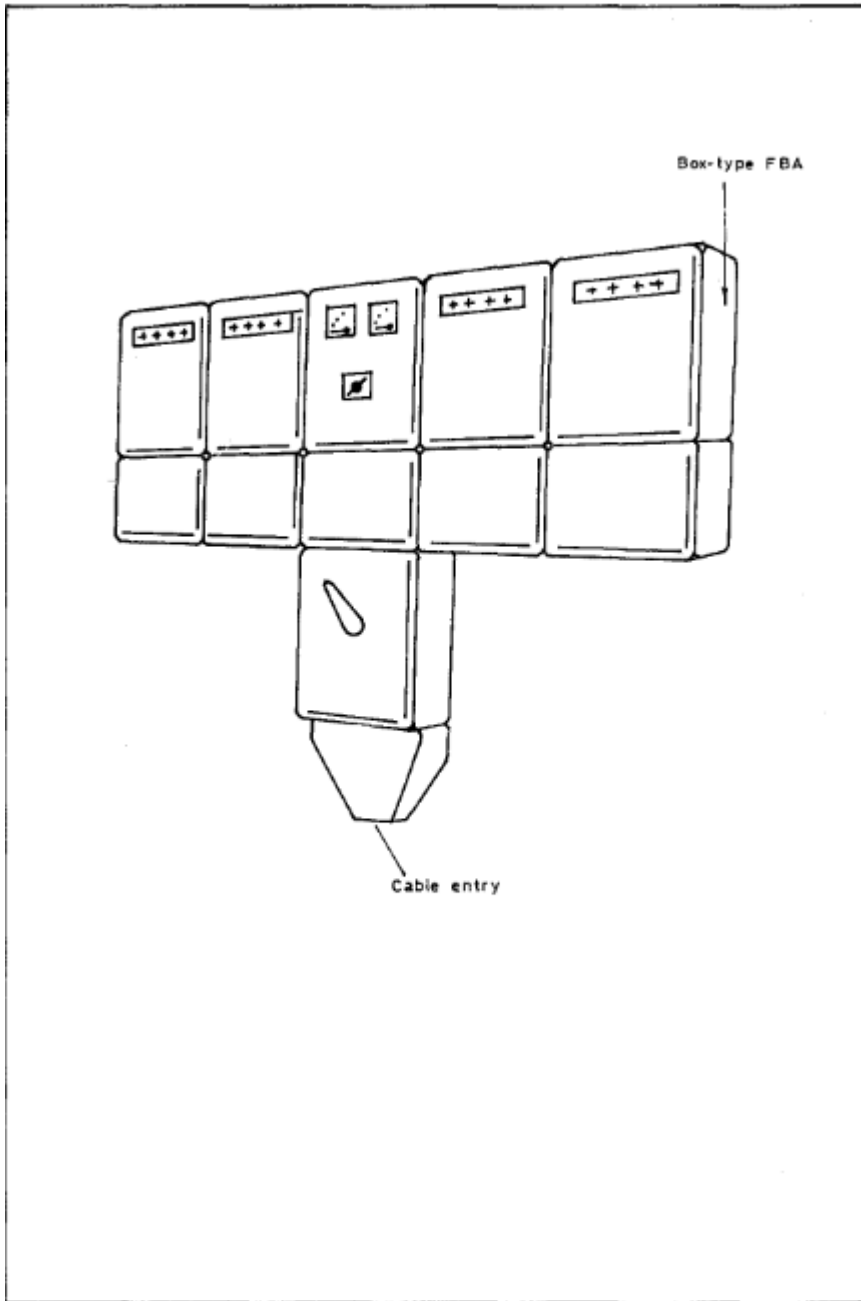


Figure 4: Multi-box type FBA

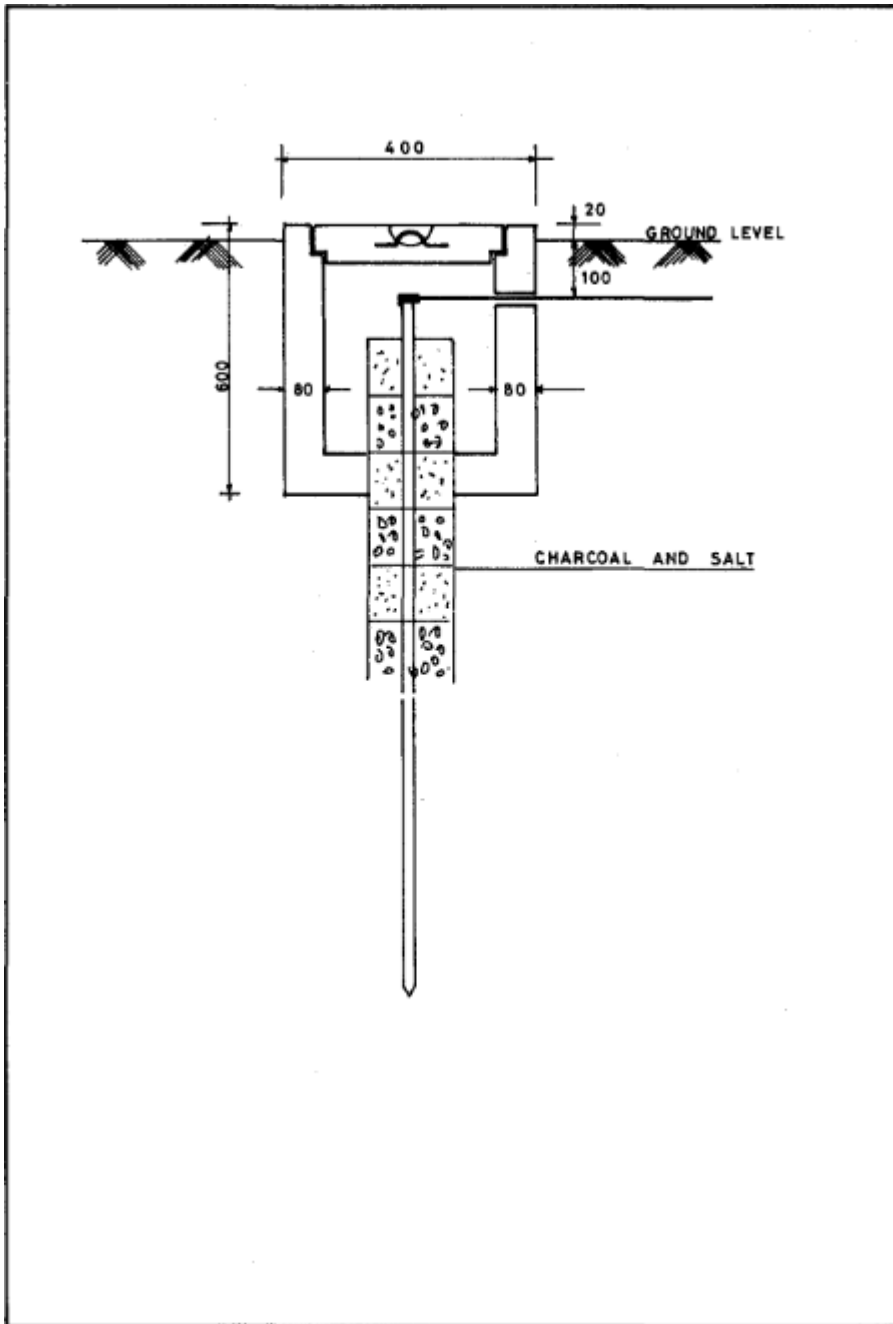


