

SULTANATE OF OMAN

Ministry of Electricity & Water

REGULATIONS FOR ELECTRICAL INSTALLATIONS

SECOND EDITION

MAY 1989

INTRODUCTION

This first 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 MINISTRY OF ELECTRICITY AND WATER.

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 immediate effect.

NOTE : Some of the material in the current Electrical Installation Regulations of IEE, IEC, Kuwait, Bahrain and Abu Dhabi has been adapted as appropriate and applicable to the Sultanate. This is hereby acknowledged.

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SULTANATE OF OMAN
MINISTRY OF ELECTRICITY & WATER
REGULATIONS
FOR
ELECTRICAL INSTALLATIONS

SECTION 1

GENERAL

1.1 SCOPE

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

- a. Residential premises
- b. Commercial premises
- c. Public premises
- d. Industrial premises
- e. Agricultural and horticultural premises
- f. Prefabricated buildings
- g. Construction sites, exhibitions, fairs and other temporary installations.

The regulations cover :-

- a) Circuits supplied at nominal voltages upto 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 utilisation of electricity in and around buildings.

1.3 SUBMISSION OF DRAWINGS

Schematic and wiring diagrams, layout drawings and schedules of points with site layout should be submitted to the Ministry of Electricity and Water (MEW) before commencement of any electrical work whatsoever, large or small, new or additions, and work shall start only after due approval of the Ministry. All work shall be carried out in accordance with the approved drawings.

1.4 **INSPECTION**

All installation work will be subject to inspection and testing by the Ministry and will be connected to the power supply only after the work is checked and approved by the Ministry.

1.5 **ELECTRICAL SUPERVISION**

All electrical installation works shall be carried out by or under the direct supervision of a qualified electrical engineer or a supervisor holding a competency licence issued by the Ministry. Such competency licence will be issued after necessary tests and interview by the Ministry.

1.6 **STANDARDS, MATERIALS AND WORKMANSHIP**

The works shall be carried out in a neat and workmanlike manner to meet the requirements of these regulations. All materials used shall be the best of their respective kinds and shall comply with the latest relevant recommendations of the International Electrotechnical Commission (I.E.C.), if available, and if no IEC recommendation is available with the latest relevant British Standard Specification (B.S.S.).

1.7 **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 lampholder or ceiling rose.

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.

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.

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.

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 Ministry of Electricity and Water.

Consumer's terminals

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

Core (of a cable)

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

Dead

At earth potential and disconnected from any live system.

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.

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 consumer's 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.

Excess-current protection, close

Excess-current protection which will operate within four hours at 1.5 times the designed load current of the circuit it protects.

Devices affording close excess-current protection include

- (i) B.S. 88 fuses fitted with fuse-links marked to indicate a class P or class Q I fusing factor.
- (ii) Fuses fitted with fuse-links complying with B.S. 1361.
- (iii) Miniature and moulded-case circuit-breaker complying with B.S. 3871.
- (iv) Circuit breakers set to operate at an overload not exceeding 1.5 times the designed load current of the circuit.

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 4mm²

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.

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.

Live

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

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 B.S 476 — Fire tests on building materials and structures, Part 4 — Non-combustibility test for materials.

Oil-resisting and flame-retardant sheath (of a cable)

Oil-resisting and flame-retardant sheath complying with B.S 6899 (e.g. based on polychloroprene).

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.

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

Polyvinylchloride compound complying with B.S 6746/IEC 540.

XLPE (as insulation of cable)

Cross linked polyethylene complying with B.S. 5467/IEC 540.

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.

Shock current

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

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.

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.

Voltage

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

Low

Normally exceeding extra-low voltage but not exceeding 1000 volts A.C. or 1500 volts DC between conductors or 600 A.C. volts or 900 volts DC between conductors and earth.

Extra-Low

Normally not exceeding 50 volts A.C. or 100 volts D.C. whether between conductors or to earth.

SECTION 2

REQUIREMENTS FOR SAFETY

2.1 GENERAL PRINCIPLES

In electrical installations, two major types of risk exist :

- shock currents;
- excessive temperature likely to cause burns, fires and other injurious effects.

Persons and livestock shall be protected against dangers that may arise :

- a. from contact with live parts of the installation by :
 - appropriate measures to prevent contact;
 - limiting the value and duration of current which can pass through a body to a value lower than the shock current.
- b. from contact with exposed metal parts by one of the following methods :
 - preventing a fault current from passing through the body of any person or any live-stock;
 - 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 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 or livestock shall be protected against injury and property shall be protected against damage due to excessive temperatures or electromechanical stresses caused by overcurrents likely to arise in live conductors by :

- automatic disconnection on the occurrence of overcurrent before the overcurrent attains a dangerous value taking into 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.

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 EQUIPMENT AND MATERIALS

Every item of electrical equipment and materials shall comply with IEC/B.S.S. and be approved by MEW.

2.3 **INSTALLATION WORK**

For the erection of the electrical installation, good workmanship by suitably qualified personnel shall be provided. All work shall be carried out by MEW registered contractors.

2.4 **TESTS ON COMPLETION**

On completion of an installation or an extension or major alterations to an installation :

1. 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;
2. labels or other suitable means of identifications in Arabic and/or English shall be provided to all the final sub-circuits in distribution boards and feeders in submain distribution boards and switchboards at respective protection devices and isolators for equipment.

The installation shall be subject to inspection and approval by MEW before connection to supply.

2.5 **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;
- b. the admissible voltage drop;
- c. the electromechanical stresses and thermal effects likely to occur due to shortcircuits;
- d. other mechanical stresses to which the conductors may be exposed.

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

2.6 **SUITABILITY OF EQUIPMENT**

Every item of electrical equipment and apparatus shall fulfill the following basic requirements:

- a. shall be suitable with respect to maximum steady voltage likely to be applied as well as overvoltage likely to occur;
- b. shall be suitable with respect to the maximum steady current which it is to carry in normal service (under the climatic conditions of the Sultanate) and with respect to the current likely to be carried in abnormal conditions for the period during which it may be expected to flow;
- c. shall be suitable for the duty demanded of the equipment taking into account the load factor and the climatic conditions of the Sultanate.

2.7 **PROTECTIVE EQUIPMENT**

- a. 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;
- under voltage and no-voltage;
- single phasing.

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

b. Every electrical circuit and sub-circuit shall be protected against excess current 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.

2.8 MEANS FOR ISOLATION

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 recognised 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.

2.9 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.

2.10 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.

2.11 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).

2.12 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 earth continuity conductor of the electrical installation.

SECTION 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
Maximum 24 hour rain fall	80 mm
Maximum ambient temperature	50 °C
Minimum 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	4-5m/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 into account the above site conditions.

Tables 1 to 11 (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 MEW mains supply, the characteristics of which are as follows:-

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

3.3 VOLTAGE DROP

The voltage drop from the consumer's main board to any point in his installation shall not exceed 2.5% of the rated service voltage when all the conductors in the installation are carrying the maximum current.

3.4 CONDUCTORS AND CABLES

3.4.1 Non flexible cables

Non flexible 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 B.S. 6004/IEC 227. The minimum size of conductor shall be 1.5 sq. mm (7/0.50 mm).

Inflammable/explosive situations the cables shall be mineral insulated copper sheathed complying with B.S. 6207/IEC 702. The minimum size shall be 1.5 sq. mm. copper.

3.4.2 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 B.S. 6500/6004/IEC 227/245. The minimum size of conductor shall be 1 sq. mm.

Cables for connection between ceiling rose and lampholder for pendant type light fittings and for enclosed luminaire shall be heat resistant silicone rubber insulated with stranded copper conductor complying with B.S. 6141. Minimum size of conductor shall be 1 sq. mm.

Cables for lifts shall be braided rubber insulated travelling cables complying with B.S. 6977.

3.4.3 Under ground cables

Under ground cables for use in electrical installations shall be in accordance with Standard OES 2 of the Ministry of Electricity and Water.

3.4.4 Overhead line conductors

Overhead line conductors for use in electrical installations shall meet the requirements in Standard OES 3 of the Ministry of Electricity and Water.

3.5 LOW VOLTAGE SWITCHGEAR AND CONTROL GEAR

L.V. switchgear shall be factory built assembly (FBA), metalclad, totally enclosed, cubicle or box type complying with B.S. 5486 / IEC 439, and generally as illustrated in Figs. 1 & 2 (Appendix V). All current carrying components of the switchgear shall be of copper.

Switchgear busbars and connections shall conform to BS 159. The Minimum creepage distance of insulators shall be 30 mm to earth and 50 mm between phases. The minimum clearance in air to earth and between phases shall be 25 mm. The phase busbar, neutral bar and earth bar shall be colour identified in accordance with clause 5.19. The neutral bar shall be of the same cross-section as the phase busbars and the earth bar a minimum cross-section of 100 mm²

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

This derating shall apply to all equipment covered by the sub-clauses 3.5.1 through 3.5.7. 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.

FBA for installation indoor shall have a degree of protection IP 31 according to IEC 114 and for outdoor it shall be IP 55.

Equipment installed in explosive atmosphere shall comply in addition with B.S. 5345.

3.5.1 AIR BREAK SWITCHES AND FUSE SWITCHES

Air break switches and fuse-switches / switch-fuse units shall comply with B.S. 5419/IEC 408.

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 B.S. 88/IEC 269.1.

The use of re-wireable fuses is not permissible.

3.5.2 CIRCUIT BREAKERS

Circuit breakers shall comply with BS 4752 part 1/IEC 157, and designed and manufactured for uninterrupted duty.

Circuit breakers shall be moulded case air break type.

3.5.3 FUSE BOARDS

Single and three phase distribution fuse boards with ratings not exceeding 200 Amps for individual outgoing circuits shall be factory built assemblies complying with BS 5486 parts 1 and 11/IEC 439.

3.5.4 MINIATURE CIRCUIT BREAKER BOARDS

Single phase and three phase miniature circuit breaker 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 5486 parts 1 and 12. An integral isolator shall be included for isolating incoming supply.

3.5.5 MINIATURE CIRCUIT BREAKERS

Miniature circuit breakers (which are essentially devices for the protection of sub-circuits) shall comply with BS 3871 of duty category M 9 having short circuit capacity of 9 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 class E of BS 2757/IEC 85.

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

3.5.6 CONSUMER UNITS...

Consumer units for installation in consumer's premises for single phase service connection for loads upto 100 A shall be factory built assemblies complying with BS 5486 part 1 and 13.

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

3.5.7 EARTH LEAKAGE CIRCUIT BREAKERS

Earth leakage circuit breakers shall be residual current operated conforming to BS 4293 with continuous current ratings upto and including 125 A and tripping current ratings of 100 mA for main circuits and 30 mA for sub-circuits.

3.6 SWITCHES FOR USE IN WIRING INSTALLATIONS

Switches used in wiring installations shall conform to BS 3676. For outdoor and industrial use, switches shall be metal clad and watertight to degree of protection IP65.

3.7 PLUGS AND SOCKET-OUTLETS

- a. Plugs and socket outlets for domestic and similar general use shall conform to BS 1363 with fuse links conforming to BS 1362.
- b. Plugs, socket outlets, cable couplers and appliance couplers for industrial applications shall comply with the following British Standards/IEC Recommendations.
 - BS 196 : For use in single phase a.c. and d.c. upto 250 volts and current ratings upto 30 amps.
 - BS 4343/IEC 309 : For use in single phase a.c. and d.c. circuits upto 250 volts and current ratings above 30 amps.
 - BS 4343/IEC 309 : For use in a.c. three phase circuits for all current ratings.

3.8 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 amps shall be in accordance with the requirements of BS 67.

3.9 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 5042 : Part 1 : Bayonet lamp holders, for use with tungsten filament lamps to BS 5971 : Part 1 having caps to BS 5101 : Part 1 on supply voltages upto 250 V in indoor installations.
- BS 5042 : Part 2/IEC 238 : Edison screw lamp holders for use indoors or outdoors in residential as well as in industrial installations.
- BS 5042 : Part 4/IEC 400 : Built in lamp holders and starter holders for tubular fluorescent lamps intended for use in a.c. circuits not exceeding 250 V.

3.10 COOKER CONTROL UNIT

Cooker control unit shall comply with BS 4177 comprising main switch 30 A rating, an auxiliary switch 13 A rating and a 13 Amp socket-outlet to BS 1363.

3.11 ELECTRIC SHAVER SUPPLY UNIT

Electric shaver fixed supply units containing double wound transformer having separate input and earth free output windings and 110 volt output socket for the supply of electric dry shavers, shall comply with BS 3052.

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.

3.12 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 Part 1 suitable for use at ambient temperature upto 50°C. The material shall not soften or suffer structural degradation at a temperature of 70°C and shall be non-hygroscopic, fire retardant.

