REVISED/MODIFIED

NEW ADDITION

MINISTRY OF ELECTRICITY & WATER

REGULATIONS FOR ELECTRICAL INSTALLATIONS

M.E.W. R-1

Sixth Edition 2013

Copies may be obtained from the Electrical Installation Department
Ministry of Electricity & Water
P.O.Box:12, Safat, Kuwait

OTHER RELATED PUBLICATIONS

(1)	Procedures for Approval of Electrical & A/C Drawings and connection of power supply for construction and buildings projects. 1st Edition 1983	MEW R-2
(2)	Electrical load form and explanatory memo. 2nd Edition 1983	MEW R-3
(3)	Regulations for testing of Electrical installations before connection of Power Supply. 1st Edition 1983	MEW R-4
(4)	General Guidelines for Energy Conservation in building. 2nd Edition 1983	MEW R-5
(5)	Code of Practice for Energy Conservation measures in Kuwait building and Appendices. 1st Edition 1983	MEW R-6
(6)	Rules and Regulations for design of A/C System and Equipment. 3rd Edition 1983	MEW R-7
(7)	Rules and Regulations for handing over Engineering Services (Electrical and Mechanical) to the Maintenance Authority. 2nd Edition 1983	MEW R-8
(8)	General specification for electrical installations. 4th Edition 2014	MEW S -1

Preface to Sixth Edition

The Ministry of Electricity and Water has updated the fifth edition of Regulations for Electrical Installations in the light of various comments received and also to take into account of the publication of the new or amended IEC, BS and IET Regulations after adapting them to Kuwaiti conditions where necessary. It is the intention of the Ministry to re-examine these regulations once every three months and if found necessary, to issue amendment sheets. Engineers and others are there- fore requested to contact the Ministry of Electricity and Water, Consumers Electrical Installations Department every three months and collect any amendment sheets that may have been issued.

As acknowledged in the earlier edition of the regulation, certain clauses and tables of the present Regulations are included by permission of the International Electro-technical Commission (IEC) which retain the copy right.

Likewise some other clauses and material of the present Regulations are included from the 17th edition of IET Regulations by permission of the Institution of Engineering and Technology (IET), UK, which retains the copy right.

This sixth edition of the regulation includes three new sections in it. One section has been included to take into account the specific requirements for electrical installations in special locations, like marina and similar locations and medical locations. This is included in Section 11.

One section is dedicated to provide the regulations on power factor correction of the electrical distribution systems that is governed by the Ministerial Decree No. 5/2010 dated 18th January 2010. This is included in Section 12.

A third section provides the regulations on the requirements for connecting the solar power generation to the MEW grid. This is included in Section 13. Previous Sections 11, 12 and 13 have been renumbered accordingly.

In addition, in this new edition, the installation methods of cables have been updated in line with the 17th edition of IET Regulations and tables of current carrying capacities for all copper cables and tables for all correction factors have been fully revised. Also additional tables for current carrying capacities for Aluminium cables have been included in the edition.

Contents

SECTION 1

SCOPE

101 These regulations are applicable to all electrical installations in buildings, structures and premises in the State of Kuwait.

102 Compliance to these regulations is compulsory and electrical power supply shall not be made available if these regulations are not met with in their entirety.

103 These regulations are not intended to be design or material specifications but are primarily related to the requirements for electrical installations so as to ensure safety of persons and property from hazards arising from the use of electricity.

NOTE - The Ministry of Electricity and Water publishes from time to time standard specifications for electrical installation works. It is recommended that all consumers make reference to these standard specifications and require compliance to them in their contract agreements with the electrical contractors.

104 The regulations do not provide for all types of conditions but encompasses the general type of installations generally encountered. Where difficult or special situations are met with which are not covered or allowed for in these regulations, the services of the Ministry of Electricity and Water may be sought to obtain the best solution.

105 Various explanatory notes are added to the different regulations. These notes are not part of the regulations and have been included to give a convenient explanation of the regulations only.

106 Existing electrical installations executed in accordance with the previous regulations and already connected to the electrical supply, shall be exempted from the additional safety requirements stated herein.

107 These regulations are equally applicable for all electrical installations in caravans and pre-fabricated buildings.

108 Where for construction purposes or otherwise a temporary supply is required, then the temporary electrical installations shall fulfil as a minimum with all the safety requirements and shall be to the approval of the Ministry of Electricity and Water in each case.

SECTION 2

DEFINITIONS

Accessory. A device other than current-using equipment associated with such equipment or with the wiring of an installation.

Adaptor, Socket outlet. An accessory for insertion into a socket outlet and containing metal contacts to which may be fitted one or more plugs for the purpose of connecting to the supply portable lighting fittings or current using appliances.

Ambient temperature. The temperature of the air or other medium where the equipment is to be used.

Appliance. An item of current-using equipment other than a luminaire or an independent motor.

Barrier. A part providing a defined degree of protection against contact with live parts, from any usual direction of access.

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

Busbar trunking system. A type-tested assembly, in the form of an enclosed conductor system comprising solid conductors separated by insulating material. The assembly may consist of units such as:

- busbar trunking units, with or without tap-off facilities
- tap-off units where applicable
- phase-transposition, expansion, building-movement, flexible, end-feeder and adaptor units.

NOTE - Other system components may include tap-off units.

Cable coupler. A means enabling the connection, at will, of two flexible cables. It consists of a connector and a plug.

Cable trunking. A closed enclosure normally of rectangular cross-section, of which one side is removable or hinged, used for the protection of cables and for the accommodation of other electrical equipment.

Caravan. Any structure designed or adapted for human habitation which is capable of being moved from one place to another.

Circuit breaker. A mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions and also of making, carrying for a specified time, and breaking currents under specified abnormal circuit conditions such as those of short circuit.

NOTE - A circuit breaker is usually intended to operate infrequently, although some types are suitable for frequent operation.

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

Connector. A device intended for connection to a flexible cord or flexible cable which has protected current carrying contact tubes similar to those of a socket outlet.

Consumer's installation. Wiring and apparatus situated upon the consumer's premises and controlled or/and installed by him, excluding any switchgear of the supply undertaking.

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

Current-carrying capacity of a conductor. The maximum current which can be carried by a conductor under specified conditions without its steady state temperature exceeding a specified value.

Damp and Dust-proof. Applied to apparatus and accessories to denote that the live and other component parts are protected by an enclosure or enclosures being so protected and/or fitted as to prevent the ready ingress of dust and/or moisture.

Damp situation. A situation in which moisture is either permanently present or intermittently present to such an extent as to be likely to impair the effectiveness of an installation conforming to the requirements for ordinary situations.

Danger. Danger to health or danger to life or limb from shock, burn, or injury from mechanical movement to persons (and livestock where present), or from fire, attendant upon the use of electrical energy.

Distribution board. An assemblage of parts including one or more fuses or circuit-breakers, arranged for the distribution of electrical energy to final circuits or to other distribution boards.

Duct. 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 including any clamp, connecting to the consumer's earthing terminal, those parts of an installation which are required to be earthed. It may be in whole or in part the metal conduit, trunking, or duct, or the metal sheath and /or armouring of a cable, or the special earth continuity conductor of a cable or flexible cord incorporating such a conductor.

Earth electrode. A metal rod or rods, or other conducting object, providing an effectual connection with the general mass of the earth.

Earthed. Effectually connected to the general mass of the earth.

Earthing lead. The final conductor by which the connection to the earth electrode, or other means of earthing, is made.

Electrode boiler (or electrode water heater). Equipment for the electrical heating of water or electrolyte by the passage of an electric current between electrodes immersed in the water or electrolyte.

Electric discharge lamp. An electric lamp comprising a hermetically sealed bulb or tube containing gas and/or metal intended to be vaporized during operation and fitted with electrodes between which a discharge of electricity takes place, the useful light being emitted either by the discharge through the gas or vapour or by the fluorescence of translucent coating which may be on the inner surface of the outer tube or bulb.

Emergency switching. Rapid cutting off of electrical energy to remove any hazard to persons, livestock, or property which may occur unexpectedly.

Enclosure. A part providing an appropriate degree of protection of equipment against certain external influences and a defined degree of protection against contact with live parts from any direction.

Excess current protection. Excess current protection which will operate within four hours at 1.45 times the designed load current of the circuit which it protects.

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

Fixed equipment. Equipment fastened to a support or otherwise secured in a specific location.

Fuse element. A part of a fuse designed to melt when the fuse operates.

Fuse link. A part of a fuse, including the fuse element(s), which requires replacement by a new fuse link after the fuse has operated and before the fuse is put back into service.

Insulation. Suitable non-conducting material enclosing, surrounding or supporting a conductor.

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 and a difference of voltage exists between the conductor and earth.

Neutral conductor. The neutral conductor of a three phase 4-wire system, the conductor of a single phase installation which is earthed by the M.E.W.

Occupancy single. A single occupancy building is one which is normally occupied by one consumer only and is provided with one kilo-watt-hour meter at each intake.

NOTE- Buildings and premises which have only one kilo-watt-hour meter but are occupied by Different tenants will not be considered as a single occupancy.

EXCEPTION- Residential, hotels and other similar resorts will be considered as single occupancy buildings with one or more kilo-watt-hour meters to the same consumer.

Occupancy-multi. A multi-occupancy building is one which is occupied by more than one tenant and is provided with one or more kilo-watt-hour meters.

Phase conductor. A conductor of an a.c. system for the transmission of electrical energy, other than a neutral conductor.

Plug. A device, provided with contact pins, which is intended to be attached to a flexible cable, and which can be engaged with a socket outlet or with a connector.

Point (in wiring). A termination of the fixed wiring intended for the connection of current-using equipment.

Portable equipment. Equipment which is moved while in operation or which can easily be moved from one place to another while connected to the supply.

Ring circuit. A final circuit arranged in the form of a ring and connected to a single point of supply.

Socket outlet. A device, provided with female contacts, which is intended to be installed with the fixed wiring, and intended to receive a plug.

NOTE- A luminaire track system is not regarded as a socket outlet.

Space factor. The ratio (expressed as a percentage) of the sum of the overall cross-sectional areas of cables (including insulation and any sheath) to the internal cross-sectional area of the conduit or other cable enclosure in which they are installed. The effective over-all cross-sectional area of a non-circular cable is taken as that of a circle of diameter equal to the major axis of the cable.

Spur. A branch cable connected to a ring circuit.

Stationary equipment. Equipment which is either fixed, or equipment having a mass exceeding 18 kg and not provided with a carrying handle.

Switch. A mechanical switching device capable of making, carrying and breaking current under normal circuit conditions, which may include specified operating overload conditions, and also of carrying for a specified time currents under specified abnormal circuit conditions such as those of short circuit.

NOTE- A switch may also be capable of making, but not breaking, short circuit currents.

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

Switchboard. An assembly of switchgear with or without instruments, but the term does not apply to a group of local switches in a final circuit.

Switchgear. An assembly of main and auxiliary switching apparatus for operation, regulation, protection or other control of electrical installations.

Trunking. Refer to cable trunking

Voltage nominal. Voltage by which an installation (or part of an installation) is designated. The following ranges of nominal voltage (r.m.s. values for a.c.) are defined:

Extra low - Normally not exceeding 50 V a.c. whether between conductors or to Earth.

Low - Normally exceeding extra-low voltage but not exceeding 1000V a.c. between conductors, or 600V a.c. between conductors and Earth.

NOTE - The actual voltage of the installation may differ from the nominal value by a quantity within normal tolerances.

SECTION 3

GENERAL REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

301 All electrical equipment, accessories and fittings employed in electrical installations shall be fully suitable for use in the extreme climatic conditions of Kuwait having the following salient features:-

Maximum sun radiation temperature in summer.	: 84 ^{o}C
Maximum ambient temperature in summer.	: 55 ^{o}C
Average maximum ambient temperature in summer.	: 45 ^{o}C
Minimum ambient temperature in Winter.	: -6 ^{o}C

Periods of high humidity are common and a relative humidity of 100% at 30°C has been recorded. Violent sand storms are common and even on comparatively still days fine dust is carried in suspension in the air.

302 In buildings of substantial construction, all electrical equipment and cables shall be rated for continuous operation at the maximum and the minimum ambient temperatures encountered in Kuwait.

303 All electrical equipment, accessories and fittings shall be designed and manufactured to operate continuously in the electricity supply system having the following characteristics:-

Voltage	415 volts $\pm$ 6 percent, 3 phase, 4 wire.
Frequency	50 Hz $\pm$ 4 percent.
Neutral	Solidly earthed, TT System
Fault level	31 MVA at 415 volts.
Fault duration	0.5 seconds.

NOTE - Where it can be established that the fault level is lower than 31 MVA, electrical switchgear and accessories with a lower interrupting capacity may be employed subject to the prior approval of the Ministry of Electricity and Water.

304 All electrical wiring shall be so installed that when completed the system will be free from short circuits and earth faults.

305 Devices intended to break current shall have a breaking capacity sufficient for the voltage employed and for the current that must be interrupted.

306 All electrical equipment shall be firmly secured to the surface on which it is mounted. Wooden plugs driven into holes in masonry, concrete, plaster or similar materials shall not be used.

307 All electrical equipment, accessories and fittings exposed to weather, corrosive atmosphere or other adverse conditions shall be so constructed or protected as may be necessary to prevent danger arising from such exposure.

308 Where electrical equipment, accessories, fittings and cables are likely to be exposed to flammable surroundings or an explosive atmosphere, it shall be protected by a flame-proof enclosure or be otherwise so designed and constructed as to prevent danger. Cables with improved fire-resisting characteristics shall be used for such installations.

309 All electrical equipment, accessories, fittings and cables shall be installed in a neat and workmanlike manner so as to facilitate its easy operation, inspection and maintenance.

310 All materials used in electrical installation shall be of good quality and shall comply as a minimum with the latest relevant recommendations of the International Electro-Technical Commission (l.E.C.) and If this is not available to the latest relevant British Standard Specifications (B.S.S.). Materials of other national standards may also be employed provided they are comparable with IEC/BSS.

311 No addition, temporary or permanent, shall be made to the authorized load of an existing installation, unless it has been ascertained that the current rating and the condition of any existing conductors and equipment which will have to carry the additional load are adequate for the increased loading and that the earthing arrangements are also adequate.

NOTES - l. Any additions to existing installations shall only be executed after approval of drawings by the Ministry of Electricity and Water.

2. The Ministry of Electricity and Water reserves the full right to disconnect the electrical supply to any consumer who has carried out unauthorized addition or extension to the originally approved electrical installation.

313 All electrical installation works, new and/or a additions shall only be carried out by licensed electrical supervisors or approved electrical contractors, as authorized by the Ministry of Electricity and Water from time to time.

314 All electrical equipment including fractional H.P. motors, window A/C units, fluorescent light fittings, etc., shall be so selected that the over-all power factor is not less than the following:

	P.	P. F.
Fluorescent and discharge light fittings		0.90
Window type A/C units		0.85
Refrigerators		0.85
Other single phase motors		0.80
3-phase motors (415 V, 50 Hz, 1450 rpm)		
Motors 15 HP - 50 HP		0.83
Motors 50 HP - 100 HP		0.85
Motors 100 HP - 200 HP		0.87
Motors 200 HP - 400 HP		0.88
Motors Above 400 HP		0.89

SECTION 4

SERVICE INTAKE

401 A building or premises shall normally be provided with only one service intake by the Ministry of Electricity and Water.

EXCEPTIONS: 1. Where the total connected load requirements are in excess of 200 KVA and the prior approval of the Ministry of Electricity and Water has been obtained, two or more service intakes may be permitted. In all such cases the electrical installations shall be so designed and arranged that each supply caters to a distinct and separate part of the building.

2. A second service intake may also be allowed for a building to serve an electrically operated fire pump provided the local Fire Authorities have approved the installation of such a pump without requiring its connection to an alternate source of emergency power.

402 The Ministry of Electricity and Water shall normally provide a three phase and neutral service and the consumers electrical installations shall be arranged for connection to the three phases. In special situations where the total connected load is less than 10 KVA, the Ministry of Electricity and Water may provide a single phase and neutral service.

403 Where the total connected load requirements of any building is in excess of 400 KVA the consumer may be required to provide within his own premises and at an approved location adequate space for the installation of an electrical sub-station.

404 The sub-station shall comprise of an 11KV switchboard and one or more 11/0.433KV transformers, all of which will be provided by the Ministry of Electricity and Water. The low tension switchboard controlling the electrical installations of the building or premises shall be supplied by the consumer in case the sub-station is purely to cater to the load of his premises. This low tension switch board shall be installed in a room adjacent to the sub-station. All civil works, ventilation and fire protection within the sub-station shall be to the requirements and approval of the Ministry of Electricity and Water.

405 The electrical installations in every building shall be adequately controlled by switchgear located adjacent to the service intake and which is readily accessible to the consumer. The switchgear shall form an integral part of the low tension switchboard of the building and shall be completely enclosed in metal or approved insulating material. This switchgear shall incorporate means of isolation, means of excess current protection and means of earth leakage protection.

NOTES - 1. For reasons of selectivity, means of earth leakage protection may be sub divided and provided on the various outgoing feeders from the switchgear. In this event earth leakage protection on the incoming switchgear may be omitted.

2. The switchgear shall not be installed in store, kitchen, bathroom/toilets, above sinks and below staircase having less than 2 metres of vertical distance between floor and the celling.

406 In single occupancy buildings, the switchgear detailed in Clause 405 shall also be the consumers main means of isolation and provision for installing the MEW's service cabinet or cable cut-out and Kilo-watt-hour-meter shall be allowed immediately preceding the switchgear. The service cabinet shall be installed on the outside of the front boundary wall of the premises.

NOTE - The Kilo-watt-hour-meter may be integrated into the low tension switchboard of the building.

407 In multi-occupancy buildings, the switchgear detailed in Clause 405 shall be considered only as a means of isolating the electricity supply from the entire building in the event of an emergency and separate means of isolating the electrical supply of each individual consumer shall be provided. Such means of isolation shall incorporate separate means of excess current and earth leakage protection and shall be located at a position which is fully under the control of the consumer.

NOTES - 1. In multi-occupancy buildings proper selection of both excess current and earth leakage protection is essential in order to ensure discrimination in the operation of these protective devices.

2. In multi-occupancy buildings, the requirements of a separate means of earth leakage protection as set out in Clauses 405 and 412 may be omitted. Provided each individual consumer's switchgear is equipped with such protection and all metal works are bonded.

408 The means of isolation provided for individual consumers in a multi-occupancy building may be combined together and installed adjacent to the service intake provided facilities are available for pad- locking and sealing each individual means of isolation in the OFF position. Where such means of isolation is provided additional isolation within the consumer's premises shall also be available.

409 Adequate space shall be provided adjacent to the consumer's switchgear to install Ministry of Electricity and Water's cable cut-out and cable. The overall dimensions of Ministry of Electricity and Water's standard cable cut-outs and the minimum distance between the bottom of the cut-out and the floor level shall be as indicated below. The cable entry duct shall be laid at a depth of 750 mm below ground level and terminated immediately below the space demarcated for the cut-out in a manhole of ample dimensions.