Figure 5: Earth pit

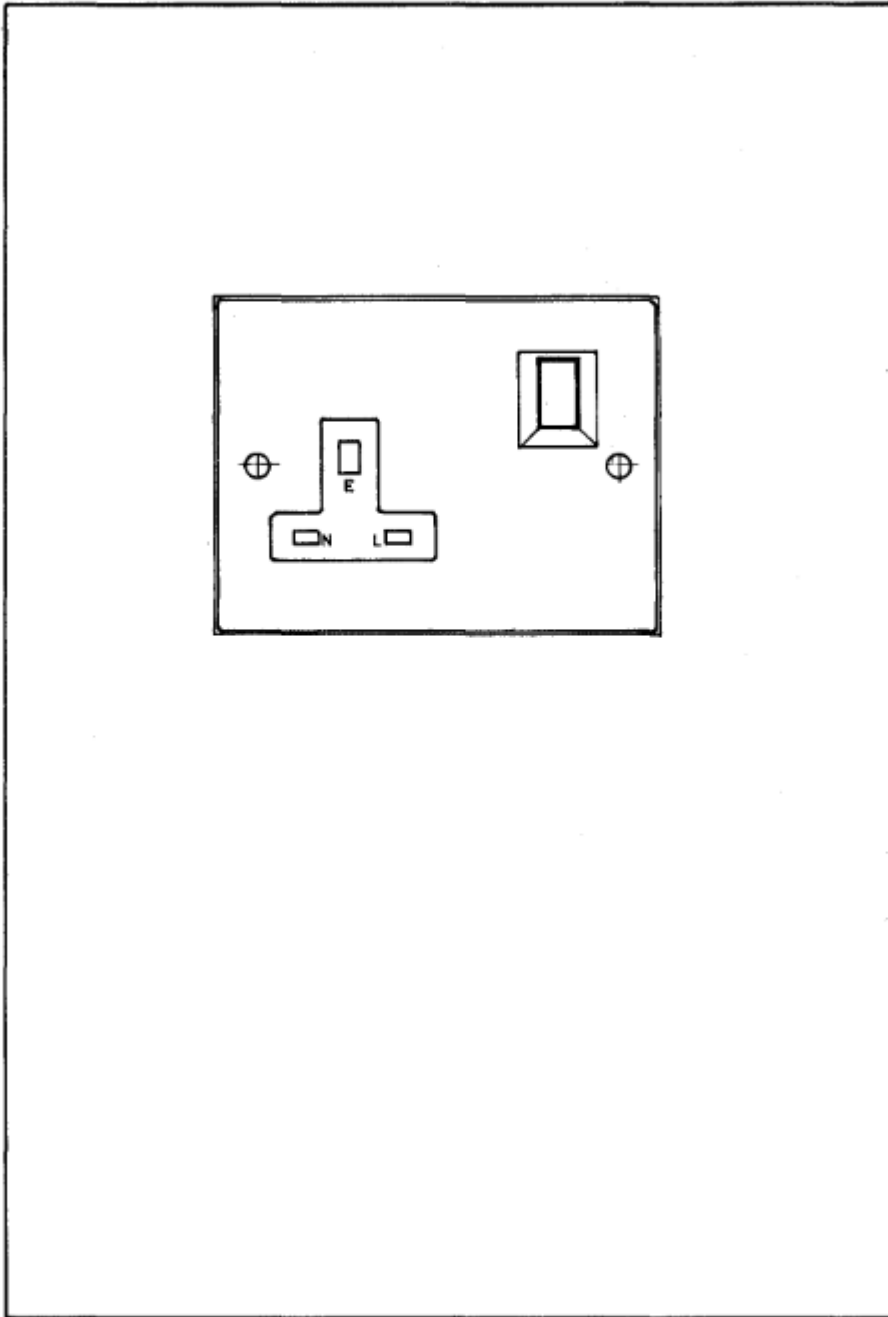


Figure 6: Identification of contacts