3.13 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 galvanised inside and outside, screwed type.

3.14 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.

3.15 AIRCONDITIONING EQUIPMENT

All central air-conditioning plant, window type airconditioners, and split-type airconditioning units for use in the Sultanate shall incorporate integral means for power factor correction to obtain a power factor of 0.9 or better and shall be fitted with hand-reset undervoltage device to trip on power failure.

3.16 DISCHARGE LAMPS

All lighting fittings with discharge lamps, mercury vapour, sodium vapour, fluorescent tubes, for use in the Sultanate shall incorporate capacitors, to obtain a power factor of 0.9 or better.

SECTION 4

SERVICE CONNECTION AND CONSUMER'S INSTALLATION

4.1 GENERAL

Power supply from MEW network shall be governed by terms, conditions, fees and tariffs stipulated in the Ministry of Electricity and Water Resolution Nos. 7/86, 12/86 and 13/86 and instructions issued by the Ministry from time to time.

Consumer 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 Directorate General of Electricity.

Power supply to a building or premises shall be either from MEW low voltage network or from a 11 KV/433 V substation installed within the building or premises.

4.1.1 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 be in the following three categories :-

4.1.1. a Category 1 : Load not exceeding 25 KVA Single phase service connection comprising :

— 3 Overhead line aluminium conductors XLPE covered 35 sq. mm

Or

2 core underground cable XLPE/PVC/SWA/PVC copper 35 sq. mm.

— Single phase and neutral cutout 100 Amps;

— Single phase KWh meter 20-100 Amps.

4.1.1. 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 sq. mm.

— Three phase four wire KWh meter 50 AMPS/100 AMPS.

— Three phase and neutral cutout 100 AMPS.

4.1.1. 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 sq. mm. (as appropriate).

— 200/5, 300/5 or 400/5 AMP 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 AMP cutouts and three phase 4 wire 50 AMP/100 AMP KWh meters shall be grouped together and installed either in the ground floor, or in each floor of multi-storey buildings where rising mains are adopted. In all cases, KWh meters should be accessible for meter reading personnel.

Drawings MEW/OH-GA/16 and 19 (Appendix V) show typical arrangements for the three categories of service connection.

4.1.2 **SERVICE CONNECTION FOR LOAD EXCEEDING 400 KVA**

In cases where the total connected load exceeds 400 KVA provision shall be made in the building premises, either space or room 5 x 5 x 4 metres for housing a transformer 11 KV/415 V with its associated 11 KV switchgear, with additional space of 2.5 x 5 metres for every additional transformer. Padlocked metal door/gate 2 x 2.5 metres shall be provided for entry from road side for purposes of operation, maintenance, repairs and replacements.

The consumer's low voltage switchboard shall be installed in a room adjacent to the 11 KV/415 V substation.

Drawing No. MEW/OH-GA/17 (Appendix V) shows typical arrangements for 11 KV/415 V substation installation in consumer's premises.

4.1.3 **SERVICE CONNECTION TO DETACHED BUILDINGS**

Normally a single service connection shall be provided for supply to a building or premises. In case a consumer's installation comprises installation in two or more detached / semi-detached buildings, or distinct and separate parts of buildings, two or more service connections may be permitted. 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.

4.1.4 **LOAD BALANCING**

In all cases where three phase supply is availed, the load shall be balanced between the phases.

4.2 **CONSUMER'S INSTALLATION**

4.2.1 **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 :

- i. means of isolation.
- ii. means of close excess current protection.
- iii. means of earth leakage protection.

4.2.2 **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.

4.2.3 **CLOSE EXCESS CURRENT PROTECTION**

The means of close excess current protection shall be in the form of cartridge fuse link (class P or Q1 of BS 88) inserted in each live conductor or a circuit breaker set to operate at an overload not exceeding 1.5 times the rated current of the circuit.

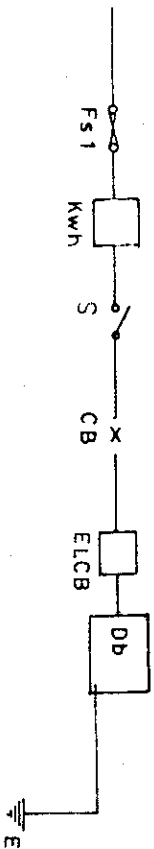
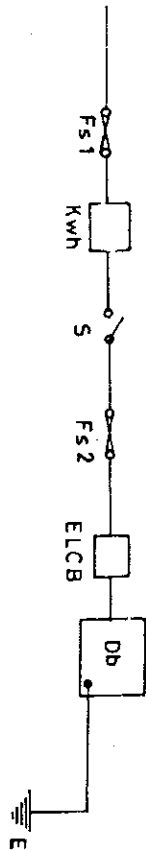
4.2.4 **EARTH LEAKAGE PROTECTION**

The means of earth leakage protection shall comprise current operated earth leakage circuit breaker with a minimum operating current of 100 mA. The consumer's earthing terminal shall be connected to a suitable earth electrode provided by the consumer.

4.2.5

SEQUENCE OF PROTECTIVE DEVICES: SINGLE CONSUMER INSTALLATION

The sequence of protective devices to meet the requirements of clause 4.2.1 shall be as shown in the diagrams below :



- | | |
|------|---|
| FS1 | SERVICE CUTOUT (MEW) |
| KWH | KILOWATT HOUR METER (MEW) |
| S | CONSUMER'S LOAD BREAK SWITCH |
| FS2 | CONSUMER'S MAIN FUSE |
| CB | CONSUMER'S MAIN CIRCUIT BREAKER |
| ELCB | CONSUMER'S CURRENT OPERATED EARTH LEAKAGE CIRCUIT BREAKER |
| Db | CONSUMER'S DISTRIBUTION BOARD |
| E | CONSUMER'S EARTH ELECTRODE |

4.2.6

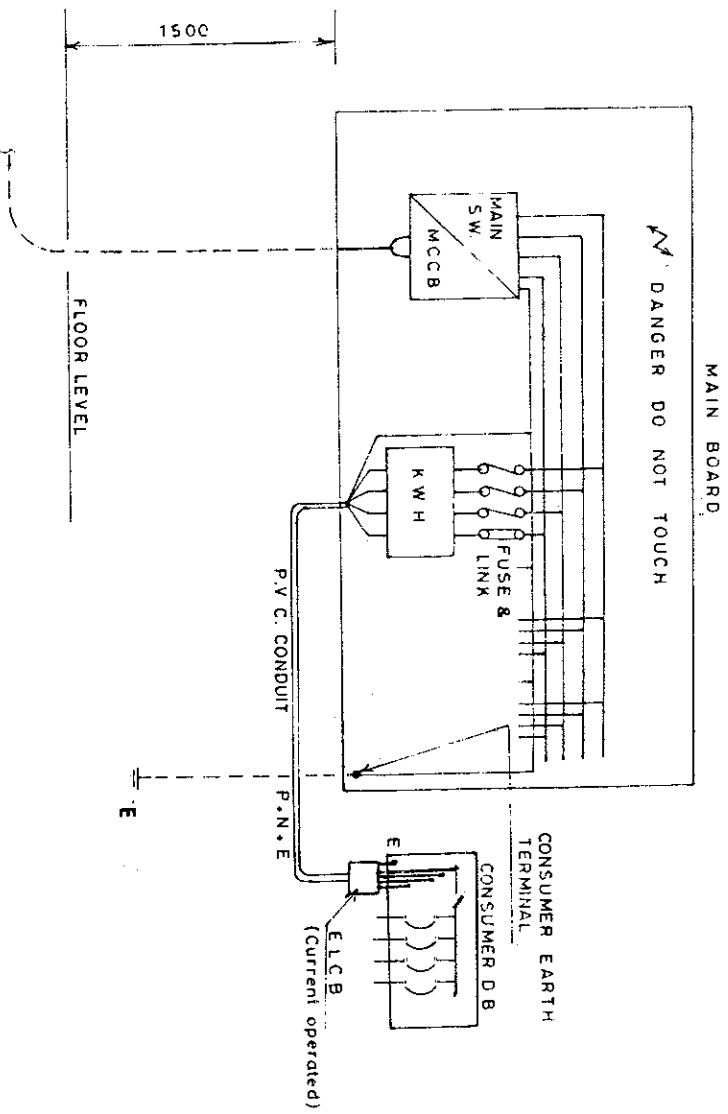
SEQUENCE OF PROTECTIVE DEVICES : MULTI-CONSUMER INSTALLATION

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, (clause 4.1.1. c).

Each individual consumer's equipment for isolation, excess current 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 the required arrangement :



4.2.7

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 at all times. A minimum space of 1500 mm shall be provided in the front and 600 mm on the sides, to permit safe operation, inspection and repairs. 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.

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

4.2.8

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.

4.2.9

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 metres. 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 sq mm copper for single consumer installation and 70 sq mm 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 ohms. To achieve this value in areas of high soil resistivity, additional earth electrodes with a minimum spacing of 3 metres, shall be installed.
- Consumer's earth electrode resistance shall be measured in accordance with the method described in Appendix VI.
- 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 MEW earthing system (MEW incoming cable armour/protective earth-continuity conductor i.e. fifth wire of the MEW system).
- The neutral conductor shall remain insulated throughout the installation and shall not at any point be connected to the earthing system.

4.2.10 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.

4.2.11 PROTECTION OF INDIVIDUAL CIRCUITS

Every circuit in the installation shall be protected against excess current 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 close excess current protection to the lowest rated conductor in the circuit.

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

4.2.12 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.

4.2.13 CONNECTION OF NEUTRAL CONDUCTORS IN DISTRIBUTION BOARDS

The neutral conductors of the final subcircuits 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.

4.2.14 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 metres 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.

4.2.15 CONTROL OF WATER HEATERS

Water heater upto 3 KW shall be controlled by a 20 AMP 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 heater shall be connected to a separate final subcircuit from the distribution board.

Water heater 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.

4.2.16 CONTROL OF AIR CONDITIONING UNIT/PLANT

Every room airconditioning 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 AMPS for unit with cooling capacity upto 24000 BTU and 45 AMPs for larger units. The switch shall be connected to a separate final subcircuit from the distribution board.

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

4.2.17 **LOAD ON LIGHTING CIRCUITS**

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

4.2.18 **SOCKET-OUTLETS IN DOMESTIC AND COMMERCIAL INSTALLATIONS**

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

A radial final sub-circuit may be installed to serve a maximum of 6 socket-outlets in rooms other than kitchen and controlled by a 20 AMP 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 AMP 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 6 socket-outlets in the kitchen and controlled by a 30 AMP circuit breaker. If additional socket outlets are required, a second ring shall be installed.

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

No socket-outlet other than shaver socket-outlet to BS 3052 shall be installed in a bath room.

4.2.19 **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 upto 30 Amps and to BS 433/IEC 309 for single phase circuits above 30 Amps 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 3535.

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

4.2.20 **LIGHTING SWITCHES**

Local switches for lighting points and for appliances not connected to socket-outlets shall have a minimum current rating of 5 AMPS. For outdoor and industrial use, switches shall be metal clad 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 metres 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.

4.3

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 (4.1.1 a and b).
- 150 mm inside diameter for service connection under category 3 (4.1.1 c).

4.4

MAINS SUPPLY FOR MOTORS

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

4.5

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 energised 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 power factor of 0.9 throughout the normal working range of the units or motors.

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 AMP or twice full load current whichever is the larger.
- Three phase motor 30 AMP 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

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

SECTION 5

INSTALLATION OF CONDUCTORS AND CABLES

5.1 PERMISSIBLE VOLTAGE DROP

The maximum voltage drop from the consumer's incoming supply terminals to any point in his installation shall not exceed 2.5% of the nominal voltage when the conductors are carrying full load current (6 volts for single phase and 10 volts for three phase circuits).

5.2 CURRENT RATINGS

Current ratings for single core and multicore cables to be adopted for use in consumer's installation are set out in tables 2, 3, 4, and 5 (Appendix IV). The current carried by the cables at any time shall not exceed the specified ratings.

5.3 PARALLEL OPERATION

Cables shall not be operated in parallel. Where two or more incoming cables are connected to busbars in a common switch board, bus-section isolators/breakers interlocked with feeder isolators or breakers shall be provided to inhibit parallel operation.

5.4 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.

5.5 METHODS OF INSTALLATION

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

- i. 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.
- ii. Single core PVC insulated cable to BS 6004 shall only be run in conduit or trunking.
- iii. 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.
- iv. Mineral insulated cables 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 cable shall be further protected with PVC covering over the copper sheath. MICC cables shall be run on copper saddles and cleats mounted on walls at close intervals.