Size of Cut-out Amp	Height mm	Width mm	Depth mm	Minimum distance between bottom of cut-out and floor mm
100	375	400	150	1000
160	600	400	150	1000
200	600	400	150	1000
250	600	400	150	1000
300	730	400	150	1000

410 The means of isolation shall be by a load break switch or circuit breaker arranged to disconnect all the live conductors only and equipped with an isolating link on the neutral conductor.

411 The excess current protection shall be either by means of fuses or over-current releases fitted in each live conductor. The rating of the excess current and isolation devices shall be determined in accordance with the total connected load.

NOTE - Section 5 of these regulations deals in detail with excess current protection which shall be complied with fully.

412 The earth leakage protection shall be by means of an appropriate earth leakage circuit breaker or by means of an earth leakage relay operating the shunt trip of the circuit breaker. The earth leakage protection shall disconnect the electricity supply to the building or to sections of the building in the event of any danger from earth leakage currents.

413 The installation of automatic earth leakage protection as set out in clause 412 does not exclude the necessity of bonding all non-current carrying metal to the earthing system or for the necessity of providing sufficient and adequate earth electrodes.

NOTE - Section 6 of these regulations deals in detail with earthing and earth leakage protection which shall be complied with fully.

414 The means of isolation, excess current and earth leakage protection may all be combined into one component equipment.

415 In multi-occupancy buildings, the Kilo-watt-hour meters for all consumers shall preferably be installed adjacent to the service intake.

NOTES - 1. Kilo-watt-hour meters shall not be installed within the consumer's premises or at locations which don't have ready access to Ministry's meter reader. All kilo-watt-hour meters shall be installed prior to the consumers means of isolation.

2. Where a number of kilo-watt-hour meters are grouped together at one place, they shall be Housed inside a suitable and neatly manufactured and installed cabinet with hinged doors (not lockable) so as to conceal all wiring connections.

EXCEPTION: ln multi-occupancy buildings where it is impracticable to group the various kilo-watt-hour Meters at one single location adjacent to the service intake, kilo-watt-hour meters may be grouped at different locations within the building, provided always that such locations are readily accessible for meter readers and the Ministry's prior approval has been obtained.

416 In multi-occupancy buildings the feeders from the service intake position to the individual consumer's switchgear shall always be installed in separate conduits and no conduit shall contain the feeders to more than one consumer.

EXCEPTION: Where bus bar trunking is employed for load distribution to different floors of multi-occupancy buildings, then the feeders from the floor distribution boards to the individual consumers switchgear shall comply with the above requirements.

417 Sufficient and adequate working space shall be provided in the vicinity of the service intake and associated switchgear to permit safe operation, inspection and repairs. Unless the service intake and switchgear are located in a separate room, access to which is available at all times, it shall be properly enclosed to prevent entry by unauthorized persons.

418 Adequate illumination shall be provided in the vicinity of the service intake and switchgear. In multi-occupancy buildings or other public premises self-contained emergency lights capable of providing illumination for a period of 3 hours from a battery sources shall be provided. Such emergency lights shall be switched on automatically in the event of failure of supply. Alternatively, lights connected to a maintained/emergency source with automatic change over in the event of failure of normal supply shall be provided.

NOTE - In single occupancy buildings the installation of emergency lights as described above is recommended.

SECTION 5

EXCESS CURRENT PROTECTION

501 Every conductor in an installation, other than an earthed conductor or those exempted under clause 504 shall be protected against excess current by a fuse or circuit-breaker fitted at the origin of a circuit of which the conductor forms a part.

502 The current rating of every fuse employed for the above purpose shall not exceed the current rating of the conductor to be protected.

503 The current rating of every circuit breaker employed for the purpose of affording excess current Protection shall be such that it will operate when subjected to a sustained excess of 1.45 times the rating of The conductor to be protected.

504 Clause 501 may be omitted in the following cases:

(a) Circuits in which the omission of excess current protection is necessary to prevent danger, e.g. shunt trip circuit of a circuit breaker.

(b) Auxiliary circuits of apparatus contained entirely within the enclosure of the apparatus.

505 All fuses employed within the electrical installations shall be H.R.C. Cartridge fuses. Rewireable fuses shall not be employed. ·.,

506 The rating of the excess current protective device indicated in clauses 502 and 503 above applies to the phase conductor only and in a 3 phase, 4 wire installation, having a reduced neutral conductor, the excess current protective device need not be related to the rating of the neutral conductor.

507 Where floor distribution boards are connected by means of tap off units from adjacent bus bar trunking the excess current protection may located at the load end and not at the origin of the circuit provided that both are located in the same room.

508 Each excess current protective device shall be fully suitable for withstanding the maximum short circuit current attainable at that location.

509 The selection and ratings of excess current protective devices throughout an installation shall be so arranged that proper discrimination is ensured during operation of these excess current protective devices.

SECTION 6

EARTHING AND EARTH LEAKAGE PROTECTION

601 Every consumer, who is provided with a separate service intake by the Ministry of Electricity and Water, shall provide an adequate earth electrode immediately adjacent to the service intake. The earth electrode shall be housed in an approved handhole which shall be fitted with a heavy duty inspection cover. The earth electrode shall comprise of a copper clad rod of 16 mm. diameter driven to a minimum depth of 3 metres. The radial copper coating shall be minimum 250 microns with 99.9% copper content. The top of the electrode shall be provided with a corrosion resistant terminal connection. The connection of the earthing lead to the earth electrode shall be soundly made and electrically and mechanically satisfactory and suitably labeled.

602 The overall resistance between any point on the earth installation and the general mass of the earth shall be less than 2.0 ohms.

NOTE - In order to achieve the above value in areas of high soil resistivity It may be necessary to install more than one earth electrode.

603 Every consumer's electrical installation shall be provided with an earthing terminal which shall be located adjacent to the consumers supply intake and within his boundaries. Throughout the consumers electrical installation, an earth continuity conductor of adequate size and coloured green/yellow shall be provided and connected to the earthing terminal. The cross sectional area of copper earth continuity conductors shall be in accordance with the appropriate table in Section 15. In mechanical plant rooms and other similar locations flat copper tape may be employed in place of stranded conductors.

604 The earthing terminal of every socket outlet shall be connected to the earth continuity conductor of the final circuit. Where the earth continuity conductor is formed by conduit or trunking, the earthing terminal of each socket outlet shall be connected by a conductor of adequate size to an earthing terminal incorporated in the associated box or other enclosure.

605 At every lighting point an earth terminal shall be provided and connected to the earth continuity conductor of the final circuit. An earth terminal, connected to the earth continuity conductor of the final circuit, shall be provided at every lighting switch position unless this takes the form of an earthed metal box having a means of fixing the switch plate in reliable electrical contact with the box.

606 Where wiring is enclosed in a continuous system of metallic conduit or trunking, such conduit or trunking may be employed as an earth continuity conductor provided all joints are electrically sound and the specified earth continuity resistances can be obtained and maintained. The steel armouring of cables may also be employed as a near the continuity conductor provided the specified earth continuity resistances can be obtained and maintained.

607 Where steel conduit, trunking and/or cable sheath, armouring, form a part or whole of the earth continuity conductor, the resistance of any point in the earth continuity system to the main earth electrode shall not exceed 0.5 ohms including the connection to the main earth electrode. Where the earth continuity conductor is composed entirely of copper then they said resistance shall not exceed 1ohm.

608 All metal work of wiring systems (other than current carrying parts) including cable sheaths and armour, conduits, ducts, trunking and boxes shall be connected to the appropriate earth continuity conductors. The exposed metal work of all domestic apparatus and equipment like window air conditioning units, washing machines, refrigerators and the like shall also be connected to appropriate earth continuity conductors. The exposed metal work of motors, starters and other non-domestic equipment like package and central air conditioning units, air handling equipment, laundry, lift machinery and the like, shall also be effectively connected to a main earth continuity conductor which is directly connected at both ends to earth electrodes. The connection

from each piece of equipment to the main earth continuity conductor shall be by separate branch earth continuity conductors of adequate sizes and in accordance with the appropriate table in Section 15. Branch earth continuity conductors shall be connected to main earth continuity conductors by permanently soldered, fusion welded or mechanically clamped joints that will not be accidentally or unwittingly broken. The series method of earthing one piece of apparatus to another shall not be permitted except in the case of socket outlets connected to a ring circuit and lighting points.

609 The consumers earthing terminal mentioned in clause 603 shall be connected by an earthing lead of appropriate size to the earth electrode located adjacent to the service intake. The main earthing lead from the consumer earthing terminal to the earth electrode shall not be run through steel or other conduit or duct of magnetic material, but shall be protected from damage by suitable sheathing which shall not completely encircle the earth conductor, if the sheathing is of steel or other magnetic materials. No earthing lead run separately shall be smaller than 6 sq.mm. The size of earthing leads shall be in accordance with the appropriate table in Section. 15.

610 Every consumer's installation shall in addition to the foregoing be equipped with earth leakage protection by one or more current operated earth leakage circuit breakers to afford the protection stipulated in Clause 611 to 613.

611 The following degree of protection against earth leakage shall be provided throughout the electrical installation.

Maximum 10 mA trip rating - for under-water lighting.
Maximum 30 mA trip rating - all socket outlets and domestic apparatus.
Maximum 300 mA trip rating - lights
Preferably 300 mA and maximum 500 mA trip rating - all other apparatus and equipment such as A/C plants, lifts, pumps, etc.

EXCEPTION:

1. Where an immediate disconnection of the electricity supply will cause difficulties to consummers, the M.E.W. may permit omission of earth leakage circuit breakers provided in each case a separate approval is obtained and the portion of the installation so exempted is provided with an audio-visual alarm indicator.

2. For motors driving fire pumps, the provision of current operated earth leakage circuit breakers will not be permitted and an audio-visual alarm indicator shall be provided.

3. For motors over 15 H.P. earth leakage protection shall be provided individually for each motor and a common earth leakage protection for a group of motors will not be permitted.

612 In multi-occupancy buildings and other similar locations the operation of any current operated earth leakage circuit breaker shall not interrupt the electricity supply from any other consumer in the same premises.

613 The neutral conductor shall not be earthed anywhere within the consumers premises.

614 Throughout the low voltage electrical installation the earthing system shall be separated and divorced from the earthing system of 11 KV or higher voltage systems.

SECTION 7

WIRING AND DISTRIBUTION ARRANGEMENTS

700 WIRES AND CABLES

700--1 Every cable for use as fixed wiring shall be selected from one of the following types:

i) 600/1000 Volts multi-core PVC insulated and PVC sheathed armoured and unarmoured cables.

ii) 600/1000 Volts multi-core XLPE insulated, PVC sheathed armoured and unarmoured cables.

iii) 600/1000 Volts multi-core silicone rubber insulted hard grade PVC sheath bonded to coated aluminium foil cable with fire resistance and fire retardant properties.

iv) 600/1000 Volts single core PVC insulated and PVC sheathed armoured and unarmoured cables.

v) 600/1000 Volts single core XLPE insulated, PVC sheathed armoured and unarmoured cables.

vi) 600/1000 Volts and single core PVC or XLPE insulated and non-magnetic armoured cables.

vii) 600 Volts Mineral insulated cables.

viii) 450/750 Volts single core PVC insulated and sheathed cables.

ix) 450/750 Volts single core PVC insulated cables.

x) 450/750 Volts twin core and earth PVC insulated and sheathed cables.

xi) Other cables subject to the approval of M.E.W .

All cables except (i), (ii), (iv) and (v) shall have conductors of plain annealed copper. Cables (i), (ii), (iv) and (v) may have conductors of aluminium or plain annealed copper. The PVC insulation employed shall be suitable for the site conditions.

700--2 The maximum permissible drop in voltage from the consumer's terminals (Service Intake) 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 3 phase systems). When a project is having its own electrical distribution substation, the maximum permissible drop in voltage from the substation to any point in the installation shall not exceed 5% of the nominal voltage when the conductors are carrying full load current.

700--3 Sizes of single core and multi-core cables shall be such that current carried by them shall not exceed those shown in the appropriate tables in Section 15.

700--4 Cables shall not generally be connected in parallel except where for a particular loading, a single cable is insufficient and it is not practicable to employ bus bar trunking. In such situations single core or multi-core cables may be connected in parallel provided that the cables are of the same type, size and length to ensure proper division of the current.

700--5 Identification of wires and cables

(a) Single core, PVC insulated, non-armoured cables used for wiring shall be identified by the following colours:

Phase	Red
Neutral	Black
Earth	Green/Yellow

(b) The conductors of multi-core PVC insulated armoured and non-armoured cables shall be identified by the following colours:

Two-core cable	Red, Black
Three-core cable	Red, Yellow, Blue or Red, Black, Green/Yellow
Four-core cable	Red, Yellow, Blue and Black.

(c) All wires or conductors of cables connected to the neutral of the supply shall have "BLACK" outer layer of insulation and shall not be used as phase conductor. Similarly, Green/Yellow coloured wires or conductors of cables shall be used as "EARTH" conductor only.

700--6 All conductors and cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of service.

700--7 Cables shall not be run in a lift shaft unless they form a part of the lift installation. Cables of lift installations other than travelling cables in such a shaft shall be protected from mechanical damage and shall be armoured or mineral insulated cables or enclosed in metal conduits.

700--8 The different cables specified in Clause 700 -1 shall be installed in the manner indicated below:

(a) Multi-core and single core PVC or XLPE insulated, armoured and PVC sheathed cables may be directly buried in the ground, laid in trenches and trays or drawn through ducts.
The maximum current carried by any cable will depend upon the worst conditions of installation.

(b) Multi-core and single core PVC or XLPE insulated, non-armoured and PVC sheathed cables may be installed in cable trays and in trenches or fixed to the walls by cleats.
These cables shall only be installed at locations where they will not be damaged.

(c) Single core PVC insulated cables shall only be run in conduits or in trunking.

(d) Twin core and earth PVC insulated and PVC sheathed cables may be run on wooden battens fixed to the walls or may be installed within metallic partitions provided always that they are not liable to damage.

(e) Mineral insulated cables may be installed at locations where flame-proof installations are necessary or at locations of high temperature and elsewhere as required.

NOTE - The ends of mineral insulated metal sheathed cables shall be protected from moisture by being suitably sealed and the insulation shall be thoroughly dry before the sealing material is applied. Such sealing material, and any material used to insulate the conductors where they emerge from the insulation shall have adequate insulating and moisture-proofing properties, and shall retain these properties throughout the range of temperatures to which the cable is subject in service.

(f) Multi-core silicone rubber insulated PVC sheath bonded to coated aluminium foil cable with fire resistant and retardant properties may be employed where flame proof installations are necessary, or at locations of high temperature or for emergency and fire alarms circuits and elsewhere as required.

(g) Single core PVC or XLPE insulated and non-magnetic armoured cables may be installed in cable trays, trenches and ducts or fitted to the walls by cleats. At all locations they shall be protected from mechanical damage.

(h) Single core PVC insulated and sheathed cables may be installed in cable trays.

705 FLEXIBLE CORDS AND CABLES

705--1 No size smaller than 16/0.20mm (0.50 mm²) shall be used. Size of flexible cords and cables shall be such that the current normally carried by them shall not exceed the values shown in the appropriate table in Section 15.

705--2 Where apparatus requires to be earthed, flexible with earth core shall be used.

705--3 Flexible cords and cables shall be so connected to plugs or ceiling roses, etc., that the Brown or Black sheathed conductor is connected to the phase, the Blue sheathed conductor to the neutral and the Green/Yellow conductor to the earth .

705--4 Flexible cables and cords shall be so connected to portable or fixed apparatus, standard lamps, etc., that the green/yellow conductor is connected to the frame of the apparatus and any single pole switches are so connected that they break the phase conductor to the apparatus.

705--5 In all situations where flexible cables and cords are exposed to the risk of mechanical damage, they shall as a minimum be of a type sheathed with rubber or PVC and where necessary shall also be armoured.

705--6 Where flexible cables and cords are normally exposed to the risk of damage due to high temperatures, they shall be insulated with silicone rubber or other approved insulating materials.

705--7 Connections of flexible cords and cables to terminals of apparatus and accessories shall be made in a similar manner to those of cables.

705--8 The current carrying capacities of flexible cables and cords and the maximum weight that they may carry shall not exceed the values given in the appropriate table in Section 12.

705--9 All flexible cables and cords shall have the following identifications:

(a) Two core	Brown	Phase
	Blue	Neutral
(b) Three core	Brown or Black	Phase
	Blue	Neutral
	Green/Yellow	Earth
(c) Four or Five core	Brown or Black	Phase
	Blue	Neutral
	Green/Yellow	Earth

705--10 Flexible cables and cords shall be used only for the following purposes:

(a) as pendants

(b) as wiring of fixtures

(c) as connection of portable lamps or apparatus

(d) as lift travelling cables.

NOTE - In other special situations flexible cables may be employed after the prior approval of the M. E. W .

705--11 Flexible cables and cords shall not be used as a substitute for the fixed wiring.

710 JOINTS, CONNECTIONS AND TERMINATIONS

710-- 1 Joints shall be avoided in conductors of all sizes wherever possible, and in final circuits feeding two or more lights, switches, sockets and/or other accessories, the loop-in system of wiring shall be employed.

710-- 2 Where joints are essential, they shall be housed in purpose made boxes and/or otherwise readily accessible for inspection throughout the life of the installation. Under no circumstances shall joints be drawn into conduits or positioned in the thickness of walls, ceiling or floor, etc., or behind plaster, tile or panel finishes, etc.

710--3 Joints in cable conductors shall be mechanically and electrically sound and shall be made by

soldering, brazing, welding or mechanical clamps or be of the compression type. All mechanical clamps and compression type sockets shall securely retain all the wires of the conductors.

710-4 Every joint in a cable shall be provided with insulation not less effective than that of the cable cores and shall be protected against moisture and against mechanical damage. Soldering fluxes which remain acidic or corrosive at the completion of the soldering operation shall not be used.

710-5 Joints in earth continuity conductors, earth leads, etc., shall be made in a similar manner to those in current carrying conductors.

710-6 Joints in flexible cables and cords shall not be permitted.

710-7 All terminations of cable conductors shall be mechanically and electrically sound and every termination shall be made by means of a terminal, soldering socket or compression type of socket. The termination arrangement shall contain and anchor all the wires of the conductor and shall not impose any serious mechanical strain on the terminal or socket.

710-8 At all terminations of cables, the insulation shall be neatly stripped without nicking the strands of the conductor. The conductor shall be tightly twisted and doubled backed (where space is available in the terminal) before being clamped with pinching screws. Where two or more cables are looped into the same terminal, their conductors shall be tightly twisted together before being inserted into the terminal. In no case shall bare conductor be allowed to project beyond any insulated shrouding or mounting of a live terminal.

710-9 At all terminations of wires and cables, sweating sockets or cable lugs shall be used unless adequate pinching screw terminals or clamps are provided and their use approved by the Engineer. In all such cases, the cable ends shall be tinned solid. Such lugs and sockets shall be connected in a manner that they are and will remain both mechanically and electrically sound and efficient. Only acid-free soldering fluxes shall be used. Any insulation and/or protective covering on the cables damaged by heat of the soldering shall be replaced by suitable and approved insulating sleeves.