for 13 Amps switched socket-outlet domestic

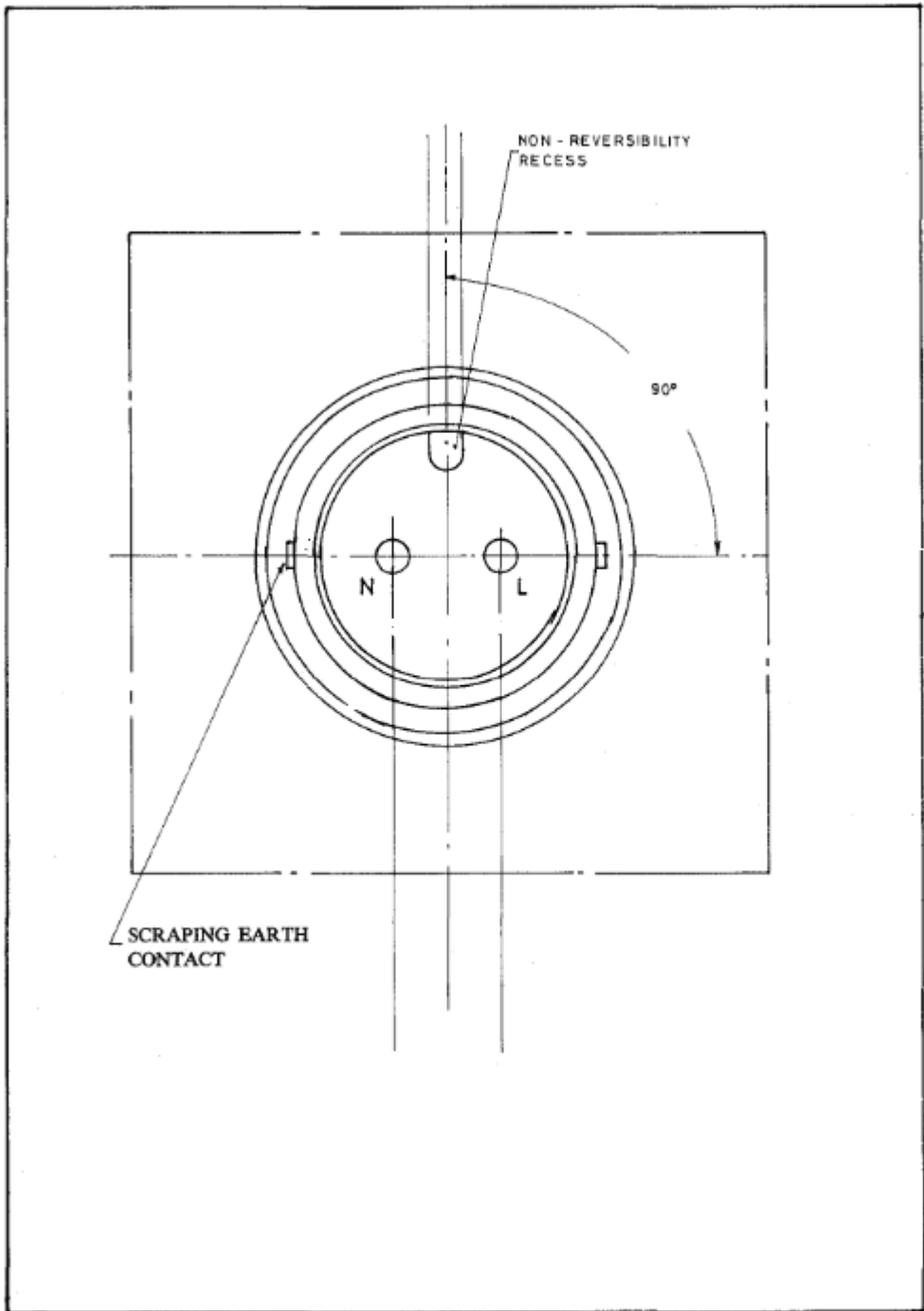


Figure 7: View