5.6 CABLES FOR LIFT

Cable shall not be installed in a lift (or hoist) shaft unless they form part of the lift installation.

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

- armoured, or
- MICC, or
- enclosed in metal conduits.

5.7 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.

- i. Multicore armoured and sheathed cables, two core and earth sheathed cables, and MICC cables may be supported by clips at spacings not exceeding the appropriate value stated in Table 6 (Appendix IV).
- ii. Multicore armoured and sheathed cables in horizontal runs may rest on trays or in dry and smooth concrete trench without fixing.
- iii. 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 metres in length. Intermediate supports for cables shall be provided if the vertical run in any situation exceeds 5 metres.
- iv. Sheathed cables without armour may be supported and enclosed in conduits provided vertical runs do not exceed 5 metres in length.

5.8 RADIUS OF BEND

The internal radius of bend for cable in fixed wiring shall not be less than the appropriate value stated in Table 7 (Appendix IV).

5.9 CABLE TERMINATIONS

- a. 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 nicking 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 into the same terminal, their conductors shall be tightly twisted together before being inserted into 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 busbars, compression type bi-metallic lugs with copper palm and aluminium barrel shall be used.

- b. Cable glands for multicore cables (insulated and armoured) shall be of brass compression type to BS 6121 with earth tag and PVC shroud.
- c. 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 6081.

- d. 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 bus-bars. 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.

5.10 JOINTS

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

5.11 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 to the full thickness of the floor, wall, etc. to inhibit spread of fire or smoke.

5.12 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 8 (Appendix IV).

5.13 DISTRIBUTION SYSTEM IN MULTI-STOREY BUILDING

In a multi-storey building, one of the following distribution systems shall be adopted :-

- i. Supplies direct from the main board to individual consumer distribution boards, comprising single core PVC insulated cables installed in separate conduit for each consumer.
- ii. Sub-main multicore cable (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, a separate conduit being used for each consumer.
- iii. Rising main system comprising bare copper conductors supported by insulators and totally enclosed in earthed metal trunking, 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 and especially assembled for the purpose with adequate strength to withstand short circuit forces and necessary provisions for thermal expansion and contraction.
Rising main system shall comprise the following where it passes through floors :
 - copper conductors or bus-bars 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 rising main system shall comply with BS 5486 : Part 2/IEC 439-2.
The current rating of each rising main system shall not exceed 400 amps.

5.14 CONSUMER'S UNDERGROUND WIRING

Consumer's wiring installed underground for distribution between a building and a point of utilisation not attached to it (e.g. another building) shall be in the form of XLPE insulated

PVC sheathed single galvanised steel wire armoured cable (XLPE/PVC/SWA/PVC) drawn in duct or laid direct in ground.

The installation shall in general conform to MEW standard OES 2.

5.15 CONSUMER'S OVERHEAD WIRING

Consumer's overhead wiring for distribution between a building and a point of utilisation 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 MEW standard OES 3.

5.16 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 structurals, 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.

5.17 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 each shall be installed in its own separate conduit. The segregation shall be as follows :-

- i. a.c. circuits for general purpose (lighting, sock-outlets, etc.)
- ii. fire alarm circuits
- iii. radio
- iv. television
- v. telephone
- vi. telephone and telex
- vii. sound distribution
- viii. burglar alarm
- ix. bell and call circuits

Note : Extra-low voltage circuits items (iii) to (ix) may be run together on trays or installed in a common trunking or duct, but not in common conduit.

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 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.

FLEXIBLE CORDS AND CABLES

Current ratings for flexible cords and cables are set out in Table 1 (Appendix IV).

Where apparatus requires to be earthed, flexibles 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 type E 12 of BS 6899/IEC 540.

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 1 (Appendix IV).

Flexible cords shall not be used as fixed wiring.

COLOUR IDENTIFICATION OF CABLE CORES

a. Colour identification of insulated cable cores for fixed installation and of sleeve, band or disc for bare conductors shall be as follows :-

— earthing conductor	green and yellow
— phase of a.c. single phase circuit	red
— neutral of a.c. single or three phase circuit	black
— phase R of 3 phase a.c. circuit	red
— phase Y of 3 phase a.c. circuit	yellow
— phase B of 3 phase a.c. circuit	blue
— positive of d.c. 2 wire	red
— negative of d.c. 2 wire	black

b. Colour identification of flexible cables and flexible cords shall be as follows :-

— live	brown
— neutral	blue
— earthing	green and yellow

SECTION 6

INSTALLATION OF CONDUITS, TRUNKING AND TRAYS

6.1 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, drawboxes. Provisions shall be such that cables can be drawn-in or replaced without the cables being damaged or the conduit dismantled.

All runs of conduits shall be truly vertical or horizontal.

6.2 CONDUIT SADDLES

Where conduits are installed on the surface of building fabric they shall be supported by purpose made conduit saddles or spacer bar saddles.

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

6.3 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.

6.4 RADIUS OF BENDS

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

6.5 GALVANISED STEEL CONDUITS

Galvanised 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 conduit shall not, however, be used as an earth-continuity conductor; and a separate earth-continuity cable shall be drawn into the conduit for every final sub-circuit.

Only galvanised steel conduits 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.

Galvanised 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.

6.6 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 construction. A cement that shall remain in adhesive plasticised state shall be used for expansion couplers.

6.7

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 part 3. Metallic flexible conduits and fittings shall comply with BS 731 Part 1 and shall preferably be provided with an outer sheath of PVC.

Flexible metal conduit 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.

6.8

CONDUIT SIZES

Conduits shall be limited to the following sizes :
16mm, 20mm, 25mm, 32mm and 50mm

6.9

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 galvanised 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.

6.10

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. Cable tray system shall be constructed of galvanised steel or aluminium forming a rigid structural system. 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 accessories shall be of substantial sections and of the same quality as the trays themselves.

Cables shall be fastened securely by purpose made clips, cleats or saddles.

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 12 (Appendix IV) are not exceeded.

SECTION 7

EARTHING AND EARTH LEAKAGE PROTECTION

- 7.1 **CONSUMER'S EARTHING INSTALLATION**
- Consumer's earthing installation shall be provided in accordance with clause 4.2.9, with earth electrode and main earth lead connected between the electrode and the consumer's main earthing terminal.
- 7.2 **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 8 (Appendix IV).
- 7.3 **EARTHING TERMINAL OF SOCKET-OUTLETS**
- The earth-continuity cable of the final sub-circuit shall be connected to the earth terminal of the galvanised steel box for the socket-outlet.
- 7.4 **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.
- 7.5 **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 ohm.
- 7.6 **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 airconditioning 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 submain circuit.
- 7.7 **NEUTRAL CONDUCTOR**
- The neutral conductor shall not be earthed at any point within the consumer's premises.
- 7.8 **EARTH LEAKAGE CIRCUIT BREAKERS**
- Each and every consumer's installation shall be protected on the incoming side of the consumer's main distribution board with residual current operated earth leakage circuit breaker (ELCB) of the required continuous current rating and operating current of 100 mA.
- Besides the main ELCB it is recommended that ELCB's with the following rated operating currents shall be provided to afford maximum protection against shock.
- | | |
|--------------------------------------|-------|
| Under water lighting | 10 mA |
| Socket-outlet and apparatus circuits | 30 mA |

SECTION 8

INSTALLATION OF ACCESSORIES AND APPARATUS

8.1 VOLTAGE RATING

All apparatus shall be rated for a voltage of A.C. 415/240 volts 50 cycles.

8.2 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 (clause 3.1).

8.3 DESIGN

All apparatus shall be of a design appropriate to the situation in which it is to be used and its mode of installation shall take account of the conditions likely to be encountered.

In damp situations, every item of apparatus shall be of the damp and dust-proof type and cable entries shall be provided with glands or bushings with gaskets or be suitable to receive screwed conduit.

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.

Flame proof enclosure, intrinsically safe apparatus complying with BS 229, BS 4683 Part 2 and BS 1259 shall be used in flammable and/or explosive situations.

8.4 TERMINAL MARKINGS AND EARTH MONITORING

a. 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 Fig. 4 (Appendix V).

Figure 5 (Appendix V) shows the markings and disposition of the contacts of single phase industrial socket-outlet to BS 196.

Figure 6 (Appendix V) shows the markings and disposition of 3 phase and earth terminals of socket-outlet to BS 4343/IEC 309.

Figure 7 (Appendix V) shows the markings and disposition of 3 phase, neutral and earth terminals of socket-outlet to BS 4343/IEC 309.

Socket outlets and corresponding plugs shall be wired and connected according to figures 4, 5, 6 and 7 (Appendix V).

b. 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, it is recommended that electrical earth monitoring be provided.

This may comprise the following :

- pilot contacts on plugs and sockets
- pilot core in the flexible cable in addition to earthing-continuity conductor.
- two independent earth terminals on the appliance casing.

The above to form a complete earth monitoring loop for continuous circulation of a small current at a safe extra-low voltage derived from the secondary winding of a double wound transformer. This is shown diagrammatically in figure 9 (Appendix V).

The entire monitoring protection shall comply with BS 4444.

8.5 LIGHTING SWITCHES

Local lighting switches shall be of minimum 5 amp 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.

8.6

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 galvanised 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.

8.7

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 lampholders shall be connected to the neutral conductor.

8.8

PENDANT LIGHTING

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

8.9

MOUNTING HEIGHTS OF ACCESSORIES

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

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

8.10

PROTECTION OF CONSUMER'S SUB-CIRCUITS

All final sub-circuits in consumer's domestic & commercial installation shall be controlled and protected by MCB's. 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 circuit breakers, (earth leakage, overcurrent and short circuit) with earth leakage trip rating of 30 mA.

8.11 **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 carried out with PVC cable of 1.0 mm² stranded copper. Segregation of low voltage and extra-low voltage circuits shall be in accordance with clause 5.17.

8.12 **ACCESSORY BOXES**

Where conduits are run on surface, all branch switches, switched socket-outlets, ceiling roses, etc. shall be mounted on galvanised 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 galvanised steel boxes which shall be installed flush with the plaster.

8.13 **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.

8.14 **WATER HEATER**

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

8.15 **UNDER WATER LIGHTING**

All underwater lighting circuits shall operate at voltage not exceeding 36 volts and shall be installed to ensure full safety.

Lighting fixtures shall be completely water tight and tested to ensure complete safety in operation.

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 a current operated earth leakage circuit breaker having a trip rating of 10 milli amps. installed on the supply side of L.V. transformer.

8.16 **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.

8.17 **STAND-BY GENERATORS**

Where it is intended to provide 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 MEW 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.

Drawing No. MEW/OH-GA/20 (Appendix V) illustrates the basic requirements of the change-over arrangement.

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

8.18 **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, oil resisting and flame retardant polychloroprene (PCP) sheath overall with lampholder shrouded in insulating material and permanently moulded to the cable sheath.

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

8.19 **BUILDING LIGHTNING PROTECTION**

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

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

The downlead for the lightning protection shall be either XLPE insulated or run on insulated saddles.

SECTION 9
INSTALLATIONS ON CONSTRUCTION AND
BUILDING SITES

9.1 GENERAL

Installations on construction and building sites shall comply with the requirements for permanent installations and in addition with the specific requirements of clauses 9.2—9.11 below.

9.2 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.

9.3 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.

9.4 PORTABLE APPARATUS AND SITE LIGHTING

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

9.5 SOCKET-OUTLETS

Single phase socket-outlets, plugs and couplers upto 30 amps shall comply with BS 196 and above 30 amps with BS 4343.

Three phase socket-outlets, plugs and couplers shall comply with BS 4343.

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

9.6 110 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.

9.7 COLOUR CODE FOR ACCESSORIES

Identification colours for accessories shall be as follows :

110 V	Yellow
240 V	Blue
415 V	Red

9.8

EARTH LEAKAGE PROTECTION

All final sub-circuits operating at 65 volts and above shall be protected with residual current operated earth leakage circuit breakers, having minimum tripping current of 30 mA.

9.9

REDUCED VOLTAGE SYSTEM

Reduced voltage system operating at 110 V three phase should be obtained from a double wound transformer 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.

9.10

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 polychloroprene (PCP) or a heat resisting, oil resisting and flame-retardant (HOFR) sheath overall. Non-flexible cables shall comply with BS 5467 and flexible cables shall comply with BS 6116 with armour and overall covering of PCP or HOFR.

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

9.11

LAMP HOLDERS

Types of lampholders 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 lampholder 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 lampholder is shrouded in insulating material and permanently moulded to the cable sheath, shall be used for illumination of discrete areas.

9.12

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, by a competent person, is therefore essential to promote safety and efficient operation.