715 BUNCHING AND SEGREGATION OF CONDUCTORS

715-1 Where conductors or bunches of conductors are protected by metallic sheathing, installed in metalic conduits. trunking or ducts, the conductors of all phases and neutral, associated with any one circuit, shall be included in the same sheath, conduit, trunking or duct.

715-2 Where conductors pass through the metallic case of any switch fuse, distribution board or other apparatus, or through any structural steel of any building, etc., all phase conductors and the neutral associated with any circuit shall pass through the same hole or aperture.

715-3 The dividing of the conductors of any circuit in such a manner that they induce magnetic fluxes or electrical currents in their sheathing or adjacent or surrounding metal of any sort shall not be permitted.

715-4 Where 240 volt loads are fed from a three phase and neutral distribution board no multi-gang s witch or socket outlet box shall contain the wiring fed from more than one phase.

715-5 Not more than three lighting circuit or two socket circuits shall be bunched in the same conduit.

715-6 Where circuits are bunched proceeding from the distribution board and have separated they shall not be brought back again into any common conduit.

715-7 Circuits fed from distinct sources of supply from different distribution boards or through separate isolators shall not be bunched in one conduit.

720 RIGID METALLIC CONDUITS

720-1 The use of rigid metallic conduits shall be permitted for general electrical installation provided that it is from heavy gauge steel and hot-dip galvanized inside and outside. Black enameled steel conduits shall not be used for electrical installations. All metallic conduits shall be screwed type.

720-2 The metallic conduit and its accessories shall form a continuous metallic sheath of adequate strength surrounding the cables throughout the length of the conduit.

720-3 Metallic conduits shall not be run under floor tiles of buildings.

720-4 The bores of all conduits shall be smooth and free from projections and/or sharp edges which may injure the wires or prevent them being drawn in. The internal edges of the ends of all lengths of conduit shall be radiused or chamfered before assembling into position.

720-5 All runs of conduit shall be assembled complete with all necessary accessories and the whole firmly attached to the structure of the building before any wires are drawn in. All wires shall be drawn through the covers of inspection and other fittings installed for the purpose.

720-6 All threads, vice marks, tool marks and breaks in the protective coating on metallic conduit and/or conduit fittings shall be painted with a steel preserving paint immediately after erection.

720-7 No run of conduit shall exceed 10 meters between adjacent draw-in points. nor shall contain more than two right angle bends, set or other deviation from the straight line.

720-8 Inspection couplings or long through draw-in boxes shall be used where necessary in straight runs of conduits for drawn-in purposes and shall be placed so that cables can be inspected and if necessary withdrawn throughout the life of installation.

720-9 Where conduit and/or conduit fittings are attached to switches, distribution boards, boxes or other equipment, smooth bore male brass bushes and flanged couplings shall be used.

720-10 Circular or hexagonal heavy locknuts shall be used at all positions where running joints are required and great care shall be taken to see that they seat firmly and evenly into mating faces of couplings or other adjacent accessories.

720-11 Where exposed to water. rain or weather, all covers shall be arranged or fitted with machined joints and/or fitted with durable gaskets such that water cannot get inside.

720-12 All runs of conduits shall be truly vertical or horizontal except where the architectural features of the building demand otherwise.

720-13 Except where provision is made for fastening a box or other conduit fitting directly to the structure of the building and such fastening is made, conduit shall be saddled to the structure of the building within 15 ems. of each terminal box, angle box, bend or other conduit fitting and at intervals not greater than 1.5 m. Couplings and through type drawing boxes shall be counted as part of a straight run of conduit.

720-14 All boxes, bends and other accessories shall be of the same material as the conduit and shall have the same protective coatings. Grey cast iron boxes etc. may be used with metallic conduit, but shall be finished in the same manner as the conduit to which they are directly attached.

720-15 The number of single core PVC insulated non-sheathed cables run in metallic conduit shall be such as to permit easy drawing of the cables. The actual number of cables drawn into any conduit shall not be greater than the number given in the appropriate table in Section 15. Where different sizes of cables are drawn into a conduit, the number and sizes of cables installed shall be selected in accordance with the method detailed in Section 12.

720-16 Metallic conduits system need not be provided with a separate insulated earth wire and the conduit itself may be considered as the earthing system provided all joints shall be made mechanically and electrically continuous.

720-17 The minimum size of metallic conduit that may be used in electrical installations shall be 16 mm diameter. Other sizes of conduits shall be limited to the following diameters:

20 mm, 25 mm, 32 mm, 38 mm and 50 mm.

725 RIGID NON-METALLIC CONDUITS

725-1 Rigid non-metallic conduits may be employed in general electrical installations provided it is made from polyvinyl chloride or equivalent material that has been certified as suitable for use at ambient temperatures up to 55°C. Additionally the material shall not soften or suffer any structural degradation at a temperature of 85°C, shall be non-hygroscopic, and self-extinguishing type.

NOTE - Rigid non-metallic conduits shall not be used at locations where they will be subjected to mechanical damage.

725-2 The inside and outside surfaces of non-metallic conduits shall be smooth and free from burrs and similar defects. The interior and ends of conduit fittings shall have no sharp edges and corners, shall be smooth and well rounded to permit easy drawing in of cable and prevent any damages to cable insulation.

725-3 The entries of non-metallic conduit fittings shall be so designed that a reliable water tight joint can be made between the conduit and fittings. Vinyl cement shall be used to make all joints. A vinyl solvent shall be used for permanent joints and a cement of the type that shall continue to remain in a sticky condition shall be used for expansion couplers.

725-4 Rigid non-metallic conduits shall be so constructed that it will be possible to bend the conduit easily with the aid of bending spring and all conduits and conduit fittings shall be of the unthreaded type.

725-5 The minimum size of rigid non-metallic conduit used for general electrical installation shall be 16mm diameter. Other sizes of rigid non-metallic conduits shall be of the following diameters:

20mm, 25mm, 32mm, 38mm, and 50mm.

725-6 The number of single core PVC insulated non-sheathed cables run in one conduit shall be such that it permits easy drawing of the cables. The actual number of cables drawn into any conduit shall not be greater than the number given in the appropriate table in Section 15. Where different sizes of cables are drawn into a conduit, the number and sizes of cables installed shall be selected in accordance with the method detailed in Section 12.

NOTE- Where a number of cables are bunched in one conduit, the current carrying capacity of the cables shall be reduced by using the stipulated grouping factor. For full details refer to Section 15.

725-7 A separate insulated earth wire shall be drawn into all rigid non-metallic conduits.

725-8 Rigid non-metallic conduits shall be installed generally in accordance with the requirements set out for metallic conduits. Additionally the method of supporting rigid non-metallic conduit shall allow for the longitudinal expansion and contraction of the conduits.

725-9 Where a lighting fitting is suspended from a non-metallic conduit box, care shall be taken to ensure that the temperature of the box does not exceed the permitted safe temperature of the material and is fitted with screwed metal insert clips. The mass suspended from the box shall not exceed 2 kgs.

730 CABLE TRAYS

730- 1 Cable trays may be employed in warehouses and other industrial buildings for supporting cables. In residential and commercial buildings cable trays may be employed in mechanical equipment and plant rooms. Where service floors or similar facilities are available cable trays may be employed at other locations in commercial and residential buildings also.

730-2 Cable tray system shall comprise of a unit or assembly of units or sections, and associated fittings,

made of metal or other non-combustible materials forming a rigid structural system. Cable tray systems include ladders, troughs, channels and solid bottom trays.

730-3 Multi-core armoured or non-armoured cables may be supported by cable trays. Single core insulated and sheathed cables may also be installed in cable trays.

730-4 Cable trays shall not be used in lift shafts or at locations where they will be subjected to severe physical damage.

730-5 Cable trays shall have adequate strength and rigidity to provide satisfactory support for the cables contained within it. All sharp edges, burrs and projections shall be removed and the tray shall be finishedsmooth to prevent injury to cables.

730-6 Metallic cable trays shall be adequately protected against corrosion by galvanizing or shall be made of corrosion resistant material.

730-7 Non-metallic cable trays shall be made from polyvinyl chloride or equivalent and shall be fully suitable for continuous service in the climatic conditions of Kuwait.

NOTE - PVC used in cable trays shall comply with the requirements of Clause 725.

730-8 All cable trays shall be equipped with sides of adequate dimensions. All fittings, bends, tees, employed shall be of substantial sections and of the same quality as the trash itself.

730-9 Cable trays shall be installed as complete system with bends and other accessories. Each run of cable tray shall be completed before the installation of cables.

730-10 Adequate supports shall be provided to prevent stress on cables where they enter or leave the tray. Where cable trays extend transversely though partitions and walls additional protection in the form of non-combustible covers shall be used.

730-11 Sufficient space shall be provided and maintained around cable trays to permit adequate access for installing and maintaining the cables.

730-12 The number of multi-core cables that may be installed in a ventilated or solid bottom cable tray shall not be greater than the number given in the appropriate table in Section 15.

NOTE- Where a number of cables are installed in a cable tray the current carrying capacity of the cables shall be reduced by using the stipulated grouping factor. For full details, refer to Section 12

730-13 Metallic cable trays shall not be used as an earth continuity conductor.

735 CABLE TRUNKING

735-1 Cable trunking may be employed for housing single core cables at special locations where it is difficult to install conduits. They may be of metallic or non-metallic construction. Non-metallic cable trunking shall be constructed from non-combustible insulating material like polyvinyl-chloride which shall be fully suitable for use in the climatic conditions and shall comply with the requirements of Clause 725. Metallic cable trunking shall be adequately protected against corrosion by galvanizing or shall be made of corrosion resistant material or stove enameled. All cable trunking shall be provided with removable covers.

735-2 Cable trunking shall generally be run exposed and the trunking shall be completely erected before drawing in the cables. Where adequate means of access is readily available throughout its length, cable trunking may be concealed.

735-3 Every entry to trunking shall be so placed as to prevent the ingress of water and all dead ends shall be closed. Only unbroken lengths of trunking shall be employed for crossing partitions and walls.

735-4 Where a common cable trunking is employed for housing both power and communication circuits, or for housing circuits operating at different voltages, the trunking shall be provided with separate compartments for the different types of circuits.

735-5 Cable trunking 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.

735-6 All bends, tees and other accessories of cable trunking shall be of substantial sections and of the same quality as the trunking itself.

735-7 Cable trunking shall be securely supported every metre, when run exposed.

735-8 The number of single core cables that may be housed in a trunking shall be such that a space factor of 45 percent is not exceeded or shall be selected in accordance with the method detailed in Section 15.

NOTE- Where a number of cables are bunched in a trunking the current carrying capacity of the cables shall be reduced by using the stipulated grouping factor, for full details, refer to Section 15.

735-9 Metallic trunking need not be provided with a separate insulated earth wire and the trunking itself may be considered as the earthing system provided all joints shall be made mechanically and electrically continuous. The different sections of the trunking shall be bonded by copper links.

735-10 Non-metallic trunking shall be provided with an insulated earth wire for each circuit.

740 FLEXIBLE CONDUITS

740-1 Flexible conduits may be employed for connecting electric motors and other equipment subject to adjustment of position and vibration to the fixed wiring and at similar positions.

740-2 Flexible conduits may be of the metallic or non-metallic type. Metallic flexible conduits shall not be used as the sole means of providing earth continuity and in both types of flexible conduit a separate earth continuity conductor of appropriate size shall be provided.

740-3 In damp and wet locations all flexible conduits shall be of the type that prevent the ingress of water and moisture.

740-4 Flexible conduits shall only be run exposed and shall be so positioned that they are not susceptible to mechanical damage. Where necessary flexible conduits shall be adequately supported.

745 BUS BAR TRUNKING

745-1 Bus bar trunking may be employed as horizontal feeders from main switch board to sub main switch boards and as risers to the different floor distribution boards. The bus bars shall be totally enclosed in metallic housing of substantial construction and of adequate strength to withstand the electro- mechanical forces that may be induced by the prospective short circuit current.

745-2 All bus bar trunking shall be so designed and arranged that they are free to expand and contract without detriment to themselves or to adjacent parts of the installation. All dead ends of bus bar trunking shall be closed. Fire barriers shall be provided at each floor level.

745-3 All bus bar trunking shall be surface mounted and so installed that they are inaccessible to unauthorized persons. They shall be securely supported and only unbroken lengths shall be permitted at floor crossings. Bus bar trunking shall not be installed in lift shafts.

745-4 No branch connections shall be permitted except through tap off units. Tap off units shall incorporate the required excess current protective devices.

NOTE- Clause 507 allows omission of excess current protection if floor distribution board is in the same room.

745-5 All bus bars employed in bus bar trunking shall be of high conductivity copper supported on adequately rated and sized insulators.

750 FINAL CIRCUITS

750-1 Each final circuit shall be connected to a separate way of a distribution board, a consumer service unit or a splitter switch.

750-2 The wiring of each final circuit shall be electrically separate from that of every other final circuit and each circuit shall be provided with its own separate neutral.

EXCEPTION: In ware-houses, factories, workshops, hangars and other larger areas where it is desirable to Connect adjacent lights to different phase of the supply, it is permissible to employ a three-phase and neutral circuit comprising of 4-wires as a final circuit provided the circuit is controlled by a triple pole breaker in the distribution board.

750-3 Final circuit having a rating exceeding 15/16 amperes shall not supply more than one point.

EXCEPTION: 1. 13 ampere socket outlets connected to a radial or a ring circuit as per Clause 750.10 and 750.11.

2. Two or more 30/32 ampere socket outlets feeding portable x-ray or welding equipment etc. may be connected to one final circuit and protected by a maximum 30/32 ampere fuse or circuit breaker provided it is ascertained that the maximum load on the circuit will not exceed 30/32 amperes and the circuit wiring is rated as minimum for this current.

3. Two or more 60/63 ampere socket outlets feeding portable x-ray or welding equipment, etc. may be connected to one final circuit and protected by a maximum 60/63 ampere fuse or circuit breaker provided it is confirmed that the maximum demand on the circuit will not exceed 60/63 amperes and the circuit wiring is rated as minimum for this rating.

4. A cooker control unit incorporating a socket outlet or a lighting track system in which individual luminaries arc suitably protected against excess current.

750-4 No cable with a conductor smaller than 1.5 mm^2 shall be used as a final circuit.

750-5 A 1.5 mm^2 cable may be employed as a final circuit for supplying lighting points and protected by a fuse or circuit breaker of 10 amps rating provided the circuit loading is limited to 2000 VA.

NOTE- Circuits for discharge lamps including fluorescent lamps shall be designed to carry the total steady current viz., that of the lamp and any associated control gear and also their harmonic current. Where more exact information is not available, the demand in volt-amperes may be taken for the purpose of this regulation as the rated lamp watts multiplied by not less than 1.8. This multiplier is based on the assumption that the circuit is corrected to a power factor of 0.851agging as required per Clause 313 and also takes into account control gear losses and harmonic current.

750-6 Cables with conductors of 2.5 mm^2 or greater may also be employed for supplying lighting points where large distances or high wattage fittings are involved.

750-7 Two socket outlets of 13 amps rating may be connected to a single phase and neutral circuit wired with 2.5mm^2 cable, protected by a fuse or circuit breaker of rating not exceeding 15/16 amps.

750-8 One socket outlet of 15/16 amps rating may be connected to a single phase and neutral circuit wired with 2.5 mm^2 cable, protected by a fuse or circuit breaker not exceeding 15/16 amps.

750-9 Six socket outlets of 13 amps rating may be connected to a single phase and neutral circuit wired with 2.5 mm^2 cable, protected by a fuse or circuit breaker of rating not exceeding 15/16 amps, serving one room only of less than 50 sq. metres floor area which is not a kitchen, provided that no fixed water heater or window air conditioning unit shall be connected to any of those points.

750-10 Six socket outlets of 13 amps. rating may be connected to a single phase and neutral circuit wired with 4 mm² cable, protected by a circuit breaker of rating not exceeding 25 amps, provided that the total connected load of the circuit does not exceed 5 KVA and the floor space is less than 75 sq. metres. Such a circuit shall not include for more than one window air conditioning unit or one water heater.

750-11 Ten socket outlets of 13 amps rating may be connected to a single phase and neutral ring circuit subject to the following provisions:

1. The floor space is not exceeding 100 sq. metres.

2. The circuit shall consist of a ring of 2.5mm² cable looped from one socket to the next throughout the
circuit and from the last socket back to the distribution board. Except in the case of sockets connected on a spur as indicated in sub-clause 5, not more than two conductors shall be connected into one terminal of any socket. No joints shall be permitted in any box housing a socket.

3. The circuit shall be protected by a fuse or circuit breaker of rating not exceeding 30/32 Amps.

4. The circuit shall not feed more than one window type air conditioning unit or one water heater.

5. Ring circuit shall not be used where there is any likelihood of the total connected load of the circuit
exceeding 7 KVA.

6. In special situations not more than two sockets may be connected as a spur from the ring.

7. A diagram illustrating the ring circuit appear as an appendix to this Regulations.

750-12 All wire sizes indicated in sub-clause 750.4 to 750.11 inclusive, relate to PVC insulated cables run as single circuits viz: without assuming any grouping factor. Where mineral insulated cables or cables with other insulating materials are employed for final circuits, the wire sizes stipulated in the above sub-clauses may be appropriately reduced and wire sizes having the same current rating as those specified f'or PVC insulated cables may be employed.

750-13 Where two socket outlets are housed in one common box, this will be considered as one outlet only for purposes of interpreting sub-clauses 750.7 to 750.11 both inclusive.

750-14 All single phase socket outlets in any one room shall normally be connected to the same phase of the supply. In larger rooms and other areas, socket outlets may be connected to different phases of the supply provided always that the outlets connected to any one phase are grouped together and no two socket outlets connected to different phases of the supply are less than 2 metres apart.

EXCEPTION: Where an under-floor ducting system is employed the minimum distance between any two outlets connected to different phases of the supply may be further reduced to 1.2 metres.

750-15 Fixed window type air conditioning units connected to a ring circuit shall be connected to the circuit only by means of a socket and plug. Other fixed equipment like water heaters, connected to a ring circuit shall be connected to the circuit only by means of a switch fuse or circuit breaker of 15/16 Amps rating. The number affixed equipment that may be connected to one ring circuit shall be in accordance with Clause 750.ll.(3).

750-16 A shaver outlet provided with a double wound isolating transformer may be connected to a lighting circuit.

750-17 For all other final circuits the size of cable employed shall be suitable for the load connected and no diversity shall be allowed. Section 15 provides a detailed method of selecting circuit sizes and the excess current protective device to be employed, which shall be adhered to for all circuits.

755 WIRING ACCESSORIES - LOCAL SWITCHES

755-1 All local switches shall be of adequate capacity. For outdoor use switches shall be water-tight and metal-clad. Switches not designed to break an inductive load of its full rated capacity if used to control discharge lighting circuits shall have a current rating of not less than twice the total steady current which it is required to carry.

755-2 Normally all local switches shall be mounted with the dollies between 1.0 m and 1.5 m above the finished floor level. Where several switches are mounted in two or more horizontal rows, the lowest row shall have dollies at least 1.0 m above the finished floor level. Unless prevented by the swing of the door, all switches shall be mounted inside the room on the side of the door where the catch or lock is situated the nearest switches being approximately 15 ems. from the door frame. The switch nearest the door shall control one or more of the principal lights of the room. In large rooms where group of switches are employed the switching arrangement shall be carried out in a symmetrical manner.