looking at the front of an industrial single phase socket-outlet

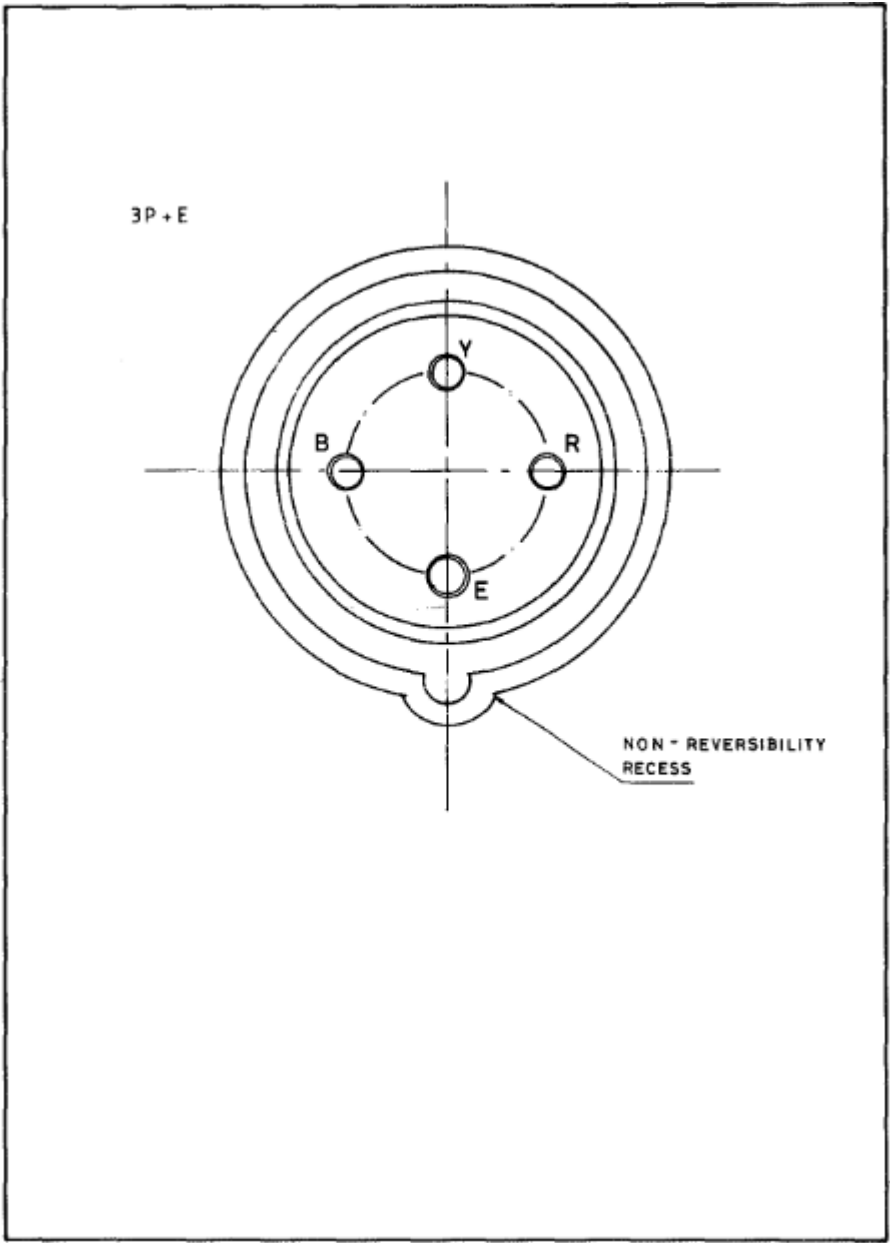


Figure 8: View looking at the front of an industrial three phase socket-outlet with no neutral connection