SECTION 10

AGRICULTURAL AND HORTICULTURAL INSTALLATIONS

10.1 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 clauses 10.2 — 10.11.

10.2 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.

10.3 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.

10.4 PROTECTION OF CABLES

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

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

10.5 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.

10.6 EARTH LEAKAGE CIRCUIT BREAKER

Every final sub-circuit shall be protected by residual current operated earth leakage circuit breaker with minimum operating current of 30 mA in addition to the main earth leakage circuit breaker of 100 mA operating current.

10.7 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.

10.8 EXTRA-LOW VOLTAGE

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 volts from a 24 volt single phase a.c. supply derived from a double wound transformer having the centre point of its secondary winding connected with earth.

SECTION 11

TESTING AND INSPECTION

11.1 GENERAL

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

11.2 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 work-manship and the installation methods adopted meet the requirements of MEW Regulations.

11.3 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.

11.4 EARTH-CONTINUITY TEST

Earth-continuity test shall be carried out between the consumer's earthing terminal and the remote end of earth-continuity conductors.
The resistance value obtained shall not exceed 0.5 ohm.

11.5 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 volts D.C. test voltage shall be applied.

The insulation resistance to earth shall not be less than 1 mega ohm, 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 mega ohm.

11.6 CONTINUITY TEST

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

11.7 EARTH ELECTRODE RESISTANCE MEASUREMENT

Earth electrode resistance shall be carried out in accordance with method described in Appendix VI. The resistance shall not exceed 50 ohms. Additional electrodes shall be provided where necessary to obtain this value.

11.8 PROTECTION TEST

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

11.9 COMPLETION CERTIFICATE

Following the inspection and testing, a completion certificate in the attached format shall be submitted by the electrical contractor to MEW signed by contractor's competent engineer. The installation will then be further inspected and tested by MEW inspector and if found satisfactory, the installation will be permitted to be connected to supply.

APPENDIX I

COMPLETION CERTIFICATE

APPENDIX I
COMPLETION CERTIFICATE

(Completion Certificate to be given by the Electrical Contractor and signed by Contractor's Competent Engineer/Supervisor) :

I hereby certify that the electrical installation at :

has been completed, inspected and tested, in accordance with the Regulations for Electrical Installations issued by the Ministry of Electricity and Water, Sultanate of Oman and is now ready for connection to mains supply.

The results are given in the attached forms.

Signed : Date :

For and on behalf of:.....

Address :
.....
.....

MEW Reg. No.
and Date :

FORM A

Particulars of the installation covered by this Certificate :

New Installation. Alteration/Extension to existing installation.

Installation Drawings :

It is anticipated that the installation would comprise the following :

S. No.	Description	No.	KW	
			Unit	Total
01	Light points			
02	Airconditioners			
03	Fans			
04	Single phase motors			
05	Three phase motors			
06	Water heaters			
07	Refrigerators			
08	Freezers			
09	Cookers			
10	13 Amps Socket outlets			
11	Other loads			
12			
13			

Comments (if any) on existing installation (where this certificate relates to an alteration or addition)

Signed :

Date :

FORM B
INSPECTION & TEST REPORT

- 1) Compliance with drawings
- 2) Standard of Installation
Material
Workmanship
- 3) Colour identification of wiring
- 4) Polarity checks
 - Switches
 - Breakers
 - Links
 - Linked switches
- 5) Resistance of earth-continuity conductor from remote end to main earthing point.
- 6) Insulation resistance
 - with all poles & phases connected together and switches, fuses and breakers all in place.
 - with all conductors on one phase connected together and inturn, all conductors connected to each other.
 - Red
 - Yellow
 - Blue
 - Neutral
- 7) Continuity of all conductors
 - Red
 - Yellow
 - Blue
 - Neutral
 - Earth

FORM B (CONTD.)

8) Continuity of earth-continuity conductor in ring circuits for socket-outlets.	:			
9) Earth Electrode Resistance	:			
10) Earth leakage circuit breakers (residual current operated type)	:	Continuous Rating - A	Operating Current - MA	
Main	:	1)		
Subsidiary	:	2)		
11) Load balance	:	Red	Yellow	Blue
— Lights	:			
— Refrigerator	:			
— Airconditioner	:			
— Freezer	:			
— Cooker	:			
— Motors	:			
— Water Heaters	:			
— 13 Amp Socket outlet	:			
— Other loads	:			

Signed :

Date :

APPENDIX II

RECOMMENDED ILLUMINATION LEVELS

APPENDIX II

RECOMMENDED ILLUMINATION LEVELS

AREA	LUX	AREA	LUX
1. GENERAL BUILDING AREAS		2. OFFICES AND SHOPS	
1.1 CIRCULATION AREAS		2.1 DRAWING OFFICES	
corridors, passage ways	100	Drawing Boards	750
Lifts	150	Reference tables and general	500
Stairs	150	Printing Room	300
Escalators	150		
1.2 ENTRANCES		2.2 SHOPS	
Entrance halls, Lobbies waiting rooms	150	Conventional with counters	500
Enquiry Desks	500	Conventional will all displays	500
Gate houses	300	Self-service	500
		Super-markets	500
1.3 KITCHENS		2.3 SHOW-ROOMS	
Food Stores	150	Car	500
General	500	General	500
1.4 MEDICAL & FIRST AID CENTRES		3. PUBLIC & EDUCATIONAL BUILDINGS	
Consulting Rooms, treatment areas	500	3.1 ASSEMBLY AND CONCERT HALLS, CINEMAS AND THEATRES	
Medical stores	100	Auditorium	100
Rest Rooms	150	Theatres and concert halls	100
		Cinemas	50
1.5 OUT-DOORS		Multi-purpose	500
Entrance and Exits	50	Booking offices	300
		Dressing rooms	300
1.6 STAFF RESTAURANTS		Platforms and stages	Spl.
Canteens, Cafeterias, Dining Rooms	300	Projection rooms	lighting 150
1.7 STAFF ROOMS		3.2 LECTURE THEATRES	
Changing Room, Cloak Rooms	150	General	300
Rest Rooms	150	Chalkboard	500
Stores	150	Demonstration benches	500
1.8 TELECOMMUNICATIONS		Examination halls,	
Cord Switchboard Rooms	500	seminar rooms,	
Apparatus Rooms	150	lecture halls	500
Teleprinter Rooms	500	Art Rooms	500
1.9 CAR PARKS		Laboratories	500
Underground	50		
Multi-storey parking floors	50		
Ramps	75		



















APPENDIX 2 (Contd.)

AREA	LUX	AREA	LUX
4. GOVT. PUBLIC AND EDUCATIONAL BUILDINGS		5.2 HOTELS	
4.1 LIBRARIES		Entrance Halls	
Shelves, book stack	150	General	75
Study tables	300	Reception, Cashier	300
4.2 READING ROOMS		Public Rooms	
Newspapers & Magazines	300	Coffee Bars	150
Reference libraries	500	Dining Rooms, Restaurants	
Counters	500	General	100
Cataloguing & sorting	500	Baggage Rooms	100
Binding	500	Laundries	300
Book stores	100	Cellars	150
4.3 MUSEUMS AND ART GALLERIES		Dining rooms, cash desks	300
Exhibits insensitive to light	300	Lounges	100
Light sensitive exhibits	150	Writing Rooms	150
Specially light-sensitive exhibits	50	Cloak Rooms	150
5. HOMES AND HOTELS		6. INDOOR SPORTS, GAMES	
5.1 HOMES		Billiard Rooms	
Living Rooms		General	100
General	50	Table	Spl.
Casual reading	150	Boxing ring	1000
Sewing and darning	300	top	500
Studies		Club	500
Desk and prolonged reading	300	Gymnasium	500
Bedrooms		Swimming pool	500
General	50	top (water level)	150
Bedhead	150	Spectator areas	300
Kitchens		Club Recreational	
Working Area	300	Tennis courts	500
Bath Rooms	100	top	300
Halls and landings	150	Club	300
Stairs	100	Recreational	150
Workshops	300	General	
Garages	50	changing rooms, showers	150
		locker rooms	

APPENDIX III

ELECTRICAL SYMBOLS




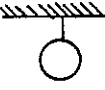










APPENDIX III ELECTRICAL SYMBOLS

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).
	Fluorescent 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.

 Shaver Socket outlet to BS 3052.

 Combined mirror light with integral shaver socket outlet to BS 3052.

APPENDIX IV

TABLES

APPENDIX IV

TABLE 1 CURRENT CARRYING CAPACITY OF FLEXIBLE CORDS INSULATED WITH SILICONE RUBBER

S. No.	Size of cord mm ²	Current rating for single phase a.c. Amps	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 2 CURRENT CARRYING CAPACITY OF P.V.C. WIRES AND CABLES (SINGLE CORE) WITH CLOSE EXCESS CURRENT PROTECTION

S. No.	Size of cable copper mm ²	Two cables in one trunking or conduit for single phase a.c. Amps	Three or four cables in one trunking or conduit for three phase a.c. Amps
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 3
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 unenclosed	
	One two core cable single phase a.c. or d.c. Amps	One three or four core cable three phase Amps
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 4
CURRENT CARRYING CAPACITY OF MULTI-CORE
XIPE INSULATED P.V.C. SHEATHED CABLES
COPPER CONDUCTORS

Cable size in mm ²	Armoured cable clipped direct to a surface or on a cable tray unenclosed Amps	Armoured cable under ground direct burial ground temperature 35 °C soil resistivity 200mw/cm per °C Amps
	4.0	27
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	0.85	0.80	0.70	0.650	0.57

TABLE 5
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 single core cables, single phase a.c. and d.c. Amps	One twin cable single phase a.c. and d.c. Amps	One three core/four core three phase Amps	Two single core cables, single phase a.c. and d.c. Amps	One twin cable single phase a.c. and d.c. Amps	One three core/four core three phase Amps
1.0	15	12	10	17	13	11
1.5	18	15	12	20	17	14
2.5	25	20	16	27	22	18
4.0	31	26	22	35	29	25
6.0	40	33	—	44	37	—
10.0	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 6
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 P.V.C. 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 7
MINIMUM INTERNAL RADI OF BENDS
FOR CABLES IN FIXED WIRING

Insulation type	Armoured 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	Non-armoured	Not exceeding 25 mm Exceeding 25 mm	4 6
XLPE multicore with shaped copper conductors	Armoured	Any	8
Mineral	Copper sheath with or without PVC covering	Any	6

TABLE 8
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 9
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	—	—	—	—
4.0	3	2	4	3	8	6	—	—	—	—
6.0	2	—	3	2	6	4	11	8	—	—
10.0	—	—	2	—	3	2	6	4	—	10
16.0	—	—	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 10
MAXIMUM NUMBER OF PVC CABLES THAT
MAY BE INSTALLED IN SURFACE
MOUNTED METAL OR PVC 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 11

**MAXIMUM NUMBER OF CABLES THAT MAY BE
INSTALLED IN UNDERFLOOR TRUNKING**

TRUNKING SIZES	CABLE SIZES										
	1.5	2.5	4.0	6.0	10.0	16.0	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
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 12

NUMBER OF CABLES THAT MAY BE INSTALLED IN CABLE TRAYS

MULTI-CORE AND SINGLE CORE CABLES :

a) Ventilated Cable Tray :

The sum of the diametres of all cables installed shall not exceed 60 percent of the cable tray width and the cables shall be installed in a single layer.

b) Solid Bottom Cable Tray :