755-3 In kitchens and other situations excepting bath rooms, where water is regularly used, no switch shall be mounted within two metres of any tap, basin, sink or metal drainage board if the switch is of the non-insulated type.

755-4 In bath rooms all switches shall be of the ceiling mounted cord operated type if located inside. Otherwise, switches shall be located in an accessible position outside the bath room and immediately adjacent to the door.

755-5 All one way switches both single and double pole shall be so mounted that the dolly is up when the switch is in the "OFF' position. All single pole switches shall be so connected that they control the phase lead to the light or other consuming device.

760 WIRING ACCESSORIES·SOCKET OUTLETS AND PLUGS

760-1 Socket outlets shall be of the 13 Amps, 3 pin flat pin type or 15/16 amps., 3 pin round pin type with shuttered line sockets. The earth contacts of each socket shall be effectively connected to the earth continuity conductor and the phase and neutral shall be connected to the correct sockets. When viewed from the front in its final mounted position, earth socket shall be at the top, the neutral socket shall be below to the left and the phase socket shall be below to the right.

760-2 No socket outlet shall be mounted in any bath room except for shaver socket outlet.

760-3 No socket outlet shall be mounted within two metres of any tap sink, basin in any kitchen, cloakroom, etc., without the special approval of the Engineer in each case. Except where otherwise specified, all socket outlets shall be mounted 30 m above the floor or work bench where apparatus specified will be used. Socket outlets shall not be mounted at locations where they are liable to come into physical contact with fabrics or other material that may catch fire due to transmission of heat.

760-4 Socket outlets and plugs for use on more than one phase shall include a pin or other approved contact for the earth continuity connection which shall make contact before and break contact after all the phase connections and the neutral connection where such is fitted. Where a pin for the neutral conductor is fitted it shall make contact not later than and break contact not earlier than all the pins for the phase conductors. The design of the socket and plug shall be such that the plug cannot be inserted in such a manner that the neutral and any phase conductors become wrongly connected to the supply.

760-5 All socket outlets and plugs larger than 15/16 amps rating shall be combined with switch so interlocked with the plug that the plug cannot be withdrawn or inserted with the switch in the' ON' position.

765 WIRING ACCESSORIES - JUNCTION BOXES AND FUSED SPUR BOXES

765-1 Junction boxes shall be complete with a terminal block suitable for connecting upto 10mm², 3core copper conductor cables and an all-insulated moulded cover plate. The cover plate shall permit easy connection of outgoing cable.

765-2 Fused spur-box shall be unswitched type equipped with fuse base and carrier and 13 amps. fuse link fully shrouded to permit safe replacement of fuse. The terminals shall accommodate 3 core, 4 mm² copper conductor cables.

770 WIRING ACCESSORIES - LAMP HOLDERS

770-1 All lamp-holders shall preferably be of the all-insulated pattern and if not separately and firmly attached to a bracket, conduit or block shall have a substantial cord grip with the flexible wire so connected that no pull due to the weight of the holder, lamp shade or fitting or pull on the flexible can be transmitted to the connections of the conductors to the terminals.

770-2 All batten, back-plate or thread mounted lamp holder shall be free from edges or other projections which might damage the wiring.

770-3 In bath room, kitchen and other places where water is regularly used, no lamp holder within 2.5 metres of the floor shall be within 2 metres of any taps, pipes, bath, basin or sink, unless it and the lamp are totally enclosed in a fitting of all insulated construction and the lamp-holder is of the heavy duty porcelain type. Such fitting shall not be of the type which is suspended by the flexible cord, but shall be permanently mounted on the wall or otherwise supported independently of the current carrying conductors.

770-4 All lamp-holders of the screw cap lamps shall be so connected that the contact formed by the screw cap is connected to the neutral conductor.

775 WIRING ACCESSORIES - CEILING ROSES

775-1 All flexible cords and cables not connected to the supply by plug and socket shall be connected by means of insulated ceiling roses. Where the flexible cord or cable contains an earth continuity conductor, the ceiling rose shall be of the three or four plate type with the following terminals:

For three plate:	Two+ Earth	(Phase, Neutral and Earth)
For four plate:	Two+ Loop-in+ Earth	(Phase, Loop-in, Neutral and Earth)

The terminals shall be clearly marked for identification by letters stamped or cast into material of which the ceiling rose is made.

775-2 Ceiling roses shall be securely fixed to the structure of the building and shall not hang on or strain any wires feeding them. Flexibles shall be securely anchored so that no pull from them can be transmitted to the conductor connections.

775-3 Where flexible cables supplying water heaters or other fixed apparatus are too large to be connected by a ceiling rose, a suitable heavy duty junction box may be used instead. In all cases the flexible cable shall be so arranged and secured that any pull on the cable shall be transmitted directly to the structure of the box and not to any current carrying or earth continuity connections.

780 WIRING ACCESSORIES - MOUNTING BLOCKS &BOXES

780-1 Where conduits are run on the surface of walls of the building, all branch switches, sockets, ceiling roses, etc., shall be mounted on purpose made galvanized, P.V.C. or equivalent boxes specially designed for surface installation. All such boxes shall be securely fixed to the structure of the building in such a manner that they cannot rotate or rock throughout the life of the installation.

780-2 Where conduits are run buried in walls of the building, all branch switches, sockets, ceiling roses, etc., shall be housed in purpose made galvanized, PVC or equivalent boxes and all switch plates, socket plates and accessories shall be installed flush with the plaster.

785 SWITCHES AND ISOLATORS

785-1 All switches and isolators shall be of the load break type, of adequate size and robust construction. They shall be completely enclosed in a heavy gauge rust-proofed sheet steel or all insulated housing with the cover interlocked with the operating handle in such a manner that the cover cannot be opened whilst the switch is in the 'ON' position.

785-2 Double pole switches shall break phase and neutral conductors simultaneously. Switches con- trolling more than one phase shall not break the neutral conductor but shall break all phases simultaneously.

EXCEPTION: 4-Pole c.o.e.l.c.b's used as isolators in distribution boards may break the neutral conductor also.

785-3 Where fuses are also incorporated within the same housing as the switch, the fuses shall be so connected that the fuses are not alive when the switch is in the 'OFF position. No fuse shall be inserted in the neutral conductor.

785-4 No switch shall be mounted in such a position that it can be touched by any person at the same time as any water taps, basins, sinks, metal drainage boards etc. The minimum clearance from any of the above plumbing fitting shall be two metres. Switches shall not be installed in any room containing a bath or shower.

790 DISTRIBUTION BOARDS

790-1 Distribution boards shall be housed in purpose made heavy guage, rust-proofed sheet' steel housing. The distribution boards shall be so installed that its top does not exceed 185 cms from finished floor level. Alternatively they may be housed in non-metallic enclosures provided the material employed is fully suitable for use in the climatic conditions and has the required insulation level.

790-2 Distribution boards having fuses or circuit breakers in the phase lead only shall not be controlled by any other switch having a fuse or circuit breaker in the neutral lead.

790-3 Each distribution board shall have a circuit schedule pasted or otherwise permanently fixed inside the cover or adjacent to the board stating what each way controls and the size or rating of the fuse or circuit breakers to be used. All such schedules shall be in both Arabic and English.

790-4 Where multi-phase circuits are connected to a distribution board, the corresponding fuse or circuit breaker in each phase shall control the same circuit.

790-5 Each phase of every distribution board shall have an adequate busbar of high conductivity electrolytic copper to distribute the electricity to the various circuit fuses or circuit breaker. Such busbar shall be provided with an adequate terminal or clamp to take the incoming main conductor.

795 UNDERFLOOR DUCTS

795-1 The installation of under floor ducts shall be permitted beneath the surface of concrete or other flooring material.

795-2 Under floor ducts shall not be installed at locations which are regularly washed or where they are subject to corrosive vapours. In hazardous locations under floor ducts shall not be employed.

795-3 Unless adequate protection against corrosion is provided, metal under floor ducts, junction boxes and fittings shall not be installed in concrete. Metallic and non-metallic under floor ducts shall be of substantial construction.

795-4 All under floor ducts shall be laid in straight lines and junction boxes shall be installed at all changes in direction. All junction boxes shall be levelled to the floor. Dead ends of all ducts shall be closed.

795-5 Under floor ducts shall be provided with tap off position for outlets at regular spacing.

795-6 Throughout the under floor duct system joints in conductors shall not be employed.

795-7 The combined cross sectional area of all conductors installed within the duct shall not exceed 40 percent of the interior cross sectional area of the duct or the duct size shall be selected in accordance with the method detailed in Section 15.

795-8 Where under floor ducts serve more than one service as telephones, intercoms, etc. in addition to socket outlets, multi-sectioned ducts shall be provided and each service shall be housed in a separate duct. Outlet boxes serving different services and installed within the same box shall be provided with suitable separators.

SECTION 8

ELECTRIC MOTORS, MOTOR CIRCUITS AND CONTROLLERS

801 All motors shall generally be totally enclosed, fan-cooled. Other types of enclosures may be employed provided that they are suitable for the particular application.

802 All motors, control gears and all ancillary apparatus (e.g. remote push buttons, pressure, float or limit switches, interlocks, relays, etc.) shall be of robust construction and shall have all windings, contacts and all current carrying live parts and components insulated with Class 'E' or "B' materials. For certain applications and locations other superior classes of insulating materials may be applicable, and each situation shall be carefully studied in order to ensure that the temperature rise of the motor as declared by the manufacturer + ambient temperature is at least 10°C below the maximum operating temperature of the Insulating material used.

NOTES: I: The ambient temperatures in plant rooms should be taken as SS'C.

2: In all cases where the motors depend totally on the outside air for cooling whether by natural ventilation or by mechanical ventilation of the motor room, the entering cooling air temperature shall be taken as not less than 48'C for the purpose of Calculating the amount of ventilating air.

803 Motors and their control gears shall be located so that adequate ventilation is provided and so that inspection and maintenance can be readily accomplished.

804 If any motor is to be located out of doors, such motor shall be protected from overheating by the sun with a canopy of approved design.

805 Motors below 1 H.P. may be connected to single phase supply. Under special conditions to be approved by M.E.W for each individual case, motors upto 5 H.P. may be connected to single phase supply. No motor higher than 5 H.P. shall be connected to single phase.

EXCEPTION: The Air-conditioning units approved by the Ministry with motors for 3-phase supply but of rating 5HP or less shall be connected to three phase supply.

806 Self-contained air conditioning units upto 2.5 KW may be connected to a single phase supply.

807 Motors up to 150 H.P. may be connected to the 415 volts supply system. Where a consumer proposes to use motors of higher capacity, he should contact the M.E.W. to obtain the approval of such supply before purchasing any motor or appliance. If power supply at voltages higher than 415 volts are required. M.E. W. can only supply 11000 volts, 3 phase, 50 Hz.

808 3-Phase motors up to and including15 H.P. may be started direct on line (D.O.L.). Motors above 15 H.P. shall be provided with equipment to ensure that starting current does not exceed 2.5 time the full load current. For larger motors, method of starting and voltage dips must be discussed with and approved by M.E.W. in each case before the motors are connected to power supply.

809 All motors over 1H.P. shall be provided with starters which have means for automatically disconnecting them from the electric supply in the event of:

Failure of supply, Serious drop in voltage, Flow of excess current

EXCEPTION: For motors driving fire pumps, the above protections may be omitted. Where no volt releases are fitted to such motors they shall be of the automatic resetting type.

810 Each motor over 1 H.P. shall be provided with means of isolation suitably placed and so connected that all voltage may be cut off from the motor and all apparatus including any automatic circuit breaker used

there with, If this means of isolation is remote from a motor, an additional means of isolation adjacent to the motor shall be installed. This means of isolation may be an isolator or "stop-lock" button.

811 Where a group of motors function as one unit, means shall be provided in the control system, to prevent the simultaneous starting of all motors at one and the same time. Where this is not possible for any reason whatsoever, then the method of starting shall be approved by the M.E.W.

812 Starters shall be provided with over load relays of the thermal type with automatic compensation for variation in ambient temperature between 0°C and 55°C.

813 All starters and push buttons shall be clearly labeled in Arabic and English stating the machines they control and the function of the various buttons.

STOP push buttons shall have large mush room heads and/or colored bright red.

START push buttons shall be shrouded to prevent accidental operation and must be colored green.

814 All motors, single phase and three phase, shall have a power factor according to clause 314 at full load. Final circuit conductor sizes for motors shall be selected in accordance with the method indicated in Section 15.

815 All motors shall be suitably earthed in accordance with the requirements set out in Section 6.

SECTION 9

OTHER ELECTRICAL EQUIPMENT

900 DOMESTIC APPLIANCES

900-1 All domestic appliances such as electric kettles, toasters, mixers, refrigerators, freezers, washing machines, etc., shall be adequately rated for the correct electrical supply conditions.

900-2 All domestic appliances shall be provided with a totally enclosed and fully shrouded terminal box which shall include a substantial earth terminal.

900-3 All domestic appliances shall be connected to the electrical supply by means of plugs and sockets or by means of junction boxes and isolators depending upon the location of the appliances.

900-4 Flexible cables employed for the purposes of connecting domestic appliances shall be fully suitable for the purpose, of sample rating and provided with an earth conductor. All flexible cables shall being accordance with Clause 705 of this regulation.

900-5 All domestic appliances shall in addition to excess current protection be provided with automatic earth leakage protection that will trip the circuit in the event of a leakage current in excess of 30 milli amperes.

900-6 The non-current carrying metal work of all domestic appliances shall be securely connected to the earthing system.

905 ELECTRIC STORAGE WATER HEATERS & ELECTRODE BOILERS

905-1 Electric storage type water heaters shall generally be either of the vented type and open to the atmosphere so that under no condition of use can the pressure at the surface of the water be other than atmospheric or of the cistern type in which the feed cistern is an integral part of the appliance or a separate part located immediately above the water heater. Where the cistern is separate the water heater shall be provided with event so arranged that any expanded water can return to the cistern. All water heaters shall be provided with thermostats to control and prevent dangerous rise in temperature.

NOTES: 1. Storage type water heaters are recommended when an elevated water tank is available at normal location on roof and the vent pipe can be easily installed.

3. Cistern type of water heathers are recommended when a high level tank is provided and vent pipes Cannot be easily installed.

905-2 Pressure type storage water heaters may be installed in particular locations where the vented type or cistern type water heaters are not practicable. Pressure type water heaters shall be provided with adequate safety devices in order to ensure that any pressure buildup within the heater which is in excess of the safe working pressure of the heater is immediately and effectively released. All pressure type water heaters shall in addition to safety valves and control thermostat shall also be fitted with high limit safety thermostat to cut off the power supply in case of the control thermostat does not function.

905-3 Storage water heaters upto3 KW may be connected to the single phase and neutral supply. Storage water heaters over 3 KW shall be suitable for connection to the three phases.

905-4 All storage water heaters shall be connected to the earthing system in accordance with Section 6 and shall additionally be protected by a current operate dearth leakage circuit breaker having a trip rating not exceeding 30 milliamps.

905-5 Electrode boilers having two or more electrodes may be employed in large premises, hospitals, industries, etc. The electrical supply to electrode boilers shall be controlled by a circuit breaker of the multi pole linked type and arranged to disconnect the supply from all electrodes simultaneously. The circuit breaker shall also be provided with excess current protection in each conductor feeding an electrode.

905-6 The earthing of the electrode boiler shall comply with the requirements of section 6. Additionally all armouring of cables, if any, shall also be connected to the shell of the boiler. The circuit feeding the boiler shall be provided with a current operated earth leakage circuit breaker having a trip rating of 300/500 milliamps.

NOTES: l . Where in some special cases it is also required to connect the neutral conductor to the shell of the boiler, the Ministry of Electricity &Water's prior approval shall be obtained before effecting such a connection .

2 . In special situations w here a 300/500 milliamp trip rating will cause nuisance tripping a higher trip current may be permitted, but this should be approved by M.E.W .

905-7 Where an electrode boiler is to be connected to a supply exceeding low voltage, then the method of connection shall be submitted to MEW for their prior approval.

910 ELEVATORS AND ESCALATORS:

910-1 All elevators, and escalators shall be provided with a separate means of isolating the entire electrical supply to the equipment.

910-2 On single and multicar installations where a separate power is used for signals or lights or any other equipment common to the group, a separate means of isolating the electrical supply to such devices shall be provided.

910-3 Where interconnections between control panels are necessary for operation of the system on multicar installations that remain energized from a source o t h e r than the isolating means. a warning sign shall be mounted on or adjacent roth isolating means. The sign shall e clearly legible and shall read "Warning- Parts of the control panel are not de-energized by this switch".

910-4 All isolators shall be located in a readily accessible location. Where practicable the isolators shall be located adjacent to the door of the machine room or enclosure .

910-5 Electrical elevators driven by poly phase alternating current machine motors shall be provided with a means to prevent starting of the elevator motor when: (I) the phase rotation is in the wrong direction. or (2) there is a failure in any phase.

910-6 Elevator, escalator driving machines. motor-generator sets, controllers, a military control equipment and isolators shall be installed in a room or enclosure set aside for that purpose. The room or enclosure shall be secured against unauthorized access.

910-7 Sufficient clear working space shall be provided around control panels to provide safe and convenient access to all live parts of the equipment necessary for maintenance and adjustment.

910-8 In public buildings and other premises it is recommended that a Fireman's break glass type switch or similar device be installed to override all operating controls and bring all the elevators to the ground floor during an emergency .

910-9 Adequate illumination shall be provided in the vicinity of the lift machinery room . Self-contained emergency lights Capable of providing illumination for a period of *3* hours from a battery source shall be provided, such emergency lights shall be automatically charged and shall be switched on automatically in the event of failure of supply. Alternatively, lights connected to a maintained/emergency source with automatic change over in the event of failure of normal supply shall be provided.

915 UNDERWATER LIGHTING:

915-1 All circuits feeding underwater lights shall be so designed and installed so that they ensure full safety for personnel.

915-2 All underwater lighting circuits shall operate at voltage not exceeding 36 volts.

EXCEPTION: ln large decorative fountains, where adequate fencing and guarding is provided to ensure that only competent persons can come in contact with the pool the normal system voltage may be employed.

915-3 Lighting fixtures and all other equipment employed in the pool shall be of approved manufacture and tested to ensure complete safety in operation.

915-4 All circuits feeding pool lights shall be protected by a current operated earth leakage circuit breaker having a trip rating of 10 milliamps. Also other equipment associated with the underwater lights viz. pumps etc., shall be protected by a current operated earth leakage circuit breaker having a trip rating of 300/500 milliamps.

915-5 All electrical equipment, lighting fittings, transformers and accessories shall be connected securely to the earthing system.

915-6 All metallic parts of the pool structure, including the reinforcing steel, all forming shells, all metal fittings within or attached to the pool structure and all metal parts of electric equipment shall be bonded together.