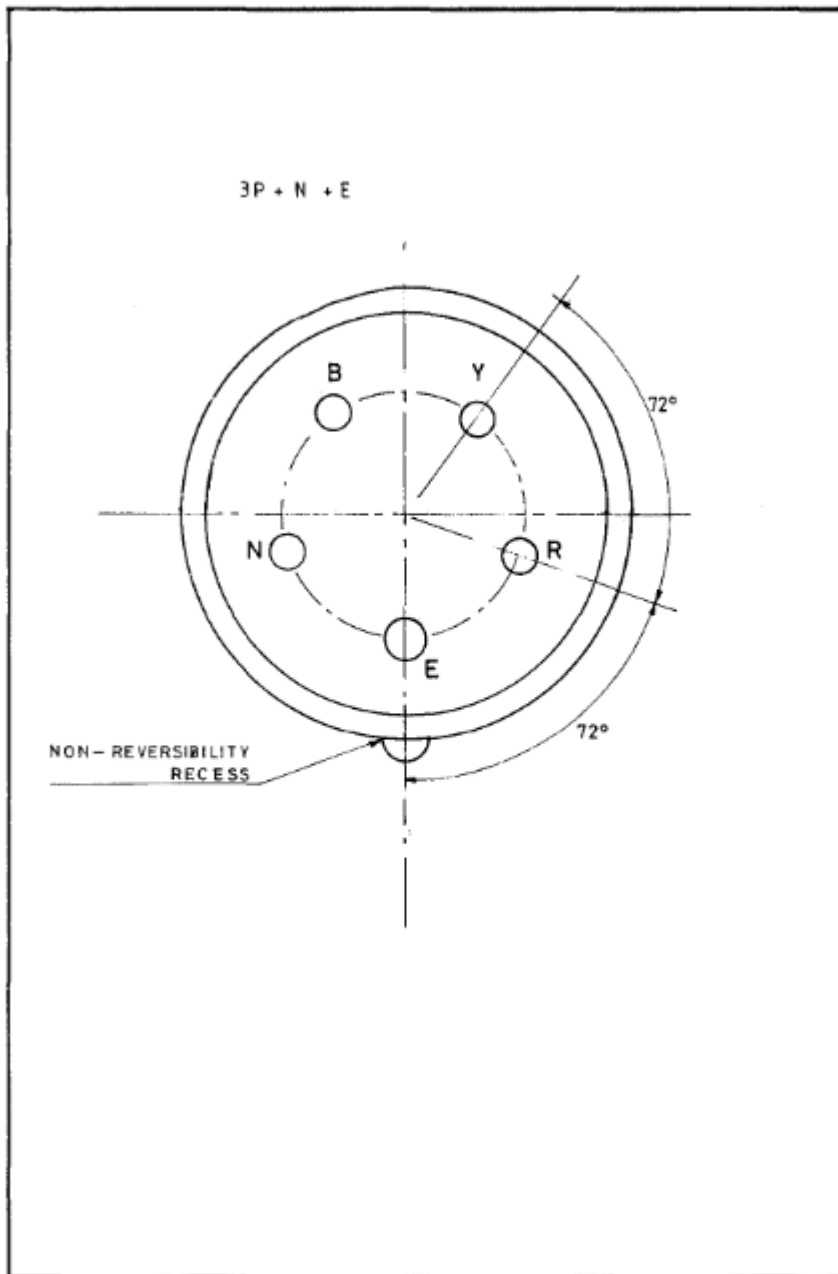
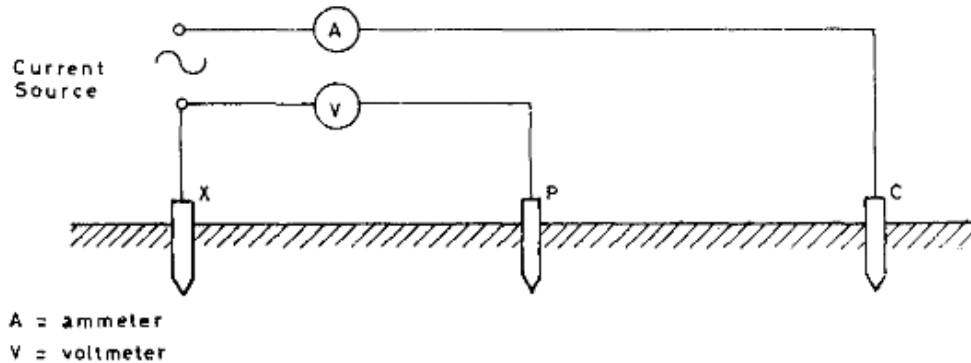


Figure 9: View looking at the front of an industrial three phase socket-outlet with a neutral connection

APPENDIX VI-MEASUREMENT OF CONSUMER'S EARTH ELECTRODE RESISTANCE

The procedure for measurement is illustrated in the diagram below .



A measured current is passed between the electrode X under test and an auxiliary electrode C (current electrode) placed at such a distance from X that the resistance areas of the two electrodes do not overlap. A second auxiliary electrode P (potential electrode) is placed half way between X and C and voltage between X and P measured. The resistance of the test electrode is then the voltage between X and P divided by the current flowing between C and X. To check if the measured resistance is a true value two further readings are taken with the electrode P moved 6 metres further and 6 metres nearer to X. If three readings substantially agree, then the mean of the three readings is taken as the resistance of the test electrode. If the readings differ, then the electrode C must be moved further away and the test repeated.