The sum of the diametres 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

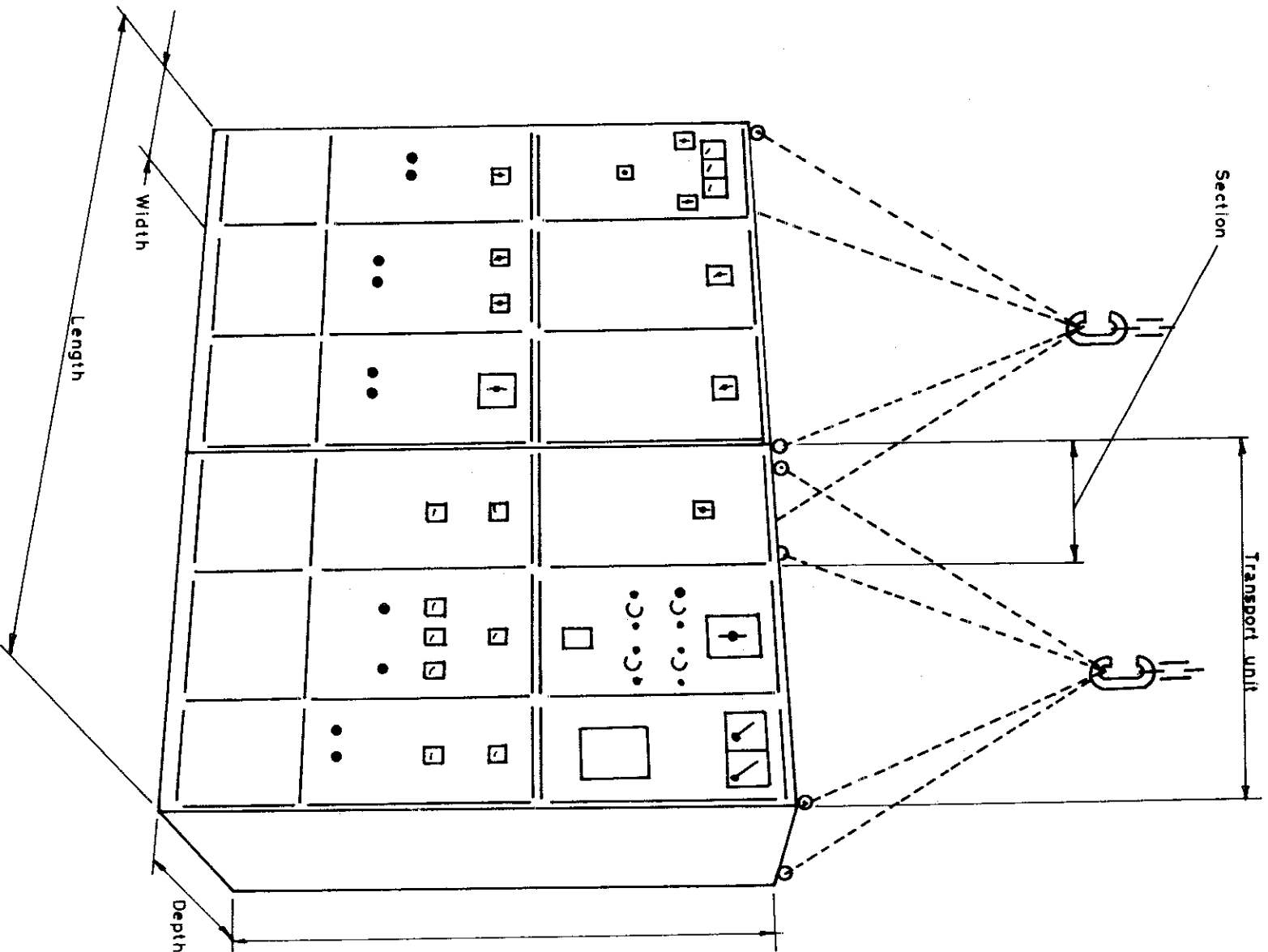


Fig-1. MULTI-CUBICLE TYPE FBA

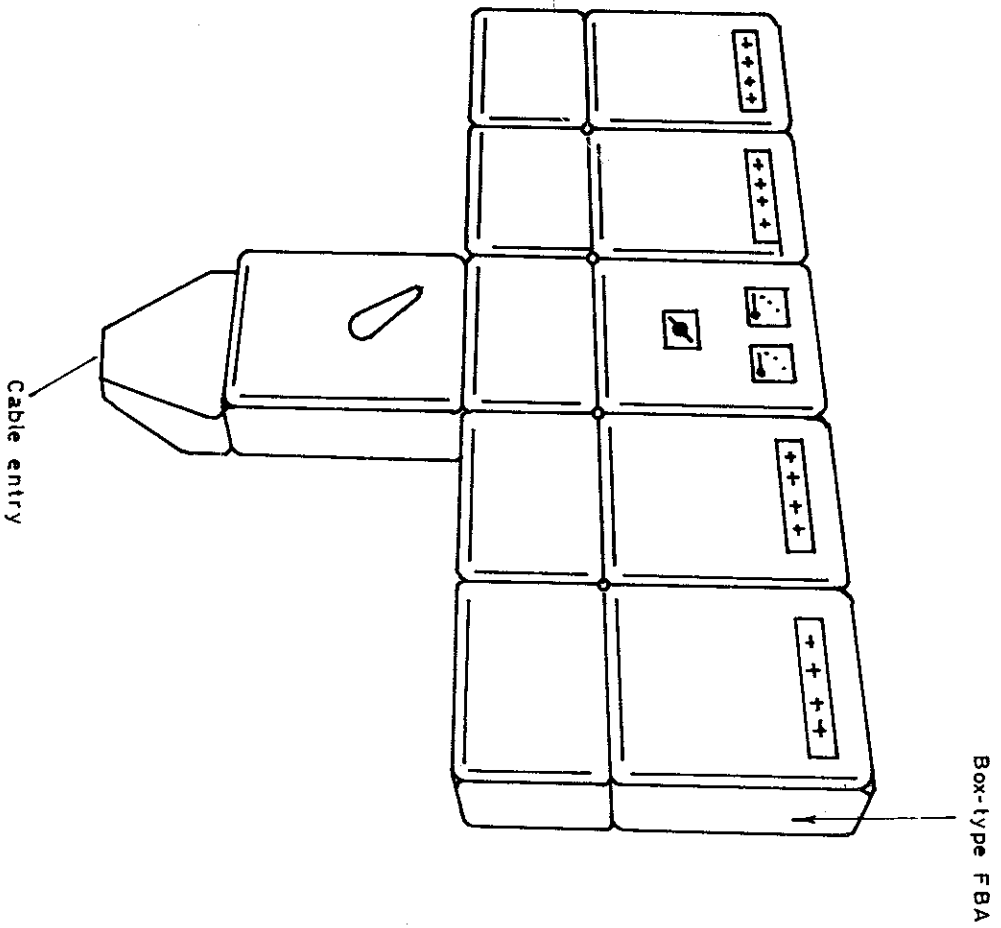


Fig-2.. MULTI - BOX -TYPE FBA

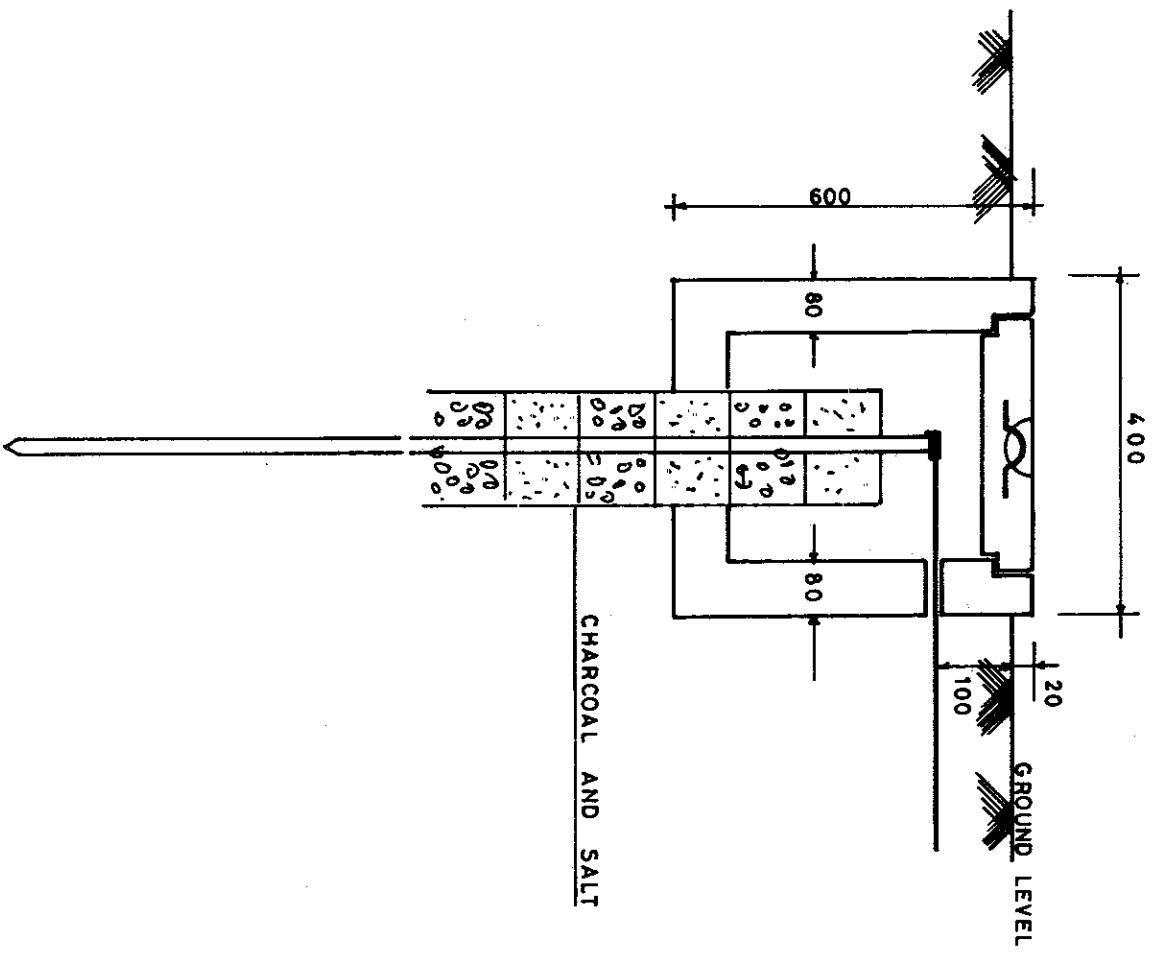


Fig. 3: EARTH PIT

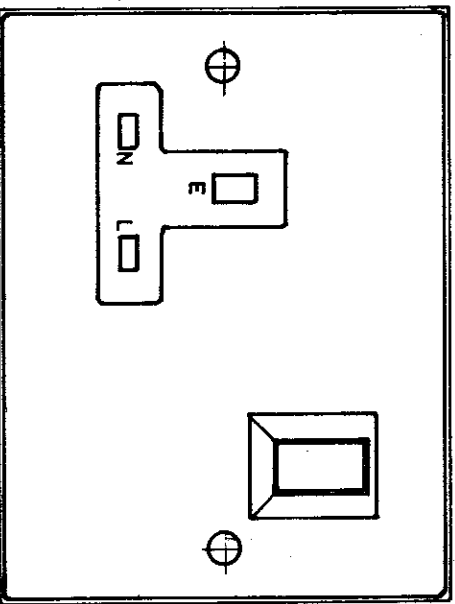


Fig. 4. IDENTIFICATION OF CONTACTS
FOR .13Amps SWITCHED SOCKET-OUTLET
DOMESTIC

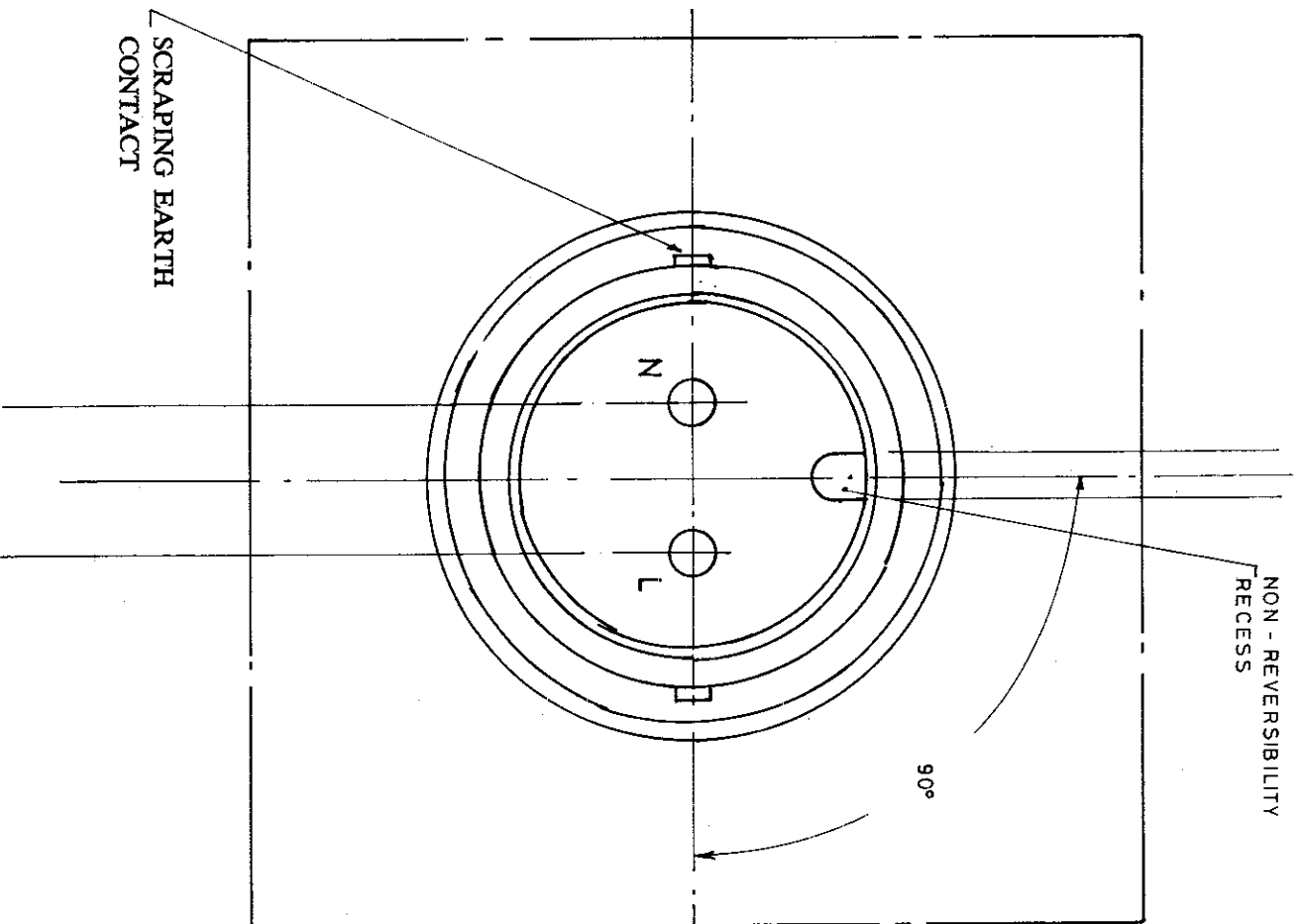


Fig 5 - VIEW LOOKING AT THE FRONT OF THE SOCKET-OUTLET
INDUSTRIAL

3P+E