SECTION 10

EMERGENCY, STAND-BY & UNINTERRUPTIBLE POWER SUPPLY SYSTEMS

1000 EMERGENCY SYSTEMS

1000--1 Emergency systems shall generally be provided in places of assembly where artificial illumination is required like buildings subject to occupancy by large number of people, hotels, theatres, multi-storey buildings, sports arenas, hospitals and similar premises and in all such premises adequate illumination shall be provided from the emergency system to safely evacuate personnel. All stairways, landings, exits and similar locations shall be provided with emergency lighting. This system shall also be capable of providing power to essential services and equipment in hospitals, refrigeration plants, in bulk cold stores, air conditioning systems in operating theatres, lifts, fire alarm systems, fire pumps, industrial processes equipment where an interruption of the normal supply would produce serious hazards, and for all other similar function.

1000--2 The emergency system shall have adequate capacity and rating for the emergency operation of all equipment connected to the system.

1000--3 The emergency system shall be so designed and constructed that in the event of failure of the normal supply to or within the building, emergency lighting and emergency power where such is required, will be immediately available.

1000--4 The type of emergency system adopted shall depend upon the nature of the occupancy and the load and one of the following systems may be provided:

(a) Storage Battery:

A storage battery of suitable rating and capacity along with inverters etc. to supply and maintain at not less than 90 percent of the system voltage the total load of the circuits supplying emergency lighting and emergency power for a minimum period of l.5 hours. The system shall be complete with automatic battery charging means.

(b) Generator Set:

A generator set driven by a prime mover of suitable rating and capacity to supply and maintain at system voltage the total load of the circuits supplying emergency lighting and emergency power. Means shall be provided for automatically starting the prime mover on failure of the normal supply. Automatic means shall also be provided for transferring from the normal supply to the emergency supply those loads necessary during emergency. For hospitals, the transition time from the instant of failure of the normal supply to the emergency supply shall not exceed 10 seconds.

NOTE - MEW's approval shall be obtained for the type of automatic transfer from normal to emergency supply.

(c) Built-in Equipment:

Individual unit equipment for emergency illumination shall comprise of a rechargeable battery, a battery charging means, lighting fixture and are laying device arranged to energize the lamps automatically upon failure of normal supply. The batteries shall be of suitable rating and capacity to supply and maintain at not less than 90 percent of the normal battery voltage, the total lamp load for a period of at least 1.5 hours.

1000--5 Prime movers associated with generator sets shall be provided with a non-site fuel supply sufficient to operate the prime mover for at least 3 hours.

1000--6 All circuit wiring for emergency systems shall be kept entirely independent of all other wiring and equipment and shall not enter the same trunking or tray as normal wiring except in transfer switches, exit or emergency light fixtures, or where the wiring is common for both systems.

1005 STAND-BY SYSTEMS

1005--1 In addition to the emergency systems due consideration shall also be given in the selection and rating of such systems to afford standby power also to non-emergency system during a failure of normal supply.

1005--2 For stand-by systems a manual or automatic change over from normal supply to standby supply shall be provided.

NOTES -

1. Under no circumstances shall there be any possibility to back feed from the generator set to the main network.

2. MEWs approval shall be obtained for the type of change over system adopted from normal supply to emergency or stand-by supply.

1010 UNINTERRUPTIBLE POWER SUPPLY SYSTEMS

1010--1 The applications for the uninterruptible power supply systems should include but are not limited to computer systems, process control, communications, testing, medical installations.

1010--2 The UPS systems should meet the load requirements and the UPS installation should be carried out in accordance with this regulation and relevant standards, and job specification and/or manufacturer's instructions.

1010--3 If the mains supply is supported by the power generator sets, the UPS system shall be so designed to interface and operate with the power generators to maintain an uninterruptible power supply in case of mains failure.

1010--4 A static change over switch shall be provided for UPS to supply power to the load. In the event of UPS fault, the static change over switch shall automatically transfer the load from UPS output to the other source without causing any interruption.

1010--5 The UPS system shall be equipped with facilities to prevent backfeed to the input terminals causing hazards to the operating and maintenance personnel.

1010--5 The cables for UPS system shall be flame retardant type with facilities to prevent backfeed to the input terminals causing hazards to the operating and maintenance personnel.

SECTION 11

ELECTRICAL INSTALLATIONS IN SPECIAL LOCATIONS

1100 MARINAS AND SIMILAR LOCATIONS

1100--1 The scope here provides specific requirements only to circuits intended to supply electrical installation in marinas or similar locations like, pleasure craft or houseboats and do not apply to the internal electrical installations of any pleasure craft or houseboats.

1100--2 The nominal supply voltage of the installation for the supply to marinas or similar locations like, pleasure craft or houseboats shall be 240 V a.c. single-phase, or 415 V a.c. three-phase.

1100--3 For protection against electric shock, the protective measures of obstacles and placing out of reach are not permitted. Also, the protective measures of non-conducting location and earth-free local equipotential bonding are not permitted

1100--4 Equipment installed on or above a jetty, wharf, pier or pontoon shall be selected with a degree of protection adequate for the operational conditions and external influences, shall be suitable for use in the presence of atmospheric corrosive or polluting substances and shall be protected against all kind of mechanical damage by taking into considerations the movement of structures, presence of flammable fuel and the increased risk of electric shock due to:

i) presence of water

ii) reduction in body resistance

iii) contact of the body with Earth potential.

1100--5 The following wiring systems shall be considered suitable for distribution circuits of marinas:

i) Underground cables

ii) Overhead cables or overhead insulated conductors

iii) Cables with copper conductors and thermoplastic or elastomeric insulation and sheath installed within an appropriate cable management system taking into account external influences such as movement, impact, corrosion and ambient temperature

iv) Mineral-insulated cables with a PVC protective covering

v) Cables with armouring and serving of thermoplastic or elastomeric material

vi) Other cables and materials that are no less suitable than those listed above.

1100--6 The following wiring systems shall not be used on or above a jetty, wharf, pier or pontoon:

i) Cables in free air suspended from or incorporating a support wire,

ii) Non-sheathed cables in cable management systems

iii) Cables with aluminium conductors

iv) Mineral insulated cables.

1100--7 Cables shall be selected and installed so that mechanical damage due to tidal and other movement of floating structures is prevented. Cable management systems shall be installed to allow the drainage of water by drainage holes and/or installation of the equipment on an incline.

1100--8 Underground distribution cables shall, unless provided with additional mechanical protection, be buried at a sufficient depth to avoid being damaged, e.g. by heavy vehicle movement.

NOTE - A depth of 0.5 m is generally considered as a minimum depth to fulfill this requirement.

1100--9 All overhead conductors shall be insulated. Poles and other supports for overhead wiring shall be located or protected so that they are unlikely to be damaged by any foreseeable vehicle movement. Overhead conductors shall be at a height above ground of not less than 6 m in all areas subjected to vehicle movement and 3.5 m in all other areas.

1100--10 Socket–outlets shall be protected individually by an RCD with a rated residual operating current not exceeding 30 mA and an operating time not exceeding 40 ms at a residual current of 5 times the rated current. Devices selected shall disconnect all poles, including the neutral.

1100--11 Each socket–outlet shall be protected by an individual excess current protection device. Also, a fixed connection for supply to each houseboat shall be protected individually by an excess current protection device.

1100--12 At least one means of isolation shall be installed in each distribution cabinet. This switching device shall disconnect all live conductors including the neutral conductor. One isolating switching device for a maximum of four socket-outlets shall be installed.

1100--13 Every socket-outlet shall be located as close as practicable to the berth to be supplied. Socket-outlets shall be installed in the distribution board or in separate enclosures. In order to avoid any hazard due to long connection cords, a maximum of four socket–outlets shall be grouped together in one enclosure.

NOTE - One step-by-step Instruction notice shall be placed in marinas adjacent to each group of socket outlets giving the exact type of power supply available and describing how to connect power supply to the on arrival and how to disconnect it before leaving.

1105 MEDICAL LOCATIONS

1105--1 The electrical installations in medical locations must ensure safety of patients and medical staff. The requirements stipulated herein are for hospitals, clinics, dental clinics, healthcare centres and dedicated medical rooms in the workplace. The requirements of this section do not apply to medical electrical equipment.

1105--2 In medical locations, the distribution system shall be designed and installed to facilitate the automatic changeover from the main distribution network to the electrical safety source feeding essential loads.

1105--3 For protection against electric shock, the protective measures of obstacles and placing out of reach are not permitted.

1105--4 As a method of protection against electric shock, exposed-conductive-parts of equipment, e.g. operating theatre luminaires, shall be connected to the circuit protective conductor.

1105--5 In operating rooms, the measured resistance of the protective conductor between the earth terminal of any socket-outlet (or fixed equipment) and any extraneous-conductive-part shall not exceed 0.2 Ohm and in other rooms this shall not exceed 0.7 Ohm.

1105--6 In all medical locations, special considerations have to be made concerning electromagnetic interference (EMI) and electromagnetic compatibility (EMC).

1105--7 Electrical devices, e.g. socket-outlets and switches, installed below any medical-gas outlets for oxidizing or flammable gases shall be located at a distance of at least 0.2 m from the outlet (centre to centre), so as to minimize the risk of ignition of flammable gases.

1105--8 Plans of the electrical installation together with records, drawings, wiring diagrams and modifications relating to the medical location, shall be provided. Information provided shall include but not be limited to:

(i) single-line overview diagrams showing the distribution system of the normal power supply and power supply for safety services in a single-line representation

(ii) distribution board block diagrams showing switchgear and controlgear and distribution boards in a single-line representation

(iii) schematic diagrams of controls

(iv) the verification of compliance with the requirements of standards

(v) functional description for the operation of the safety power supply services and of the safety power supply system.

1105-9 In medical locations at least two different sources of supply shall be provided. One of the sources shall be connected to the electrical supply system for safety services. Automatic changeover devices shall be arranged so that safe separation between supply lines is maintained.

1105--10 A power supply for safety services is required which will maintain the supply for continuous operation for a defined period within a pre-set changeover time. The safety power supply system shall automatically take over if the voltage of one or more incoming live conductors, at the main distribution board of the building, has dropped for more than 0.5 s and by more than 10% in regard to the nominal voltage.

1105--11 In case of a failure of the general power supply source, the power supply for safety services shall be energized to feed the equipment with electrical energy for a defined period of time and within a predetermined changeover period. Where socket-outlets are supplied from the safety power supply source they shall be readily identifiable according to their safety services classification.

1105-12 In the event of a voltage failure on one or more line conductors at the distribution board, a safety power supply source shall be used and be capable of providing power for a period of at least 3 h for the following:

(i) Luminaires of operating theatre tables

(ii) ME equipment containing light sources being essential for the application of the equipment, e.g. endoscopes, including associated essential equipment, e.g. monitors

(iii) Life-supporting ME equipment.

The duration of 3 h may be reduced to 1h for items (ii) and (iii) if a power source meeting the requirements of Regulation. The normal power supply shall be restored within a changeover period not exceeding 0.5 s.

1105--13 The following equipment shall be connected within 15 s to a safety power supply source capable of maintaining it for a minimum period of 24 h, when the voltage of one or more live conductors at the main distribution board for the safety services has decreased by more than 10% of the nominal value of supply voltage and for a duration greater than 3 s:

(i) Emergency lighting and exit signs

(ii) Locations for switchgear and controlgear for emergency generating sets, for main distribution boards of the normal power supply and for power supply for safety services

(iii) Rooms in which essential services are intended. In each such room at least one luminaire shall be supplied from the power source for safety services

(iv) Locations of central fire alarm and monitoring systems

(v) Operating Rooms – a minimum of 90% of the lighting shall be supplied from the power source for safety services and at least one luminaire shall be supplied from the power supply source for safety services

The luminaires of the escape routes shall be arranged on alternate circuits.

1105--14 The following equipment which is required for the maintenance of hospital services shall be connected either automatically or manually to a safety power supply source capable of maintaining it for a minimum period of 24 h:

(i) Sterilization equipment

(ii) Technical building installations, in particular air conditioning, heating and ventilation systems, building services and waste disposal systems

(iii) Cooling equipment

(iv) Catering equipment

(v) Storage battery chargers.

1105--15 The following equipment shall also be connected to a safety service supply with a changeover period not exceeding 15 s include:

(i) Selected lifts for firefighters

(ii) Ventilation systems for smoke extraction

(ii) Paging/communication systems

(iv) ME equipment used in Group 2 medical locations which serves for surgical or other procedures of vital importance

(v) Electrical equipment of medical gas supply including compressed air, vacuum supply and narcosis (anaesthetics) exhaustion as well as their monitoring devices

(vi) Fire detection and fire alarms

(vii) Fire extinguishing systems.

1105--16 Light fittings in operating rooms, anaesthetic area, recovery rooms and laboratories or where chemical reactions occur shall be explosion proof type.

SECTION 12

POWER FACTOR CORRECTION

1201 As governed and required by the Ministerial Decree No. 5/2010 dated 18th January 2010, the power factor of the electrical distribution systems shall be maintained within 0.95 lagging and unity.

1202 The power factor correction equipment shall be designed and installed in accordance with the latest "Specification for Capacitor Banks to improve Power Factor in Low Voltage Electrical Distribution Systems" as issued by the Capacitor Bank Section–Transmission Electrical Networks Sector - MEW.

1203 The approval of the capacitor banks shall be dealt with by the Capacitor Bank Section–Transmission Electrical Networks Sector - MEW.

1204 The normal rating of the power factor correction equipment shall be the maximum continuous rating at an ambient temperature of 52°C (Fifty-two degrees centigrade) as frequently encountered in Kuwait during the peak summer days and the equipment shall give continuous trouble free service in this high ambient temperature.

1205 The power factor correction equipment shall be from one of the approved manufacturers of the Ministry of Electricity & Water and must be approved by MEW.

1206 The owner and/or his consultant or contractor shall prepare and furnish to the Capacitor Bank Section of MEW, all required drawings, documents, design calculations and other information as asked in the above mentioned specification for approval of the power factor correction equipment.

1207 Only the power factor correction equipment which has been type tested in accordance with the above mentioned specification and for which type test reports and certificates from an independent laboratory (ASTA, DEKRA or, CESI) have been made available to the Ministry, shall be installed.

1208 The electrical room wherein the capacitor banks will be installed shall have suitable air-conditioning systems to ensure uninterrupted operation of the power factor correction equipment.

1209 The testing and commissioning of the power factor correction equipment shall be carried out by qualified and trained manufacturer's and/or local agent's engineer/specialist.

SECTION 13

SOLAR ENERGY CONNECTION TO GRID

1301 This section regulates the large scale solar energy generation when the client intends to connect it to the MEW grid.

1302 The solar energy systems for grid connected systems shall be connected only at the main low tension panels of the distribution substations/transformers, or for smaller projects at the main electrical switchboard.

1303 **T**he client shall engage an international consulting firm for the design of the solar energy systems that has a minimum five (5) years of experience in the relevant field and designed not less than 10 MW of PV power systems in total in the last five (5) years.

1304 Only one or two large sized inverters shall be located in the Air-Conditioned Electrical Rooms of the Distribution Substation. A series of small sized inverters for solar energy system is not acceptable.

1305 The detailed design drawings for the solar energy systems for grid connected systems shall be submitted for MEW approval to the concerned department of the Ministry.

1306 All solar energy generation calculations and other electrical design calculations including calculations for connecting cables sizing for the solar energy systems shall be submitted detailing different design parameters.

1307 The overall solar energy system of the project shall be summarized to include particulars like, Nos. of solar panels/modules, their sizes and capacities, details of inverters, available solar energy, etc. and submitted in excel sheets so as to obtain complete information on the solar energy system at a glance.

1308 There shall be two circuits to disconnect the solar energy systems in case of grid power failure: -

One circuit with the inverter.

Second circuit with a separate control to disconnect the breaker available at the connection point of the solar power to the MEW network.

On availability of power supply, the circuit with the inverter shall be automatically connected with a time delay of 2 to 3 minutes and the breaker for the second circuit shall be automatically connected with a time delay of five (5) minutes.

1309 The protection system shall include a power quality meter to monitor the quality of power generated and to disconnect the power supply in the events of:

Operating voltage is greater than 260 V phase to neutral.

Operation voltage is less than 220V phase to neutral.

Operating frequency is greater than 52 Hz.

Operating frequency is less than 48 Hz.

Total harmonic distortions exceeding 5%.

1310 The solar energy systems shall be provided with necessary energy metering (KW-Hour) at the connection point of the Solar Power to the MEW network. The metering system must be approved by MEW.

1311 The testing and commissioning of the solar energy systems shall be done by the client through an accredited and approved third party specialized in PV solar system and must be audited by MEW Engineer.

1312 It is the client who will be fully responsible for occurrences of any accidents during the operational life time of the solar energy system. The client is also responsible for proper maintenance and operation of the solar energy system.

1313 A yearly inspection shall be carried out by the client through an accredited third party inspector like, Lloyd's Register, Bureau Veritas, Vecto Inspection, Germanischer Lloyds or equally approved Third Party Inspector and Inspector's Certificate shall be provided to MEW.

1314 The Contractor shall submit all final as-built drawings for the solar energy systems to MEW for approval and record purposes.

SECTION 14

INSPECTION AND TESTING

1401 Every installation shall, on completion and before being energized, be inspected, tested and approved by MEW Inspector in accordance with this section. All necessary application forms and other details as stipulated shall be submitted to the MEW prior to testing the installation.

1402 A visual inspection shall be made to verify that the installed equipment and installation methods are in accordance with the approved drawings. The MEW Inspector will also ensure that there is no damage to any part of the installation.

1403 Visual inspection shall also be carried out to ensure satisfactory and approved methods are adopted for the following:

Connection of conductors

Identification of conductors

Connection of single pole devices in phase conductor only

Correct connection of socket outlets and lamp holders

Presence of fire barriers and protection against thermal effects

Method of protection against direct contact including measurement of distances

Labeling of circuits, switches, etc.

1404 The MEW Inspector shall carry out insulation resistance test and earth continuity test. Insulation resistance test in large buildings may be divided into groups of outlets, each containing around 50 outlets. An outlet shall include every point and every switch except that a socket outlet in corporating a switch shall be regarded as one outlet. A 500 volts D.C. supply shall be applied to the installation and the insulation resistance obtained shall not be less than one (1) mega ohm.

1405 Earth continuity test shall be carried out between the consumer earthing terminal and the remote end of earth continuity conductors. The resistance value obtained shall not exceed those stated in clause No.607.

1406 The MEW Inspector shall also carryout appropriate test to ensure efficient and correct operation of all earth leakage circuit breakers and other protective devices.

1407 The contractor shall obtain a test certificate from MEW ensuring that all control and safety devices are tested prior to the usage of the electric water heaters. All tests shall be carried out by the contractor, who must record the cut-out, cut in temperatures and the fluid pressure at which the mechanical safety valve operates and resets.

NOTE- The role of the MEW Inspector Is to witness these test only and certify the test certificates, three copies of which will be prepared, one for retention by MEW

1408 The MEW Inspector shall carry out measurements to determine the earth electrode resistance by approved methods and all necessary assistance required for carrying out this test other than the testing apparatus and auxiliary electrodes shall be provided by the consumer.