The auxiliary electrodes are usually steel or copper-weld steel rods driven upto 80 cm into the ground. The electrode C may be placed some 30 to 50 metres from the test electrode X and the electrode P placed midway between.

If the test is made at power frequency (50 Hertz) a double wound transformer is used to isolate the test from the power mains. In this case the resistance of the voltmeter must be high (of the order of 200 ohms per volt).

Stray currents in the soil can produce serious errors in the measured value, and their elimination becomes extremely difficult, if the testing current is of the same frequency as the stray currents.

It is therefore recommended that an earth tester incorporating a hand driven generator be used in preference to mains power source. The earth testers usually generate direct current and have a rotary current-reverser and synchronous rectifier mounted on the generator shaft so that alternating current is supplied to the test circuit and the resulting potentials are rectified for measurement by a direct reading moving coil ohm-meter. The presence of stray currents in the soil is indicated by the wandering of the instrument pointer; but an increase or decrease of generator handle speed will cause this to disappear.

APPENDIX VII-REFERENCED INTERNATIONAL STANDARDS

The following documents are referenced in this standard:

Table 19: Referenced International Standards

BS HD 60269-3	Low-voltage fuses. Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications).
IEC 60245	Rubber insulated cables - Rated voltages up to and including 450/750 V
IEC 60529	Degrees of protection provided by enclosures (IP Code)
BS EN 60664	Insulation coordination for equipment within low-voltage systems
BS EN 60332	Tests on electric and optical fibre cables under fire conditions.
BS EN 61034	Measurement of smoke density of cables burning under defined conditions.
BS EN 60754	Test on gases evolved during combustion of materials from cables
BS EN 60898	Electrical accessories ± Circuit breakers for overcurrent protection for household and similar installations. Circuit-breakers for a.c. operation
BS 476	Fire tests on building materials and structures
BS 7211	Electric cables. Thermosetting insulated and thermoplastic sheathed cables for voltages up to and including 450/750 V for electric power and lighting and having low emission of smoke and corrosive gases when affected by fire
BS EN 60702	Mineral insulated cables and their terminations with a rated voltage not exceeding 750 V
BS EN 6387	Test method for resistance to fire of cables required to maintain circuit integrity under fire conditions.
IEC 60811	Electric and optical fibre cables - Test methods for non-metallic materials
BS EN 61851	Electric vehicle conductive charging system
BS EN 60831	Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1000 V. General. Performance, testing and rating. Safety requirements. Guide for installation and operation
BS EN 60838	Miscellaneous lamp holders.
BS EN 61921	Power capacitors. Low-voltage power factor correction banks
BS EN 61537	Cable management -Cable tray systems and cable ladder systems
BS EN 61048	Auxiliaries for lamps. Capacitors for use in tubular fluorescent and other discharge lamp circuits. General and safety requirements.
BS EN 61049	Specification for capacitors for use in tubular fluorescent and other discharge lamp circuits. Performance requirements.
BS EN 60598	Luminaires
BS 6231	Electric cables. Single core PVC insulated flexible cables of rated voltage 600/1000 V for switchgear and control gear wiring.
BS EN 62722-2-1	Luminaire performance. Particular requirements for LED luminaires
BS 5467	Electric cables. Thermosetting insulated, armoured cables of rated