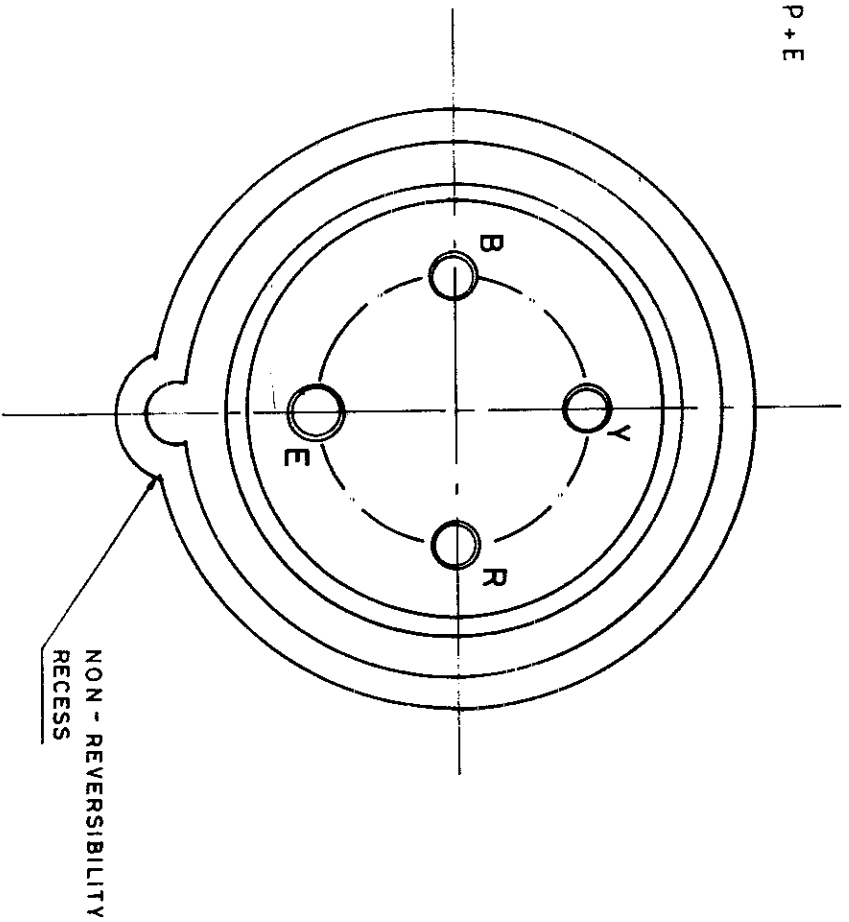


Fig. 6. VIEW LOOKING AT THE FRONT OF THE
SOCKET-OUTLET
INDUSTRIAL

3P + N + E

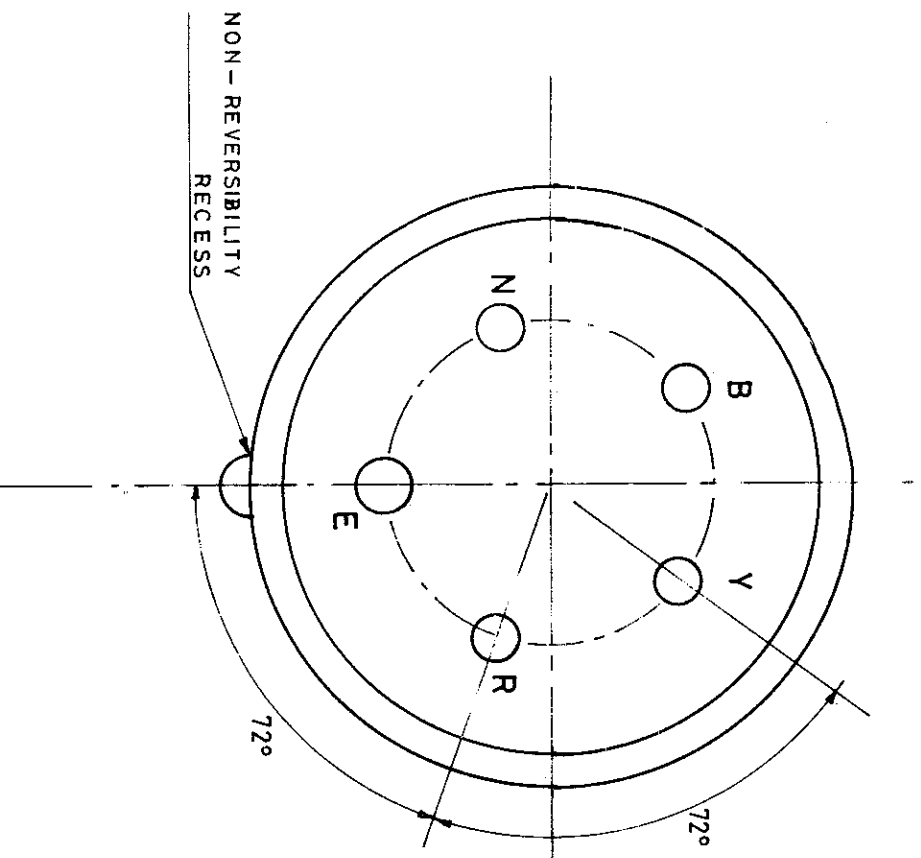


Fig-7

VIEW LOOKING AT THE FRONT OF THE
SOCKET OUTLET.-INDUSTRIAL

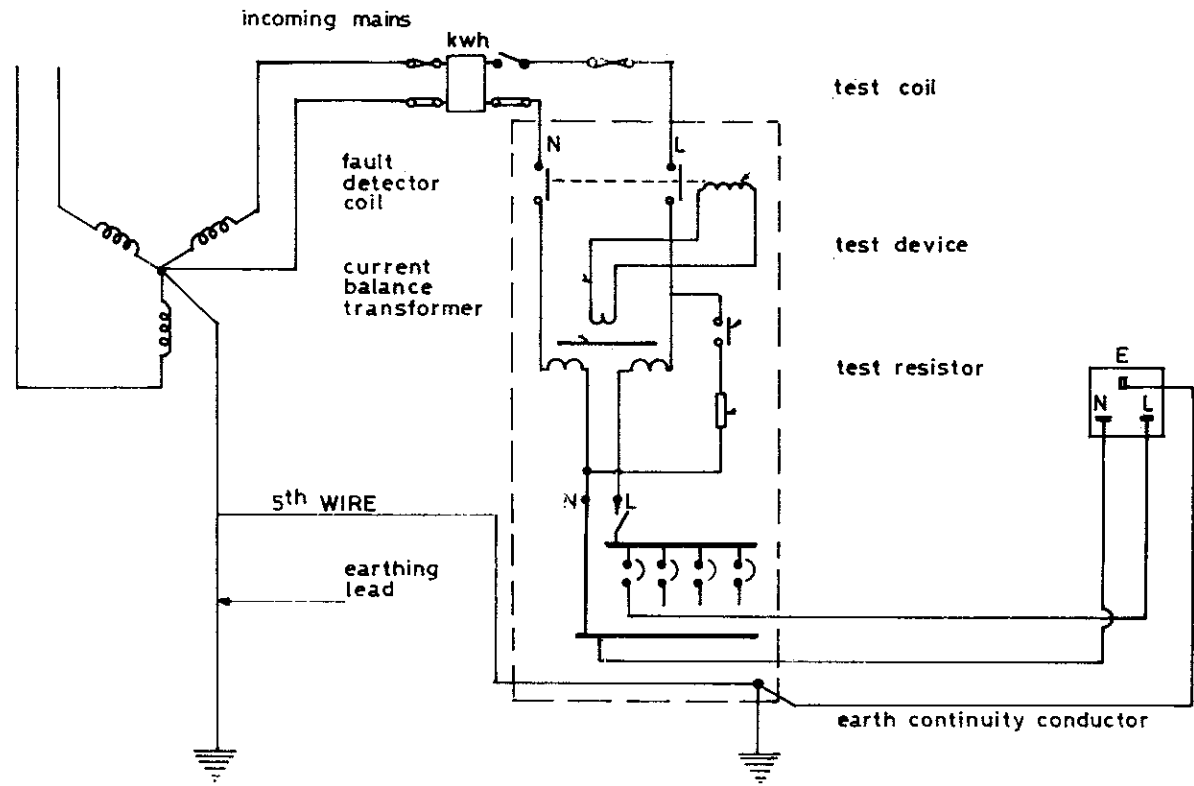


Fig. 8. TYPICAL CIRCUIT DIAGRAM FOR A RESIDUAL CURRENT-OPERATED CIRCUIT BREAKER

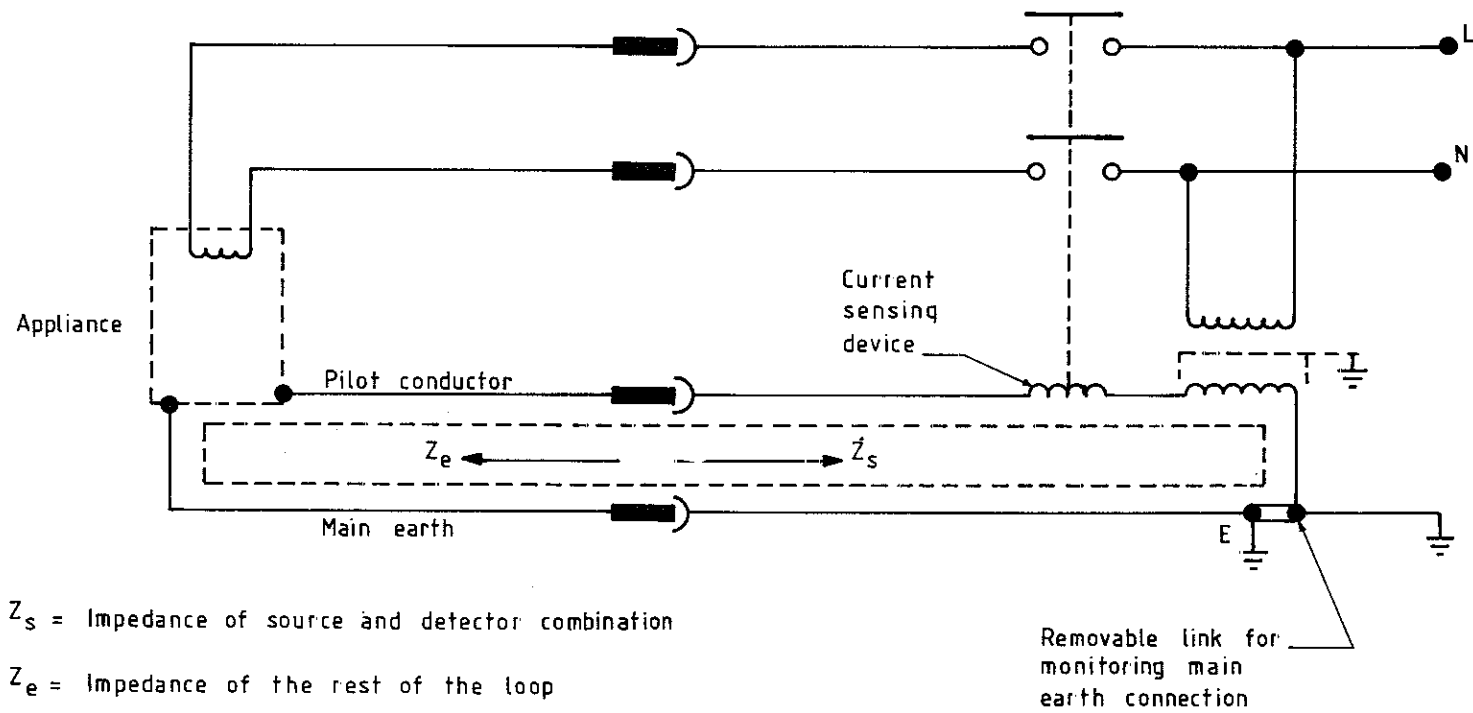
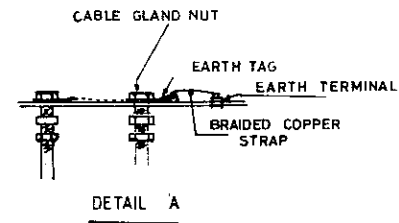
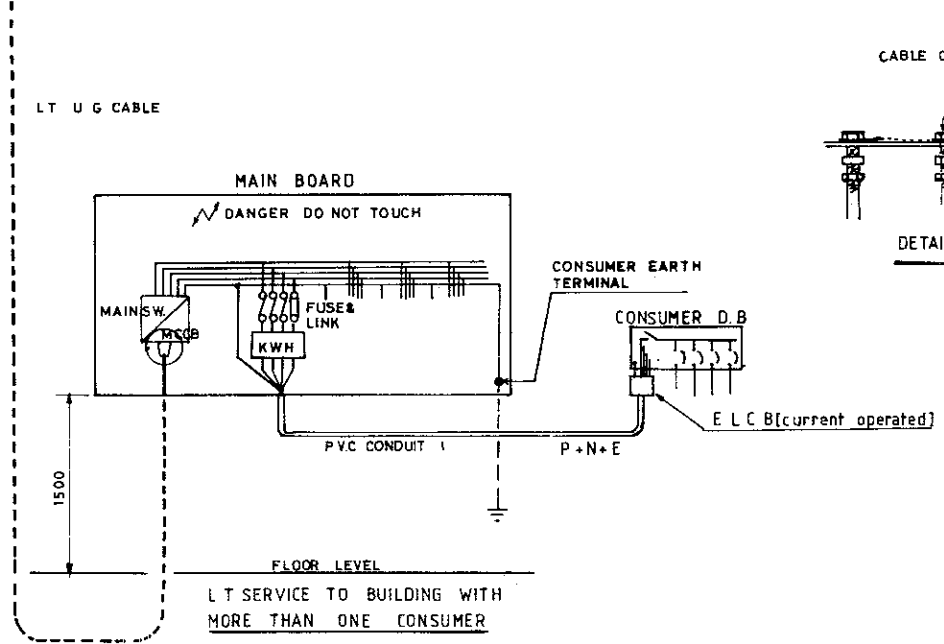
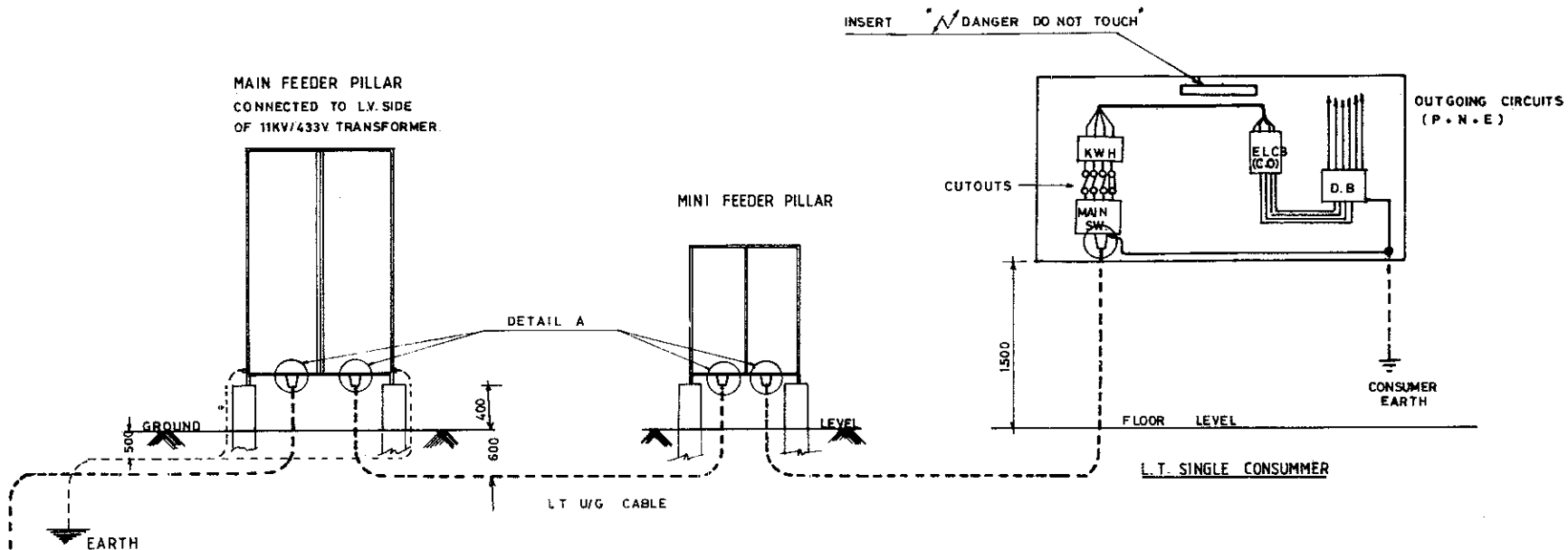
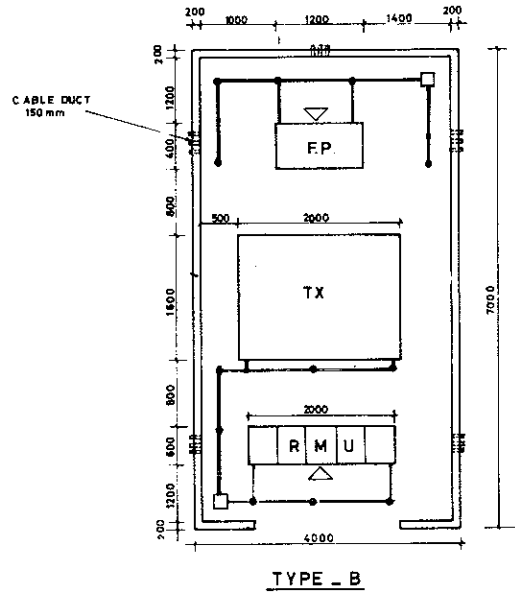