1409 Any alternation to the existing installation shall also be inspected and approved by MEW Inspector.

SECTION 15

APPENDICES, TABLES, GRAPHIC SYMBOLS

NOTES - 1. Various appendices, tables, graphic symbols, etc. are a provided in this Section. These are to be construed as a part of the Regulations and shall be complied with .

2. Where for a particular condition of installation, the appendices, tables, etc. do not apply, then MEW's prior approval shall be obtained for the method adopted.

APPENDIX 1

Co-ordination between conductor size and excess current protection device employed.

General Condition:

For compliance with Clause No. 750-17 of the Regulation the following conditions are to be fulfilled:

(i) The excess current protection device's nominal current or current setting (I_n) is not less than the design current (I_B) of the circuit, and

(ii) its nominal current or current setting does not exceed the lowest current carrying capacity (I_Z) of any of the conductors of the circuit, and

(iii) the current causing effective operation of the protective device (I_2)) does not exceed 1.45 times the lowest of the current carrying capacities (I_Z) of any of the conductor of the circuit.

The above condition may be stated as formulas:

$$I_B \leq I_n \leq I_Z$$

$$I_2 \leq 1.45 \; I_Z$$

In order to determine the size of the cable to be used for a particular condition of installation, it may be necessary to apply one or more of the following correction factors:

(i) For ambient temperature - Table 2.5A of Section 15 which gives correction factor to be applied for the actual ambient temperature of the installation when it exceeds 30°C.

(ii) For grouping - Tables 2.2, 2.3 and 2.4 of Section 15 which gives correction factors for various grouping of circuits.

Determination of Size of Cable to be used:

Having established the designed current of the circuit under consideration and having chosen the type and nominal current or current setting of the excess current protective device it is intended to use in accordance with general condition above, the following procedure shall be adopted to determine the size of cable:

(i) DIVIDE the nominal current of the excess current device by the appropriate ambient temperature correction factor given in Table 2.5A for the type of cable to be used.

(ii) Then further, DIVIDE by any applicable correction factor for grouping given in Tables 2.2, 2.3 and 2.4.

(iii) The size of the cable to be used shall be such that its tabulated current carrying capacity for the installation method concerned is not less than the value of the nominal current of the excess current protective device adjusted as above.

Example:

(a) A circuit feeding a balanced three phase load of 21 KW at 0.8 P.F., 415 volts, at an ambient temperature of 50°C by means of single core, PVC insulated cable in conduit along with another circuit.

Design current $= \frac{21}{\sqrt{3}\ x\ 0.415\ \ x0.8} = 36.5$ Amps

Nominal current of excess current protective device = 40 Amps

Adjustment for ambient temperature from Table 2.5A $= \frac{40}{0.71} = 56$ Amps

Adjustment for grouping from Table 2.2 $= \frac{56}{0.69} = 81$ Amps

Size of cable from Table 2.6A = 25 mm^2

(b) If the above circuit is run in a separate conduit,

Adjustment for ambient temperature from Table 2.5A $= \frac{40}{0.85} = 47$ Amps

Size of cable from Table 2.6A = 16 mm^2

(c) A single phase, 240 volts lighting circuit having a load of 2000 VA in an ambient temperature of 45^{o}C and wired with single core PVC insulated cable run in a conduit having two more circuits (i.e.,) three circuits together and protected by 10 amp circuit breaker

Design current $= \frac{2000}{240} = 8.3$ Amps

Nominal current of excess current protective device = 10 Amps

Adjustment for ambient temperature from Table 2.5A $= \frac{10}{0.79} = 13.0$ Amps

Adjustment for grouping from Table 2.2 $= \frac{13}{0.69} = 19$ Amps

Size of cable from Table 2.6A = 2.5 mm^2

(d) If the above circuit is run in a separate conduit,

Adjustment for ambient temperature from Table 2.5A $= \frac{10}{0.79} = 13.0$ Amps

Size of cable from Table 2.6A = 1.0 mm^2

APPENDIX 2

Current Carrying Capacity for Cables

Note -1 : The current carrying capacity under this appendix applies to sheathed and non-sheathed, and armoured and non-arnoured cables having a nominal voltage rating not exceeding 1 kV a.c.

Note -2 : The current carrying capacities for cables in air are based upon reference ambient temperatures of 30^{o}C irrespective of the method of installation.

Note -3 : The current carrying capacities for buried cables, either directly in the soil or in ducts in the ground, are based upon reference ambient temperatures of 20^{o}C .

Note -4 : For ambient temperatures other than the reference ambient temperature, the appropriate correction factors as given in Tables 2.5A and 2.5B are to be applied to the values of current-carrying capacity given in Tables 2.6A to 2. 12.

Note -5 : The current carrying capacities for cables in the ground are based upon a soil thermal resistivity of 2.5 K.m/W. Correction factors for soil thermal resistivities other than 2.5 K.m/W are to be applied as given in Table 2.5C.

Note -6 : The current carrying capacities for directly buried cables and cables in buried ducts are based upon a burial depth of 0.7 metres. Where the depths of laying are different, correction factors are to be applied as given in Table 2.5D.

Note -7 : The current carrying capacities given in Tables 2.6A to 2.12 apply to single circuits only. In case of single phase circuits, this consists of two non-sheathed cables or two single-core cables, or one two-core cable. For 3-phase circuits, this consists of three non-sheathed cables or three single-core cables, or one three-core cable. Where more number of cables are installed in the same group, the correction factors for groups as given in Tables 2.2, 2.3 and 2.4 need to be applied.

TABLE 2.1

General Methods of Installation of Cables

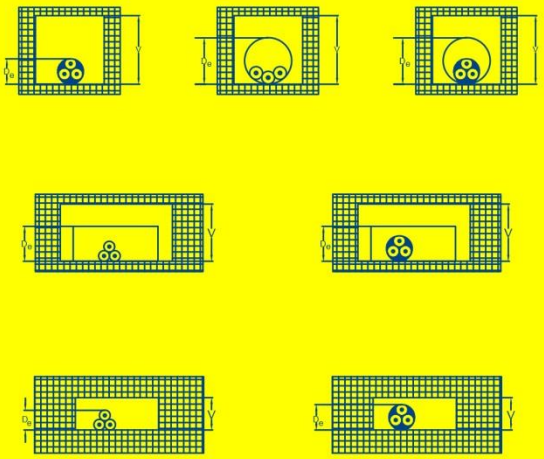
Type	Description	Examples
1	Single core cable with or without sheath or multi–core cable in conduit, or multi–core cable direct in thermally insulated wall.	
2	Single core cable with or without sheath or multi–core cable in conduit on surface of wall or structure, or spaced less than 0.3 x conduit diameter from the wall or structure.	
3	Single core cable with or without sheath or multi–core cable in cable trunking on surface of wall or structure running horizontally or vertically.	
4	Single core cable with or without sheath or multi–core armoured and non–armoured cable in conduit or in cable ducting in building of concrete or block work, or ceiling void running horizontally or vertically, where 1.5 Duct/Cable Dia (De) ≤ Void Depth	
5	Single core cable with or without sheath or multi–core armoured and non–armoured cable in conduit embedded in concrete.	

TABLE 2.1 (Contd....)

General Methods of Installation of Cables:

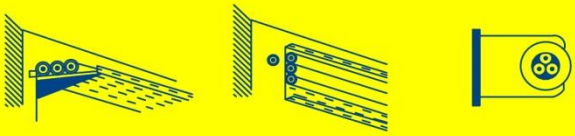
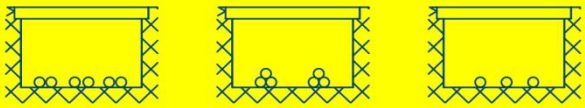
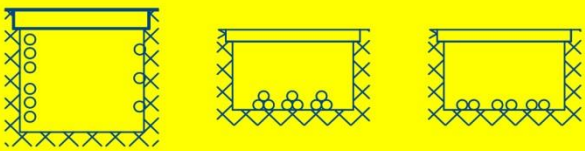
Type	Description	Examples
6	Single core or multi–core armoured and non–armoured cables fixed directly to the surface of wall or structure, or spaced less than 0.3 x cable diameter from the wall or surface, or fixed directly under the ceiling	
7	Multi–core armoured cable in conduit or in cable ducting in the ground, or buried direct in the ground with or without added mechanical protection	
8	Single core sheathed or multi–core armoured and non–armoured cables on perforated cable tray or on brackets, running horizontally or vertically	
9	Single core non–magnetic armoured or multi–core armoured and non–armoured cable enclosed in enclosed trench (minimum dimensions 450 mm wide by 300 mm deep including 100 mm cover)	
10	Single core non–magnetic armoured or multi–core armoured and non–armoured cable enclosed in infloor concrete trough (minimum dimensions 450 mm wide by 600 mm deep including 100 mm cover)	

TABLE 2.2

Correction factors for group of more than three single-core cables

Type of Installation method	Number of Conductors and Correction Factor											
	4	6	8	10	12	16	20	24	28	32	36	40
1,2,3,4,5,6,8,9 &10	0.80	0.69	0.62	0.59	0.55	0.51	0.48	0.43	0.41	0.39	0.38	0.36

NOTE – In case of one three phase circuit employing 4 wires. no correction factor is applicable and the ratings given in Table 2.6A to 2.12 shall be adopted. Where more than one three phase circuit is bunched in a conduit or trunking, then appreciate grouping factor shall be taken into consideration.

TABLE 2.3

Correction factors for group of more than one multi-core armoured and non-armoured cables

Type of Installation method	Number of cables and Correction Factor											
	2	3	4	5	6	8	10	12	14	16	18	20
1,2,3,4,5,6,8,9 &10	0.80	0.70	0.65	0.60	0.57	0.52	0.48	0.45	0.43	0.41	0.39	0.38

NOTE – Where spacing between adjacent cables exceeds twice their overall diameter, no reduction factor need be applied.

TABLE 2.4

Correction factors for group of more than one multi-core armoured and non-armoured cable buried in ground

Type of Installation method – 7	No. of Cables and Correction factors				
	2	3	4	5	6
Cable laid touching each other	0.81	0.70	0.63	0.59	0.55
Cables laid 15 cms apart	0.87	0.78	0.74	0.70	0.68

TABLE 2.5A

Correction factors for ambient air temperatures other than 30°C to be applied to the current carrying capacity shown on various tables

Ambient temperature °C	Type of Insulation			
	PVC	XLPE	Mineral	
			PVC covered or bare and exposed to touch	Bare and not exposed to touch
45	0.79	0.87	0.78	0.88
50	0.71	0.82	0.67	0.84
55	0.61	0.76	0.57	0.80
60	0.50	0.71	0.45	0.75

TABLE 2.5B

Correction factors for ambient ground temperatures other than 20°C to be applied to the current carrying capacity shown on various tables

Ground temperature °C	Insulation	
	PVC	XLPE
10	1.10	1.07
15	1.05	1.04
20	1.00	1.00
25	0.95	0.96
30	0.89	0.93
35	0.84	0.89
40	0.77	0.85
45	0.71	0.80
50	0.63	0.76
55	0.55	0.71
60	0.45	0.65

TABLE 2.5C

Correction factors for cables buried direct in the ground or in an underground Cable duct for soil thermal resistivities other than 2.5 K.m/W to be applied to the current-carrying capacities for Reference Method 7

Thermal resistivity, K.m/W	0.50	0.80	1.00	1.20	1.50	2.00	2.50	3.00
Rating factor for cables in buried ducts	1.28	1.20	1.18	1.13	1.10	1.05	1.00	0.96
Rating factor for direct buried cables	1.88	1.62	1.50	1.40	1.28	1.12	1.00	0.90

TABLE 2.5D

Correction factors for depths of laying other than 0.7 m for direct buried cables and cables in buried ducts

Depth of laying, m	Buried direct	In buried ducts
0.5	1.03	1.02
0.7	1.00	1.00
1	0.97	0.98
1.25	0.95	0.96
1.5	0.94	0.95
1.75	0.93	0.94
2	0.92	0.93
2.5	0.90	0.92
3	0.89	0.91

TABLE 2.6A
Single core PVC insulated cables, non-armoured, with or without sheath
(COPPER CONDUCTORS)

Ambient temperature: 30 °C

CURRENT-CARRYING CAPACITY (amperes): **Conductor operating temperature: 70 °C**

Conductor cross-sectional area	Installation Method 1 (enclosed in conduit in thermally insulating well etc.)		Installation Method 2, 3, 4 & 5 (enclosed in conduit on wall or in trunking etc.)		Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air or on a ventilated cable tray horizontal or vertical)				
							Touching			Spaced by one diameter	
	2 cables. Single-phase a.c.	3 or 4 cables. Three phase a.c.	2 cables. Single-phase a.c.	3 or 4 cables. Three phase a.c.	2 cables. Sibngle-phase a.c. flat and touching	3 or 4 cables. Three phase a.c. flat and touching or trefoil	2 cables. Sibngle-phase a.c. Flat	3 cables. Three phase a.c flat	3 cables. Three phase a.c trefoil	2 cables, single-phase a.c. or 3 cables three phase a.c. flat	
										Horizontal	Vertical
1	2	3	4	5	6	7	8	9	10	11	12
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
1	11	10.5	13.5	12	15.5	14	-	-	-	-	-
1.5	14.5	13.5	17.5	15.5	20	18	-	-	-	-	-
2.5	20	18	24	21	27	25	-	-	-	-	-
4	26	24	32	28	37	33	-	-	-	-	-
6	34	31	41	36	47	43	-	-	-	-	-
10	46	42	57	50	65	59	-	-	-	-	-
16	61	56	76	68	87	79	-	-	-	-	-
25	80	73	101	89	114	104	131	114	110	146	130
35	99	89	125	110	141	129	162	143	137	181	162
50	119	108	151	134	182	167	196	174	167	219	197
70	151	136	192	171	234	214	251	225	216	281	254
95	182	164	232	207	284	261	304	275	264	341	311
120	210	188	269	239	300	303	352	321	308	396	362
150	240	216	300	262	381	349	406	372	356	456	419
185	273	245	341	296	436	400	463	427	409	521	480
240	231	286	400	346	515	472	546	507	485	615	569
300	367	328	458	394	594	545	629	587	561	709	659
400	-	-	546	467	694	634	754	689	656	852	795
500	-	-	626	533	792	723	868	789	749	982	920
630	-	-	720	611	904	826	1005	905	855	1138	1070
800	-	-	-	-	1030	943	1086	1020	971	1265	1188
1000	-	-	-	-	1154	1058	1216	1149	1079	1420	1337

TABLE 2.6B
Multi-core PVC insulated PVC sheathed cables, non-armoured, (COPPER CONDUCTORS)

Ambient temperature: 30 °C

CURRENT-CARRYING CAPACITY (amperes): **Conductor operating temperature: 70 °C**

Conductor cross-sectional area	Installation Method 1 (enclosed in conduit in thermally insulating well etc.)		Installation Method 2, 3, 4 & 5 (enclosed in conduit on wall or in trunking etc.)		Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air or on a ventilated cable tray etc, horizontal or vertical)	
	1 two-core cable Single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.	1 two-core cable single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.	1 two-core cable Single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.	1 two-core cable Single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.
1	2	3	4	5	6	7	8	9
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
1	11	10	13	11.5	1.5	13.5	17	14.5
1.5	14	13	16.5	15	19.5	17.5	22	18.5
2.5	18.5	17.5	23	20	27	24	30	25
4	25	23	30	27	36	32	40	34
6	32	29	38	34	46	41	51	43
10	43	39	52	46	63	57	70	60
16	57	52	69	62	85	76	94	80
25	75	68	90	80	112	96	119	101
35	92	83	111	99	138	119	148	126
50	110	99	133	118	168	144	180	153
70	139	125	168	149	213	184	232	196
95	167	150	201	179	258	223	282	238
120	192	172	232	206	299	259	328	276
150	219	196	258	225	344	299	379	319
185	248	223	294	255	392	341	434	364
240	291	261	344	297	461	403	514	430
300	334	298	394	339	530	464	593	497
400	-	-	470	402	634	557	715	597

TABLE 2.6C
Single-core armoured PVC insulated cables (non-magnetic armour)
(COPPER CONDUCTOR)

Ambient temperature : 30°C

CURRENT -CARRYING CAPACITY (ampere) **Conductor Operating temperature: 70 °C**

Conductor cross sectional area	Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air on a ventilated cable tray, horizontal oe vertical)						
	Touching		Touching			2 cables, single phase a.c		3 or 4 cables, three phase a.c	
	2 cables, single phase a.c flat	3 or 4 cables, three phase a.c flat	2 cables, single phase a.c flat	3 cables, single phase a.c flat	3 cables, single phase a.c trefoil	Horizontal	Vertical	Horizontal	Vertical
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
(mm²)	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**
50	193	179	205	189	181	229	217	230	212
70	245	225	259	238	231	287	272	286	263
95	296	269	313	285	280	349	332	338	313
120	342	309	360	327	324	401	383	385	357
150	393	352	413	373	373	449	429	436	405
185	447	399	469	422	425	511	489	490	456
240	525	465	550	492	501	593	568	566	528
300	594	515	624	547	567	668	640	616	578
400	687	575	723	618	657	737	707	674	632
500	763	622	805	673	731	810	777	721	676
630	843	669	891	728	809	893	856	771	723
800	919	710	976	777	886	943	905	824	772
1000	975	737	1041	808	945	1008	967	872	816

TABLE 2.6D
Multi-core armoured PVC insulated cables
(COPPER CONDUCTORS)

Air ambient temperature: 30 °C

Ground ambient temperature: 20 °C

Conductor operating temperature: 70 °C

CURRENT-CARRYING CAPACITY (amperes):

Conductor cross-sectional area	Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air or on a ventilated cable tray etc, horizontal or vertical)		Installation Method 7 (direct in ground or in ducting in ground)	
	1 two- core cable, Single-phase a.c.	1 three or four-core cable, three-phase a.c.	1 two- core cable, single-phase a.c.	1 three or four-core cable, three-phase a.c.	1 two- core cable, Single-phase a.c.	1 three or four-core cable, three-phase a.c.
1	2	3	4	5	6	7
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)
1.5	21	18	22	19	22	18
2.5	28	25	31	26	29	24
4	38	33	41	35	37	30
6	49	42	53	45	46	38
10	67	58	72	62	60	50
16	89	77	97	83	78	64
25	118	102	128	110	99	82
35	145	125	157	135	119	98
50	175	151	190	163	140	116
70	222	192	241	207	173	143
95	269	231	291	251	204	169
120	310	267	336	290	231	192
150	356	306	386	332	261	217
185	405	348	439	378	292	243
240	476	409	516	445	336	280
300	547	469	592	510	379	316
400	621	540	683	590	-	-

TABLE 2.7A
Single core XLPE insulated cables, non-armoured, with or without sheath
(COPPER CONDUCTORS)