	voltages of 600/1000 V and 1900/3300 V for fixed installations. Specification.
BS 6004	Electric cables. PVC insulated and PVC sheathed cables for voltages up to and including 300/500 V, for electric power and lighting.
BS EN 60401-3	Terms and nomenclature for cores made of magnetically soft ferrites. Guidelines on the format of data appearing in manufacturers catalogues of transformer and inductor cores
BS EN 50525-Series	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U).
BS EN 50214	Flat polyvinyl chloride sheathed flexible cables.
BS EN 61439-Series	Low-voltage switchgear and control gear assemblies
BS EN 60079-Series	Explosive atmospheres.
BS EN 60947-Series	Low-voltage switchgear and control gear.
BS EN 60085	Electrical insulation. Thermal evaluation and designation
BS EN 61008	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs)
BS EN 60669	Switches for household and similar fixed-electrical installations.
BS EN 62305	Protection against lightning. Risk management
BS EN 62031	LED modules for general lighting – Safety specifications
BS EN 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
BS EN 62196	Plugs, socket-outlets, vehicle connectors and vehicle inlets. Conductive charging of electric vehicles
BS EN 61010	Safety requirements for electrical for measurement, control and laboratory use.
BS 1363	13 A plugs, socket-outlets, adaptors and connection units
BS 1362	Specification for general purpose fuse links for domestic and similar purposes (primarily for use in plugs)
BS EN 60309	Plugs, socket-outlets and couplers for industrial purposes.
BS 67	Ceiling roses
BS 4363	Specification for distribution assemblies for reduced low voltage electricity supplies for construction and building sites
BS EN 61184	Lamp holders
BS EN 60432	Incandescent lamps. Safety specifications.
BS EN 60061	Lamp caps and holders together with gauges for the control of interchangeability and safety.
BS EN IEC 60238	Edison screw lampholders
BS EN 60400	Lampholders for tubular fluorescent lamps and starterholders
BS 4177	Cooker control unit
BS EN 61558	Safety of power transformers, power supplies, reactors and similar products. General requirements and tests
BS 4573	2 - Pin reversible plugs and shaver units
BS 4607	Non-metallic conduits and fittings for electrical installations.
BS EN 61386	Conduit systems for cable management
BS 4662	Boxes for flush mounting of electrical accessories
BS 6121	Mechanical cable glands

BS 7629	Electric cables. Specification for 300/500 V fire resistant, screened, fixed installation cables having low emission of smoke and corrosive gases when affected by fire.
BS 6708	Flexible cables for use at mines and quarries
BS 8519	Selection and installation of fire-resistant power and control cable systems for life safety and fire-fighting applications – Code of practice
BS EN 81	Safety rules for the construction and installation of lifts. Lifts for the transport of persons and goods

APPENDIX VIII-DIVERSITY FACTORS

Whilst the maximum current in a circuit or electrical equipment must always be less than the current rating of the connection circuit protection and current carrying capacity of the conductors ensuring overload protection in accordance with Section 2.4.1, there are alternative ways to determine the maximum current in a given circuit. Whilst taking the sum of all connected loads as the maximum demand would provide a sufficiently conservative design, it may be appropriate to utilise diversity factors for certain installation types and loads.

For less standard installations where the Designer does not have a high degree of confidence regarding the nature of the loads, no diversity factor may be used and the maximum demand shall be taken to be the sum of all connected loads.

The following table provides some diversity factors

Table 20: Diversity Factors

Load Type	Diversity Factors			
	Single domestic installation/individual living	Domestic Blocks of living units	Non-domestic, Residential Installations	Factories, shops, stores, schools and mosques
Lighting	75%	75%	90%	90%
Socket outlets <13 A	50%			
Socket outlets connected appliance >13 A, (including laundry equipment and dishwasher)	Full Connected load	50%		
Fixed space heating,	Full Connected load	75%		
Spa and pool heaters	75%			
Communal lighting	N/A	Full connected load		
Cooker	Full Connected load	80%		
Motors (other than lifts)	Full load for first motor, 50% for subsequent motors	Full load for first motor, 50% for subsequent	Full load for first motor, 70% for subsequent	Full load for first motor, 70% for subsequent

		motors	motors	motors
Air-conditioning	90%	90%	80%	80%

NOTES:

1. *Alternative methods for commercial or light-industrial installation based on energy demand per given area for different load types may also be used where appropriate.*
2. *Allowances for diversity may vary between similar installations. The designer is responsible for selecting appropriate values representing the intensity of usage, operating characteristics, number and physical distribution of circuits.*
3. *Switchgear diversity factors may also be adopted where appropriate in accordance with IEC/BS EN 61439*