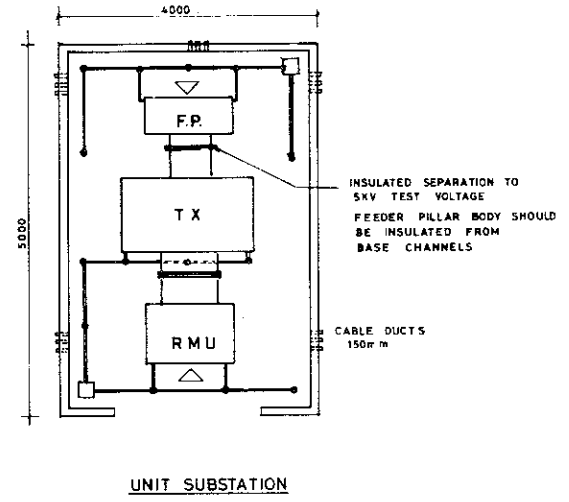
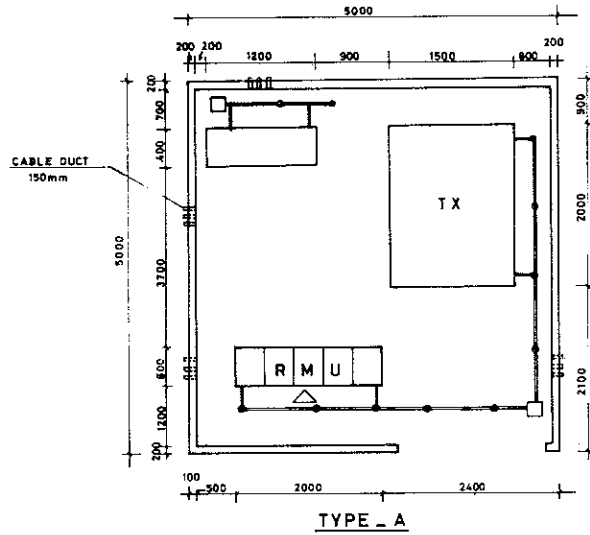


Fig.9. Basic earth monitoring circuit



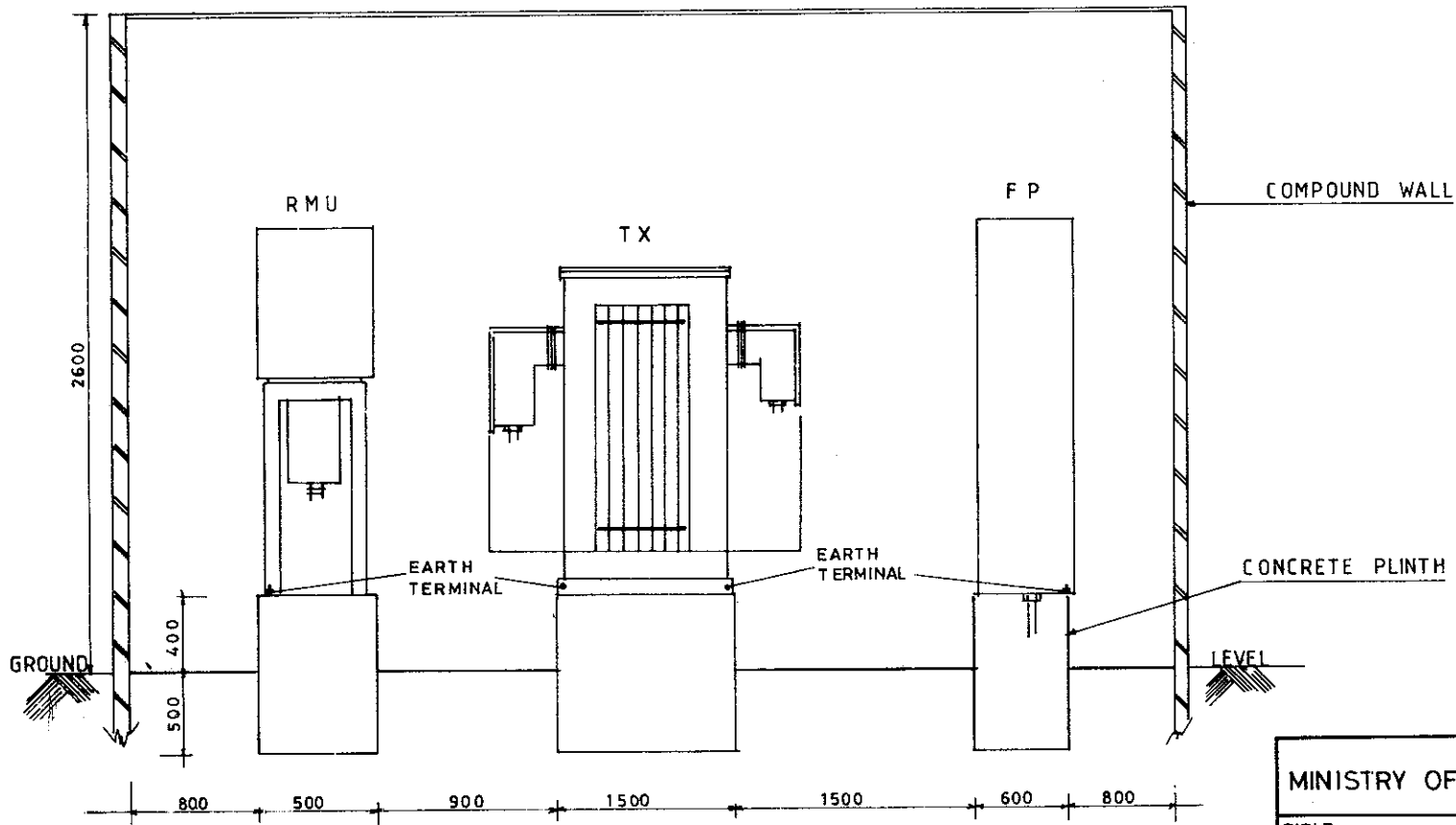
- NOTE -
- 1 All cable armour to be connected by separate braided copper strap to earth bar inside feeder pillar
 - 2 Neutral bar and earth bars inside to be connected solidly by bolted link in case of main feeder pillar and should remain separate in sub-distribution feeder pillar
 - 3 Incoming and outgoing cable armour to be connected to earth bar inside the feeder pillar