Ambient temperature: 30 °C

CURRENT-CARRYING CAPACITY (amperes): **Conductor operating temperature: 90 °C**

Conductor cross-sectional area	Installation Method 1 (enclosed in conduit in thermally insulating well etc.)		Installation Method 2, 3, 4 & 5 (enclosed in conduit on wall or in trunking etc.)		Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air or on a ventilated cable tray horizontal or vertical)				
							Touching			Spaced by one diameter	
	2 cables. Single-phase a.c.	3 or 4 cables. Three phase a.c.	2 cables. Single-phase a.c.	3 or 4 cables. Three phase a.c.	2 cables. Sibngle-phase a.c. flat and touching	3 or 4 cables. Three phase a.c. flat and touching or trefoil	2 cables. Sibngle-phase a.c. Flat	3 cables. Three phase a.c flat	3 cables. Three phase a.c trefoil	2 cables, single-phase a.c. or 3 cables three phase a.c. flat	
										Horizontal	Vertical
1	2	3	4	5	6	7	8	9	10	11	12
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
1	14	13	17	15	19	17.5	-	-	-	-	-
1.5	19	17	23	20	25	23	-	-	-	-	-
2.5	26	23	31	28	34	31	-	-	-	-	-
4	35	31	42	37	46	41	-	-	-	-	-
6	45	40	54	48	59	54	-	-	-	-	-
10	61	54	75	66	81	74	-	-	-	-	-
16	81	73	100	88	109	99	-	-	-	-	-
25	106	95	133	117	143	130	161	141	135	182	161
35	131	117	164	144	176	161	200	176	169	226	201
50	158	141	198	175	228	209	242	216	207	275	246
70	200	179	253	222	293	268	310	279	268	353	318
95	241	216	306	269	355	326	377	242	328	430	389
120	278	249	354	312	413	379	437	400	383	500	454
150	318	285	393	342	476	436	504	464	444	577	527
185	362	324	449	384	545	500	575	533	510	661	605
240	424	380	528	450	644	590	679	646	607	781	719
300	486	435	603	514	743	681	783	736	703	902	833
400	-	-	683	584	868	793	940	868	823	1085	1008
500	-	-	783	666	990	904	1083	998	946	1253	1169
630	-	-	900	764	1130	1033	1254	1151	1088	1454	1362
800	-	-	-	-	1288	1179	1358	1275	1214	1581	1485
1000	-	-	-	-	1443	1323	1520	1436	1349	1775	1671

TABLE 2.7B
Multi-core XLPE insulated PVC sheathed cables, non-armoured, (COPPER CONDUCTORS)

Ambient temperature: 30 °C

CURRENT-CARRYING CAPACITY (amperes): **Conductor operating temperature: 90 °C**

Conductor cross-sectional area	Installation Method 1 (enclosed in conduit in thermally insulating well etc.)		Installation Method 2, 3, 4 & 5 (enclosed in conduit on wall or in trunking etc.)		Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air or on a ventilated cable tray etc, horizontal or vertical)	
	1 two-core cable Single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.	1 two-core cable single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.	1 two-core cable Single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.	1 two-core cable Single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.
1	2	3	4	5	6	7	8	9
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
1	14.5	13	17	15	19	17	21	18
1.5	18.5	16.5	22	19.5	24	22	26	23
2.5	25	22	30	26	33	30	36	32
4	33	30	40	35	45	40	49	42
6	42	38	51	44	58	52	63	54
10	57	51	69	60	80	71	86	75
16	76	68	91	80	107	96	115	100
25	99	89	119	105	138	119	149	127
35	121	109	146	128	171	147	185	158
50	145	130	175	154	209	179	225	192
70	183	164	221	194	269	229	289	246
95	220	197	265	233	328	278	352	298
120	253	227	305	268	382	322	410	346
150	290	259	334	300	441	371	473	399
185	329	295	384	340	506	424	542	456
240	386	346	459	398	599	500	641	538
300	442	396	532	455	693	576	741	621
400	-	-	625	536	803	667	865	741

TABLE 2.7C
Single-core armoured XLPE insulated cables (non-magnetic armour)
(COPPER CONDUCTOR)

Ambient temperature : 30°C

CURRENT -CARRYING CAPACITY (ampere) **Conductor Operating temperature: 90 °C**

Conductor cross section al area	Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air on a ventilated cable tray, horizontal oe vertical)						
	Touching		Touching			2 cables, single phase a.c		3 or 4 cables, three phase a.c	
	2 cables, single phase a.c flat	3 or 4 cables, three phase a.c flat	2 cables, single phase a.c flat	3 cables, single phase a.c flat	3 cables, single phase a.c trefoil	Horizontal	Vertical	Horizontal	Vertical
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
(mm²)	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**	**(A)**
50	237	220	253	232	222	282	266	288	266
70	303	277	322	293	385	357	337	358	331
95	367	333	389	352	346	436	412	425	393
120	425	383	449	405	402	504	477	485	449
150	488	437	516	462	463	566	539	549	510
185	557	496	587	524	529	643	614	618	574
240	656	579	689	612	625	749	714	715	666
300	755	662	792	700	720	842	805	810	755
400	853	717	899	767	815	929	889	848	797
500	962	791	1016	851	918	1032	989	923	871
630	1082	861	1146	935	1027	1139	1092	992	940
800	1170	904	1246	987	1119	1204	1155	1042	978
1000	1261	961	1345	1055	1214	1289	1238	1110	1041

TABLE 2.7D
Multi-core armoured XLPE insulated cables
(COPPER CONDUCTORS)

Air ambient temperature: 30 °C

Ground ambient temperature: 20 °C

CURRENT-CARRYING CAPACITY (amperes): **Conductor operating temperature: 90 °C**

Conductor cross-sectional area	Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air or on a ventilated cable tray etc, horizontal or vertical)		Installation Method 7 (direct in ground or in ducting in ground)	
	1 two- core cable, Single-phase a.c.	1 three or four-core cable, three-phase a.c.	1 two- core cable, single-phase a.c.	1 three or four-core cable, three-phase a.c.	1 two- core cable, Single-phase a.c.	1 three or four-core cable, three-phase a.c.
1	2	3	4	5	6	7
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)
1.5	27	23	29	25	25	21
2.5	36	31	39	33	33	28
4	49	42	52	44	43	36
6	62	53	66	56	53	44
10	85	73	90	78	71	58
16	110	94	115	99	91	75
25	146	124	152	131	116	96
35	180	154	188	162	139	115
50	219	187	228	197	164	135
70	279	238	291	251	203	167
95	338	289	354	304	239	197
120	392	335	410	353	271	223
150	451	386	472	406	306	251
185	515	441	539	463	343	281
240	607	520	636	546	395	324
300	698	599	732	628	446	365
400	787	673	847	728	-	-

TABLE 2.8A
Single core PVC insulated cables, non-armoured, with or without sheath
(ALUMINIUM CONDUCTORS)

Ambient temperature: 30 °C

CURRENT-CARRYING CAPACITY (amperes): **Conductor operating temperature: 70 °C**

Conductor cross-sectional area	Installation Method 1 (enclosed in conduit in thermally insulating well etc.)		Installation Method 2, 3, 4 & 5 (enclosed in conduit on wall or in trunking etc.)		Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air or on a ventilated cable tray horizontal or vertical)				
							Touching			Spaced by one diameter	
	2 cables. Single-phase a.c.	3 or 4 cables. Three phase a.c.	2 cables. Single-phase a.c.	3 or 4 cables. Three phase a.c.	2 cables. Sibngle-phase a.c. flat and touching	3 or 4 cables. Three phase a.c. flat and touching or trefoil	2 cables. Sibngle-phase a.c. Flat	3 cables. Three phase a.c flat	3 cables. Three phase a.c trefoil	2 cables, single-phase a.c. or 3 cables three phase a.c. flat	
										Horizontal	Vertical
1	2	3	4	5	6	7	8	9	10	11	12
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
50	93	84	118	104	125	110	149	133	128	169	152
70	118	107	150	133	160	140	192	173	166	217	196
95	142	129	181	161	195	170	235	212	203	265	241
120	164	149	210	186	226	197	273	247	237	308	282
150	189	170	234	204	261	227	316	287	274	356	327
185	215	194	266	230	298	259	363	330	316	407	376
240	252	227	312	269	352	305	430	392	375	482	447
300	289	261	358	306	406	351	497	455	434	557	519
380	-	-	413	352	511	472	543	502	507	625	584
480	-	-	477	405	591	546	629	582	590	726	680
600	-	-	545	462	679	626	722	669	680	837	787
740	-	-	-	-	771	709	820	761	776	956	902
960	-	-	-	-	900	823	953	886	907	1125	1066
1200	-	-	-	-	1022	926	1073	999	1026	1293	1229

TABLE 2.8B
Multi-core PVC insulated PVC sheathed cables, non-armoured, (ALUMINIUM CONDUCTORS)

Ambient temperature: 30 °C

CURRENT-CARRYING CAPACITY (amperes): **Conductor operating temperature: 70 °C**

Conductor cross-sectional area	Installation Method 1 (enclosed in conduit in thermally insulating well etc.)		Installation Method 2, 3, 4 & 5 (enclosed in conduit on wall or in trunking etc.)		Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air or on a ventilated cable tray etc, horizontal or vertical)	
	1 two-core cable Single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.	1 two-core cable single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.	1 two-core cable Single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.	1 two-core cable Single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.
1	2	3	4	5	6	7	8	9
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
16	44	41	54	48	66	59	73	61
25	58	53	71	62	83	73	89	78
35	71	65	86	77	103	90	111	96
50	36	78	104	92	125	110	135	117
70	108	98	131	116	160	140	173	150
95	130	118	157	139	195	170	210	183
120	-	135	-	160	-	197	-	212
150	-	155	-	176	-	227	-	245
185	-	176	-	199	-	259	-	280
240	-	207	-	232	-	305	-	330
300	-	237	-	265	-	351	-	381

TABLE 2.8C
Single-core armoured PVC insulated cables (non-magnetic armour)
(ALUMINIUM CONDUCTOR)

Ambient temperature : 30°C

CURRENT –CARRYING CAPACITY (ampere) **Conductor Operating temperature: 70 °C**

Conductor cross section al area	Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air on a ventilated cable tray, horizontal oe vertical)						
	Touching		Touching			2 cables, single phase a.c		3 or 4 cables, three phase a.c	
	2 cables, single phase a.c flat	3 or 4 cables, three phase a.c flat	2 cables, single phase a.c flat	3 cables, single phase a.c flat	3 cables, single phase a.c trefoil	Horizontal	Vertical	Horizontal	Vertical
1 (mm²)	2 (A)	3 (A)	4 (A)	5 (A)	6 (A)	7 (A)	8 (A)	9 (A)	10 (A)
50	143	133	152	141	131	168	159	169	155
70	183	168	194	178	168	212	200	213	196
95	221	202	234	214	205	259	245	255	236
120	255	233	270	246	238	299	285	293	272
150	294	267	310	282	275	340	323	335	312
185	334	303	352	319	315	389	371	379	354
240	393	354	413	374	372	457	437	443	415
300	452	405	474	427	430	520	498	505	475
380	518	452	543	479	497	583	559	551	518
480	586	501	616	534	568	655	629	604	568
600	658	550	692	589	642	724	696	656	618
740	728	596	769	642	715	802	770	707	666
960	819	651	868	706	808	866	832	770	726
1200	893	692	952	756	880	938	902	822	774

TABLE 2.8D
Multi-core armoured PVC insulated cables
(ALUMINIUM CONDUCTORS)

Air ambient temperature: 30 °C

Ground ambient temperature: 20 °C

Conductor operating temperature: 70 °C

CURRENT-CARRYING CAPACITY (amperes):

Conductor cross-sectional area	Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air or on a ventilated cable tray etc, horizontal or vertical)		Installation Method 7 (direct in ground or in ducting in ground)	
	1 two- core cable, Single-phase a.c.	1 three or four-core cable, three-phase a.c.	1 two- core cable, single-phase a.c.	1 three or four-core cable, three-phase a.c.	1 two- core cable, Single-phase a.c.	1 three or four-core cable, three-phase a.c.
1	2	3	4	5	6	7
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)
16	68	58	71	61		
25	89	76	94	80	77	64
35	109	94	115	99	93	77
50	131	113	139	119	109	91
70	165	143	175	151	135	112
95	199	174	211	186	159	132
120	-	202	-	216	-	150
150	-	232	-	250	-	169
185	-	265	-	287	-	190
240	-	312	-	342	-	218
300	-	360	-	399	-	247

TABLE 2.9A
Single core XLPE insulated cables, non-armoured, with or without sheath
(ALUMINIUM CONDUCTORS)

Ambient temperature: 30 °C

CURRENT-CARRYING CAPACITY (amperes): **Conductor operating temperature: 90 °C**

Conductor cross-sectional area	Installation Method 1 (enclosed in conduit in thermally insulating well etc.)		Installation Method 2, 3, 4 & 5 (enclosed in conduit on wall or in trunking etc.)		Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air or on a ventilated cable tray horizontal or vertical)				
							Touching			Spaced by one diameter	
	2 cables. Single-phase a.c.	3 or 4 cables. Three phase a.c.	2 cables. Single-phase a.c.	3 or 4 cables. Three phase a.c.	2 cables. Sibngle-phase a.c. flat and touching	3 or 4 cables. Three phase a.c. flat and touching or trefoil	2 cables. Sibngle-phase a.c. Flat	3 cables. Three phase a.c flat	3 cables. Three phase a.c trefoil	2 cables, single-phase a.c. or 3 cables three phase a.c. flat	
										Horizontal	Vertical
1	2	3	4	5	6	7	8	9	10	11	12
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
50	125	113	157	140	154	136	184	165	159	210	188
70	158	142	200	179	198	174	237	215	206	271	244
95	191	171	242	217	241	211	289	264	253	332	300
120	220	197	281	251	208	245	337	308	296	387	351
150	253	226	307	267	324	283	389	358	343	448	408
185	288	256	351	300	371	323	447	413	395	515	470
240	338	300	412	351	439	382	530	492	471	611	561
300	387	344	471	402	508	440	613	571	544	708	652
380	-	-	-	-	658	594	679	628	638	798	742
480	-	-	-	-	765	592	786	728	743	927	865
600	-	-	-	-	871	791	903	836	849	1058	990
740	-	-	-	-	1001	911	1025	951	979	1218	1143
960	-	-	-	-	1176	1072	1191	1108	1151	1440	1353
1200	-	-	-	-	1333	1217	1341	1249	1307	1643	1550

TABLE 2.9B
Multi-core XLPE insulated PVC sheathed cables, non-armoured, (ALUMINIUM CONDUCTORS)

Ambient temperature: 30 °C

CURRENT-CARRYING CAPACITY (amperes): **Conductor operating temperature: 90 °C**

Conductor cross-sectional area	Installation Method 1 (enclosed in conduit in thermally insulating well etc.)		Installation Method 2, 3, 4 & 5 (enclosed in conduit on wall or in trunking etc.)		Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air or on a ventilated cable tray etc, horizontal or vertical)	
	1 two-core cable Single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.	1 two-core cable single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.	1 two-core cable Single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.	1 two-core cable Single-phase a.c.	1 three-core cable or 1 four-core cable, three-phase a.c.
1	2	3	4	5	6	7	8	9
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
16	60	55	72	64	84	76	91	77
25	78	71	94	84	101	90	108	97
35	96	87	115	103	126	112	135	120
50	115	104	138	124	154	136	164	146
70	145	131	175	156	198	174	211	187
95	175	157	210	188	241	211	257	227
120	-	180	-	216	-	245	-	263
150	-	206	-	240	-	283	-	304
185	-	233	-	272	-	323	-	347
240	-	273	-	318	-	382	-	409
300	-	313	-	364	-	440	-	471

TABLE 2.9C
Single-core armoured XLPE insulated cables (non-magnetic armour)
(ALUMINIUM CONDUCTOR)

Ambient temperature : 30°C

CURRENT -CARRYING CAPACITY (ampere) **Conductor Operating temperature: 90 °C**

Conductor cross section al area	Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air on a ventilated cable tray, horizontal oe vertical)						
	Touching		Touching			2 cables, single phase a.c		3 or 4 cables, three phase a.c	
	2 cables, single phase a.c flat	3 or 4 cables, three phase a.c flat	2 cables, single phase a.c flat	3 cables, single phase a.c flat	3 cables, single phase a.c trefoil	Horizontal	Vertical	Horizontal	Vertical
1 (mm²)	2 (A)	3 (A)	4 (A)	5 (A)	6 (A)	7 (A)	8 (A)	9 (A)	10 (A)
50	179	165	192	176	162	212	199	215	192
70	228	209	244	222	207	269	254	270	224
95	276	252	294	267	252	328	310	324	296
120	320	291	340	308	292	378	358	372	343
150	368	333	390	352	337	429	409	424	394
185	419	378	444	400	391	490	467	477	447
240	494	443	521	468	465	576	549	554	523
300	568	508	597	536	540	654	624	626	595
380	655	573	688	608	625	735	704	693	649
480	747	642	786	685	714	825	790	765	717
600	836	706	880	757	801	909	872	932	780
740	934	764	988	824	897	989	950	890	835
960	1056	838	1121	911	1014	1094	1052	970	911
1200	1163	903	1235	990	1118	11487	1141	1043	980

TABLE 2.9D
Multi-core armoured XLPE insulated cables
(ALUMINIUM CONDUCTORS)

Air ambient temperature: 30 °C

Ground ambient temperature: 20 °C

Conductor operating temperature: 90 °C

CURRENT-CARRYING CAPACITY (amperes):

Conductor cross-sectional area	Installation Method 6 (directly to the surface of wall or structure)		Installation Method 8, 9 & 10 (in free air or on a ventilated cable tray etc, horizontal or vertical)		Installation Method 7 (direct in ground or in ducting in ground)	
	1 two- core cable, Single-phase a.c.	1 three or four-core cable, three-phase a.c.	1 two- core cable, single-phase a.c.	1 three or four-core cable, three-phase a.c.	1 two- core cable, Single-phase a.c.	1 three or four-core cable, three-phase a.c.
1	2	3	4	5	6	7
(mm²)	(A)	(A)	(A)	(A)	(A)	(A)
16	82	71	85	74	71	59
25	108	92	112	98	90	75
35	132	113	138	120	108	90
50	159	137	166	145	128	106
70	201	174	211	185	158	130
95	242	214	254	224	186	154
120	-	249	-	264	-	174
150	-	284	-	305	-	197
185	-	328	-	350	-	220
240	-	386	-	418	-	253
300	-	441	-	488	-	286

TABLE 2.10

Current carrying capacity of single core and multi-core mineral insulated copper cables at 40°C ambient temperature

a) Having the sheath covered overall with PVC
b) Having the sheath bare and not exposed to touch

NOTE – Where cables of type (a) are installed bunched, the appropriate grouping factors given in Tables 2.2 and 2.3 shall be applied for the particular installation condition. For cables of type (b) no grouping factor is necessary.