MINISTRY OF ELECTRICITY & WATER		
L.T. SERVICES FROM FEEDER PILLAR		
DRAWN FRANCIS	CHECKED <i>[Signature]</i>	APPROVED <i>[Signature]</i>
DRAWING NO: MEW / OH - GA / 16		
SCALE N.T.S.	DATE - 31 - 03 - 1986	



- LEGEND**
1. EARTH PIT WITH EARTH ROD DRIVEN TO REQUIRED DEPTH TO OBTAIN RESISTANCE NOT EXCEEDING 5 OHMS. EARTH ROD SHOULD BE IN COPPER.
 2. COPPER EARTH CONDUCTOR 70mm² XLPE INSULATED [LT]
 3. COPPER EARTH CONDUCTOR 70mm² XLPE INSULATED [HT]
 4. EARTH SPIKE COPPER 16mm DIA 1200mm LONG
 5. MAIN EARTH CONDUCTOR AND SPIKE BURIED 500mm BELOW GROUND LEVEL.
- NOTE - LT SINGLE CORE CABLE ARMOUR TO BE BONDED ON FEEDER PILLAR SIDE ONLY
EARTH PIT AS PER DRAWING NO MEW/OH-GA/24

MINISTRY OF ELECTRICITY & WATER		
TITLE 11KV/433V. TYPICAL SUBSTATION LAYOUTS		
DRAWN FRANCIS	CHECKED <i>[Signature]</i>	APPROVED <i>[Signature]</i>
DRAWING NO: MEW/OH-GA/17 (Sheet 1 of 2)		
SCALE - N. T. S.	DATE - 19. 03. 1986	



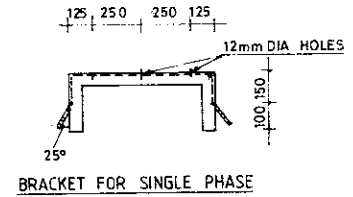
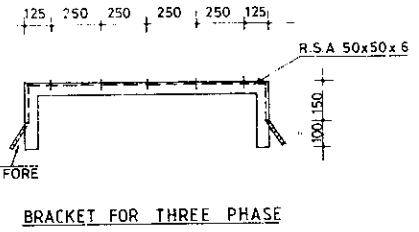
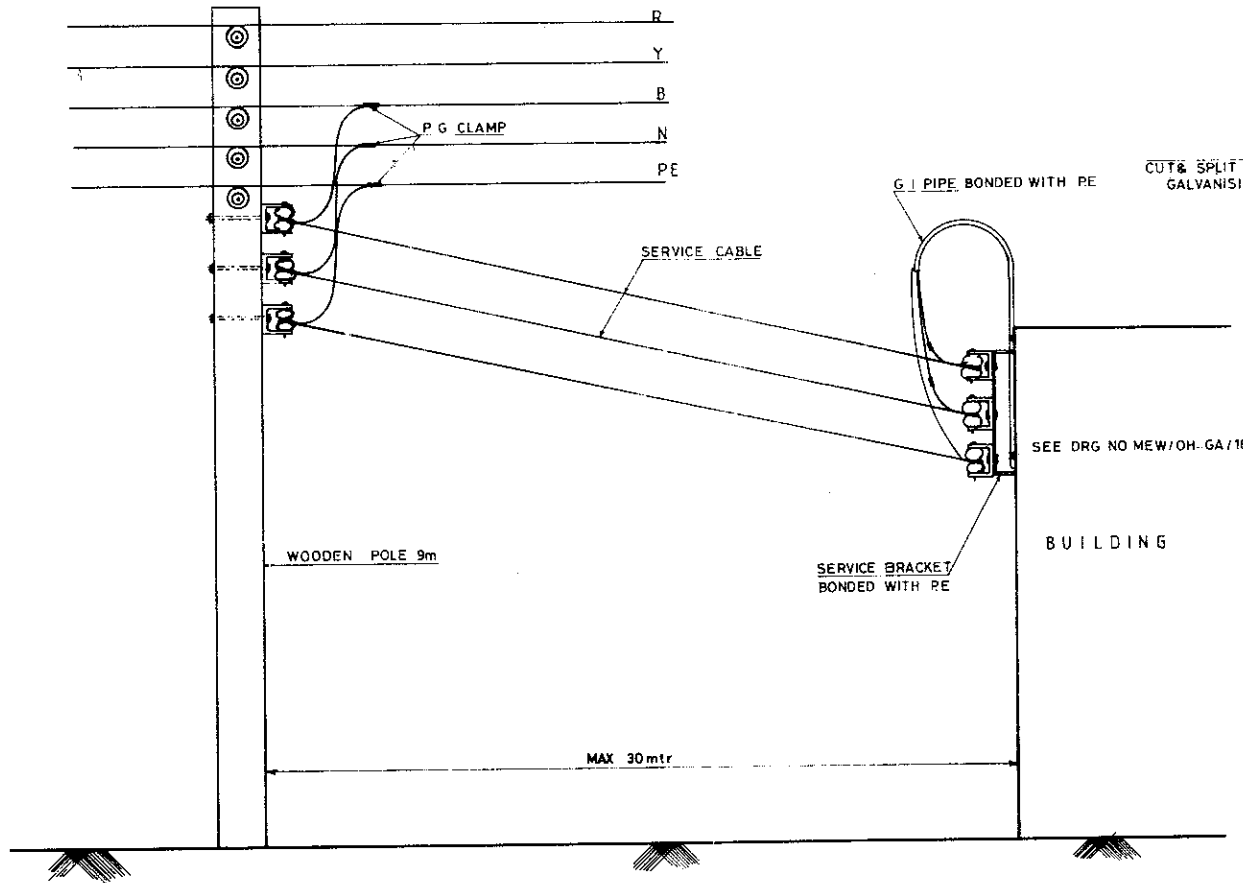
MINISTRY OF ELECTRICITY & WATER

TITLE 11KV/433V. TYPICAL
SUBSTATION LAYOUTS

DRAWN FRANCIS	CHECKED <i>[Signature]</i>	APPROVED <i>[Signature]</i>
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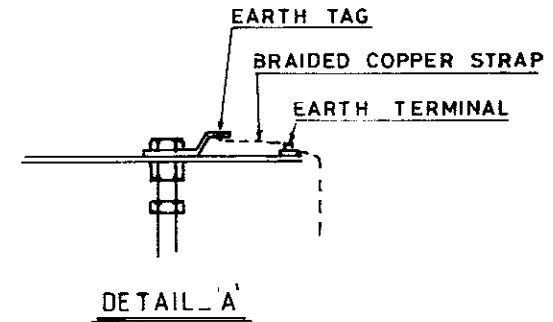
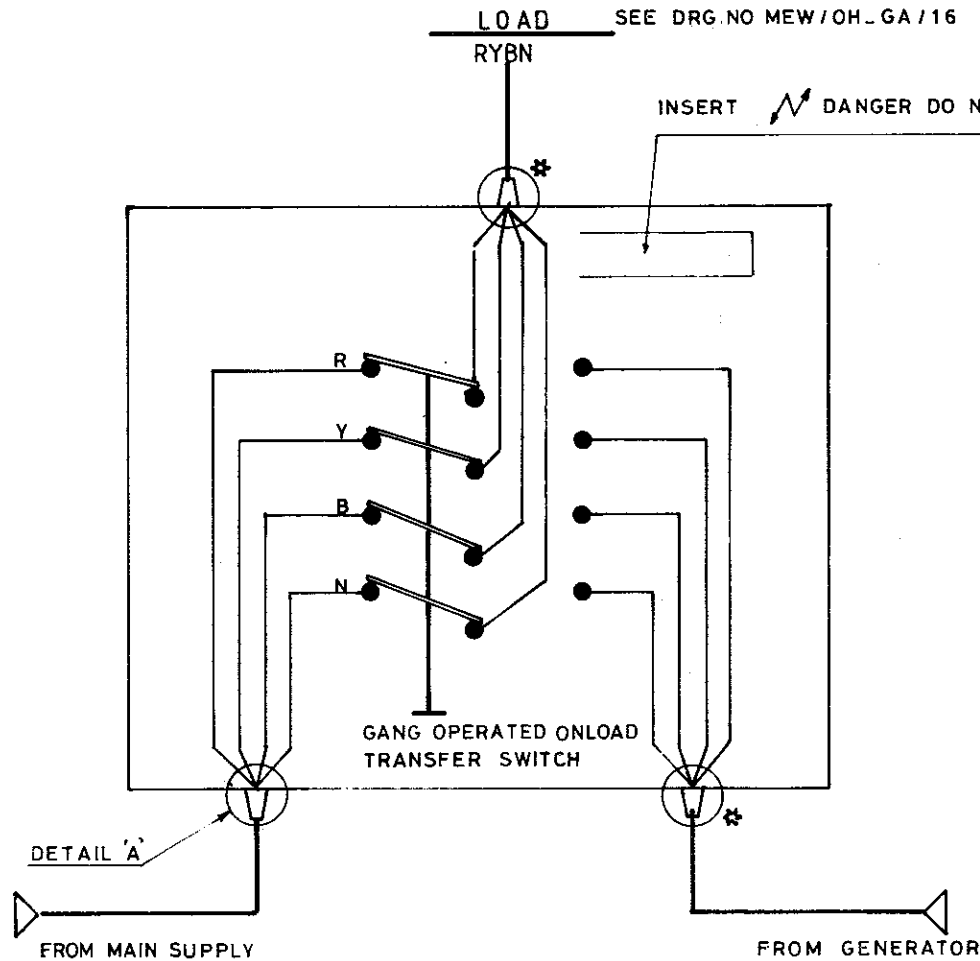
DRAWING NO: MEW/OH_GA/17 (Sheet 2 of 2)

SCALE - N.T.S. DATE - 09-04-1986



NOTE: R.S.A 50x50x6mm BRACKETS GALVANISED TO BS 729
 ALL DIMENSIONS IN MILLIMETERS

MINISTRY OF ELECTRICITY & WATER		
TITLE LT. SERVICE FROM OVERHEAD LINE		
BRAWN FRANCIS	CHECKED	APPROVED <i>base</i>
DRAWING. NO: MEW/OH-GA/19		
SCALE: N.T.S.	DATE: 18-01-1987	



NOTE -
OPERATING HANDLE OF TRANSFER SWITCH TO BE INSULATED TO 2-5KV TEST VOLTAGE

* ARMOUR NOT TO BE BONDED WITH METAL CASE

MINISTRY OF ELECTRICITY & WATER

L.T SERVICE WITH CHANGE OVER STANDBY SUPPLY

DRAWN FRANCIS	CHECKED <i>[Signature]</i>	APPROVED <i>[Signature]</i>
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DRAWING NO: MEW/OH-GA/20

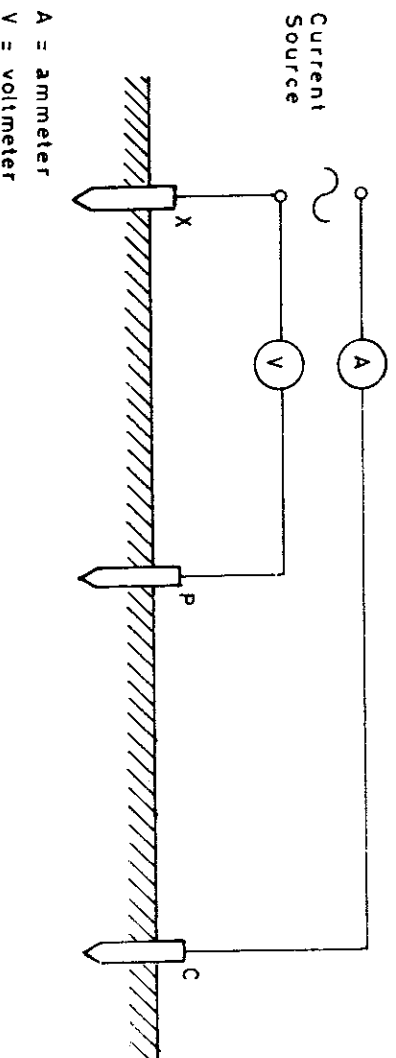
SCALE - N.T.S.

DATE - 06-04-1986

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.