	Nominal cross-Sectional area Of conductors	Single core				Multi-core					
		Single phase a.c (Amperes)		Three Phase a.c (Amperes)		Single phase a.c 2 Core (Amperes)		Three phase a.c 2 Core (Amperes)		7 Core (Amperes)	
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
LIGHT DUTY TYPE	1.0	19	24	15	24	15	20	12	17	9	12
	1.5	23	31	20	31	19	25	15	21	11	14
	2.5	31	41	26	41	25	35	20	29	15	21
	4.0	39	54	35	54	32	45	28	38		
	6.0	50	70	44	70	42	58				
	10.0	68	94	60	94						
HEAVY DUTY TYPE	1.0	20	28	17	28	16	22	14	18	9	13
	1.5	25	35	22	35	20	28	17	23	12	16
	2.5	33	45	29	45	27	37	22	31	16	22
	4.0	43	60	37	60	35	49	29	40	20	29
	6.0	54	74	48	74	45	62	37	52		
	10.0	72	101	64	101	60	84	50	70		
	16.0	94	134	84	134	80	110	66	94		
	25.0	128	173	111	173	105	149	89	120		
	35.0	153	211	136	211						
	50.0	191	264	170	264						
	70.0	234	322	204	322						
	95.0	281	389	247	389						
	120.0	323	451	285	451						
	150.0	374	518	327	518						

TABLE 2.11

Current carrying capacity of mass supportable for flexible copper cords insulated with silicone rubber

Nominal cross-sectional area of conductor mm²	Current carrying capacity Single or Three phase a.c. (Amperes)	Maximum mass supportable by twin flexible cord (Kg.)
0.5	3	2
0.75	6	3
1.0	10	5
1.25	13	5
1.5	15	5
2.5	20	5
4.0	25	5

NOTE - These ratings apply up to an ambient temperature of 120°C.

TABLE 2.12

NUMBER OF CABLES THAT MAY BE INSTALLED IN CABLE TRAYS

1. SINGLE CORE INSULATED AND SHEATHED CABLES AND SINGLE CORE INSULATED NON-MAGNETIC ARMOURED CABLES.

a) Where single core cables are installed in ventilated cable trays, the sum of the combined cross-sectional area of all cables installed in the tray shall not exceed 50 percent of the interior cross sectional area of the cable tray.

b) Where single core cable are installed in solid bottom cable trays, the sum of the combined cross- sectional area of all cables installed in the tray shall not exceed 40 percent of the interior cross sectional area of the cable tray.

2. MULTI-CORE ARMOURED OR NON-ARMOURED CABLES.

a) Where multi-core cables are installed in ventilated cable trays, the sum of the diameter of all cables installed shall not exceed 90 percent of the cable tray width and the cables shall be installed in a single layer.

b) Where multi-core cables are installed in solid bottom cable trays, the sum of the diameter of all cables installed shall not exceed 80 percent of the cable tray width and the cables shall be installed in a single layer.

NOTE - For grouping factors refer to Table 2.3

APPENDIX 3

CAPACITY OF CONDUITS, TRUNKING AND UNDERFLOOR DUCTS

TABLE 3.1

Capacity of conduits for simultaneous drawing of single core PVC insulated cable for a straight run up to 10 metres without bends

Nominal cross Sectional area of conductor	Size of Conduits (mm)					
	16	20	25	32	38	50
1.5	6	11	-	-	-	-
2.5	5	8	-	-	-	-
4.0	3	5	10	-	-	-
6.0	2	4	7	13	-	-
10.0	-	2	4	7	10	-
16.0	-	2	3	6	9	-
25.0	-	-	2	4	5	10
35.0	-	-	-	3	4	7
50.0	-	-	-	2	3	5
70.0	-	-	-	-	2	4

TABLE 3.2

Capacity of conduits for simultaneous drawing of single core PVC insulated cable for a run up to 10 metres with one bends

Nominal cross Sectional area of conductor	Size of Conduits (mm)					
	16	20	25	32	38	50
1.5	5	8	-	-	-	-
2.5	4	6	-	-	-	-
4.0	2	4	8	-	-	-
6.0	2	3	6	11	-	-
10.0	-	-	3	6	8	-
16.0	-	-	2	5	7	12
25.0	-	-	-	3	4	8
35.0	-	-	-	2	3	6
50.0	-	-	-	-	2	4
70.0	-	-	-	-	-	3

TABLE 3.3

Capacity of conduits for simultaneous drawing of single core PVC insulated cable for a run up to 10 metres with 2 bends

Nominal cross Sectional area Of conductor	Size of Conduits (mm)					
	16	20	25	32	38	50
1.5	3	6	11	-	-	-
2.5	2	4	8	-	-	-
4.0	2	3	6	-	-	-
6.0	-	2	4	8	11	-
10.0	-	-	2	4	6	10
16.0	-	-	2	3	5	9
25.0	-	-	-	2	3	5
35.0	-	-	-	-	2	4
50.0	-	-	-	-	-	3
70.0	-	-	-	-	-	2

NOTE – Table 3.1, 3.2 and 3.3 apply to both steel and PVC conducts

TABLE 3.4

Capacity of conduits for simultaneous drawing of different sizes of single core PVC insulated copper conductor in runs up to 10 metres without bends, with one bend and with two bends.

For each size of cable it is intended to use, obtain the appropriate factor from Table 3.4A.

Add all the cables factors so obtained and compare with the conduit factor given in table 3.4B.

The conduit size which will satisfactorily accommodate the cable is that size having a factor equal to or exceeding the sum of the cable factor.

TABLE 3.4 A

CABLE FACTOR

Nominal Cross-section area of conductors mm²	1.5	2.5	4.0	6.0	10.0	16.0	25.0	35.0	50.0	70.0
Cable factor	22	30	43	58	105	121	193	253	342	451

TABLE 3.4 B

CONDUIT FACTOR

Conduit Size	16 mm	20 mm	25 mm	32mm	38mm	50mm
Up to 10 meters run without bend	150	244	442	783	1092	1943
Up to 10 meters run with ONE bend	120	196	358	643	883	1571
Upto 10 meters run with TWO bends	86	141	260	474	646	1149

TABLE 3.5

Maximum number of single core PVC insulated cables in trunking of various sizes

For each size of cable it is intended to use, obtain the appropriate factor from Table 3.5A.

Add all the cables factors so obtained and compare with the trunking factor given in table 3.5B.

The trunking size which will satisfactorily accommodate the cable is that size having a factor equal to or exceeding the sum of the cable factor.

TABLE 3.5A

CABLE FACTOR

Size of Cable mm²	1.5	2.5	4.0	6.0	10.0	16.0	25.0	35.0	50.0	70.0
Cable Factor	8	11	15	22	36	45	68	90	121	158

TABLE 3.5B

TRUNKING FACTOR

Trunking Size mm x mm	50x50	75x50	75x75	100x50	100x75	100x100	150x50	150x75	150x100
Trunking Factor	1037	1555	2371	2091	3189	4252	3147	4718	6294

TABLE 3.6

Maximum number of single core PVC insulated cables in under floor ducts of various sizes

For each size of cable it is intended to use obtain the appropriate factor from Table 3.6A.

Add all the cables factors so obtained and compare with the underfloor ducts factor given in table 3.6B.

The underfloor duct size which will satisfactorily accommodate the cable is that size having a factor equal to or exceeding the sum of the cable factor.

TABLE 3.6A

CABLE FACTOR

Size of Cable mm²	1.5	2.5	4.0	6.0	10.0	16.0
Cable Factor	8	11	15	22	36	45

TABLE 3.6B

UNDER FLOOR DUCTS FACTOR

Under floor ducts mm	75x25	100x50	150x25	75x38	100x38	150x38
Under floor ducts Factor	660	875	1312	990	1312	1970

APPENDIX 4

MISCELLANEOUS TABLES AND DETAILS

TABLE 4.1

SIZE OF EARTH CONTINUITY CONDUCTORS AND EARTHING LEADS

Nominal cross-sectional area of largest associated copper circuit conductor (mm^2)	Nominal cross sectional area of copper earth continuity conductor (mm^2)	Nominal cross sectional area of copper earthing lead (mm^2)
1.5	1.0	6.0
2.5	1.0	6.0
4.0	2.5	6.0
6.0	2.5	6.0
10.0	6.0	6.0
16.0	6.0	6.0
25.0	16.0	16.0
35.0	16.0	16.0
50.0	16.0	16.0
70.0	50.0	50.0
95.0	50.0	50.0
120.0	50.0	50.0
150.0	50.0	50.0
185.0	70.0	70.0
240.0	70.0	70.0
300.0	70.0	70.0
400.0	70.0	70.0

NOTE- P.V.C insulation of earth continuity conductor should be coloured green yellow.

TABLE 4.2

RECOMMENDED ILLUMINATION LEVELS

AREA	LUX	AREA	LUX
GENERAL AREAS: **CIRCULATION AREAS:**		**OFFICE AND SHOPS:** **DRAWING OFFICE:**	
Corridor passage ways	100	Drawing boards	750
Lifts	150	Reference table and general	500
Stairs	150	Printing room	300
Escalators	150		
		SHOPS:	
ENTRANCES:		Conventional with counters	500
Entrance halls. Lobbies		Conventional with wall displays	500
Waiting rooms	150	Self-services	500
Enquiry rooms	500	Super markets	500
Gate house	300		
		SHOE ROOMS:	
KITCHENS:		Car	500
Food stores	150	General	500
General	500		
		PUBLIC & EDUCATIONAL BUILDINGS:	
MEDICAL & FIRST AID CENTRES:			
Consulting rooms Treatment areas	500	**ASSEMBLY AND CONCERT HALLS CINEMAS AND THEATRES:**	
		Auditorium	100
Medical stores	100	Theater and concert halls	100
Rest rooms	150	Cinema	50
		Multi-purpose hall	100 to 500
OUTDOORS:		Booking offices	300
Entrance & Exits	30	Dressing rooms	300
STAFF REATAURANTS:		Platforms and stages	Spl.
Canteens. Cafeterias.		Projection rooms	150
Dining rooms	300		
STAFF ROOMS:			
Changing room. Cloak rooms	150	**LECTURE THEATRES:**	
Rest rooms	150	General	300
Stores	150	Chalk board	500
		Demonstration benches	500
TELECOMMUNICATION:		Examination halls, Seminar rooms, teaching spaces	500
Switchboard Rooms	300	Art rooms	500
Apparatus rooms	150	Laboratories	500
Teleprinter rooms	500		
CAR PARKS:		**LIBRARIES:**	
Underground	50	Shelves. Book stack	150
Multi-story parking floors	50	Reading table	300
Ramps	75		

AREA	LUX	AREA	LUX
READING ROOMS:		Reading	150
Newspapers & magazines	300	Night	0.1
Reference libraries	500	Night children	1
Counters	500	Watch	5
Cataloguing & sorting	500		
Binding	500	**CIRCULATION SPACE:**	
Closed book stores	100	Evening	150
		Night	0.1
MUSEUMS AND ART GALLERIES:			
Exhibits insensitive to light	300	**NURSES STATION:**	
Light sensitive exhibits	150	Evening	300
Specially light sensitive light exhibits	50	Night	100
SCHOOLS:		**CORRIDORS:**	
ASSEMBLY HALLS:		Day	300
General	300	Evening	200
Platform & stage	Spl.	Night	3
TEACHING SPACE:		**INTEENAL ROOMS WITHOUT NATURAL LIGHTING:**	
General	300	Day	400
Chalk board	500	Evening & Night (General)	200
		Evening & Night- Task lighting	400
LECTURE THEATRES:			
General	300	**PHARMACIES:**	
Chalk board	500	Dispensing benches	500
Demonstration benches	500	Shelves	150
Needlework rooms	500		
Art Rooms	500	**RECEPTION:**	
Laboratories	500	General	300
Workshops	300	Enquiry Desk	500
Dining spaces	150		
Gymnasium	300	**TRAINING & REHABILITATION UNITS:**	
Music practice room	300	General	300
		Chalk boards	500
TRANSPORT TERMINAL BUILDING:		Laboratories	500
Reception areas (desks) Customs and immigration halls	500	Body store	150
		Post mortem room general	300
General	300		
Counters	300		
Waiting areas	300		
		OPERATING THEATRE:	
HOSPITALS. SURGERIES AND CONSULTING ROOMS:		General	400
HOSPITALS:		Operating area	Spl.
Ward Units	Spl.	Anesthetic room	300
Bed Heads, General	30 to 50	Recovery room and Intensive care Unit	30 to 50

AREA	LUX	AREA	LUX
X-RAY DEPARTMENT:		**PUBLIC ROOMS:**	
Radio-diagnostic and fluoroscopy room	500	Coffee bars	150
Radiotherapy rooms	300		
Laboratories	500	**DINING ROOMS. RESTAURANTS:**	
		General	100
SURGERIES:		Baggage rooms	100
General	300	Laundries	300
Waiting Rooms	300	Cellars	150
		Dining rooms, cash desk	300
DENTAL SURGERIES:		Lounges	300
Chair	Spl.	Writing rooms	150
Laboratories	500	Cloak rooms	150
CONSULTING ROOMS:		**INDUSTRIAL BUILDING &PROCESSES** AIRCRAFT MAINTENANCE HANGARS:	
General	300	Aircraft engine testing	750
Desk	500	Inspection and repairs	500
Examination couch	500		
Ophthalmic wall and near vision charts	500	**ASSEMBLY SHOPS:**	
		Casual work	200
HOMES AND HOTELS:		Rough work, e.g. frame and heavy Machinery assembly	300
HOMES:		Medium work, e.g. engine assembly, vehicle body assembly	500
LIVING ROOMS:		Fine work, e.g. electronic and assembly	1000
General	50	Very fine work. e.g. instrument and small precision mechanism assembly	1500
Casual reading	150		
Sewing and darning	300	**BAKERIES:**	
		General	300
STUDIES:		Decorating, icing	500
Desk and prolonged reading	300		
		BOILER HOUSES:	
BED ROOMS:		Folding. Pasting. Punching. Stitching.	500
General	50	Cutting. Assembling. embossing	750
Bed head	150		
KITCHENS:			
Working area	300	**BOOT AND SHOE FACTORIES:**	
Bath room	100		
Halls and landings	150	Sorting, grading.	1500
Stairs	100		
Workshops	300	Clicking	1000
Garages	50		
		Closing preparatory operations	1000
HOTELS:			
ENTRANCE HALLS:	75	Cutting table and presses	1500
Reception, cashier	300	Bottom stock preparation, lasting,	

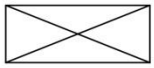
AREA	LUX	AREA	LUX
Bottoming. Finishing. Shoe rooms.	1000	Inspection	1500
		Hand tailoring	1500
BUILDING:			
Industrialized building plants	500	**COLD STORES:**	
Concrete shops	300	General Constant operation	300
		Infrequent access	150
CANNING AND PRESERVING FACTORIES:		Break-down, make-up and dispatch Air-locks	300
Preparation	500		
Canned and bottled goods retorts	300	**ELECTRICAL MACHINE SHOPS:**	
Automatic processes	200	Manufacture. Winding assembly, testing of large machine.	750
Inspection raw materials finished product	750 Spl. Ltg.	**ELECTRICAL GENRATING STATION**	
		Turbine and boiler houses: Boiler houses, platforms etc.	150
CAR PARKS – INDOOR:			
Underground	30	Boiler and turbine house basements (including feed pump bay)	100
Multi-storey Parking floors	30		
Ramps	50	Turbine and gas turbine houses (operating floor level)	150
CARPET FACTORIES:			
Winding beaming	300	Plant area:	
Designing. Jacquard card cutting, setting pattern, tufting cropping, hemming, fringing, latexing and latex drying weaving, mending	750	Battery rooms, charger and rectifiers	100
		Cable tunnels, cable basements	50
		Circulating water culverts, screen chambers	50
Inspection General	1000		
Piece dyeing	750	Control rooms:	
		Desks	300
CHEMICAL WORKS:		Vertical panels	300
Exterior walkways and platforms	50	Rear panels	150
Exterior stairs and ladders	100	Nuclear reactor plants Gas circulation bays, platforms. Reactor charge and discharge faces	150
Pump and compressor houses	150		
Interior plant areas General	300		
Automatic processes	200	Outdoor transformer compounds	30
		Precipitator chamber, platform, etc.	100
Control rooms:		Precipitator dust hopper outlets	50
Desk s	300	Pump houses	150
Vertical panels	300	Relay and telecommunication rooms	150
Rear of panels	150	Storage tanks (indoor), operating areas and filling points of-outdoor tanks	50
CHOCOLATE AND CONFECT IONERY FACTORIES:			
		Substations and switch rooms diesel Generator rooms	150
General	300		
Automatic processes	200	High voltage substation indoor out door	100 5
Hand decorating, wrapping, packing	500		
		Switch rooms (metal clad and cubicle switchgear)	150
CLOTHING FACTORIES:			
Matching-up	750		
Cutting	750		
Sewing	1000		
Pressing	500		

AREA	LUX	AREA	LUX
ENGRAVING SHOPS:		Upholstery:	
Hand	1500	Cloth inspection	1500
Machine. General	500	Filling covering	500
Fine	1500	Slipping	750
		Cutting, sewing	750
FARM BUILDINGS:			
General purpose building	30	Mattress making**:**	
floors	300	Assembly	500
General purpose buildings (windowless)	50	Tape edging	1000
Farm workshops:		Tool Rooms:	
General	100	General	500
Workbench or machine	300	Benches	750
Production Inspection	500		
Milk premises (handling and storing)	100	Spray Booths:	
Sick animal pens, calf nurseries	50	Colour finishing	500
Yards	20	Clear finishing	300
FIRE STATIONS:		**GARAGES:**	
Appliance rooms	300	External apron:	
External aprons	30	General	50
		Pumps	300
FLOUR MILLS:		Parking areas (interior)	30
Roller, purifier. Silks and packing	300	General repair, servicing, greasing, pits, washing, polishing workbench	500
Wetting tables	500		
FORGES:		**GAS WORK:**	
General	300	Exterior walkways and platform	50
		Exterior stairs and ladders	100
FOUNDRIES:		Retort houses, oil gas plants, water gas plants, purifiers	100
Charging floors, tumbling, cleaning, pouring, shaking out.	300		
Rough core making	300	Governor, meter, compressor, booster and exhauster houses	150
Fine molding, core making, inspection	500		
		HOSIERY AND KNITWEAR FACTORIES:	
FURNITURE FACTORIES:			
Raw material store	100	Flat bled knitting machines	500
Furnished good store	150	Circular knitting machines	750
		Lock stitch and over locking machines	1000
Wood machining and assembly:		Linking or running on	1000
Rough sawing and cutting	300	Mending	1500
Machining. Sanding and assembly of components	500	Examination, hand finishing	1500
		INSPECTION AND TESTING SHOPS (ENGINEERING)	
Cabinet making:			
Veneer sorting and preparation	1000	Rough work. e.g. counting	300
Veneer pressing	500	Medium work. e.g. "Go" and "No-go" gauges, sub-assemblies	500
Components stores	150	Fine work. e.g. telecommunications equipment calibrated scales. Precision mechanism instruments	1000
Fitting . final inspection	750		
		Very fine work. e.g. gauging and inspection of small intricate parts	1500

AREA	LUX	AREA	LUX
Minute work. e.g. very small instruments	3000	**PAINT SHOPS AND SPRAY BOOTHS:**	
JEWELLERY AND WATCH-MAKING FACTORIES:		Dipping, firing, rough spraying	300
		Rubbing, ordinary painting, spraying and finishing	500
General	500	Fine painting, spraying and finishing	750
Fine processes	1000	Retouching and matching	1000
Minute processes	3000		
Gem cutting. Polishing, setting	1500	**PHARMACEUTICALS AND FINE CHEMICAL WORKS:**	
LABORATORIES (GENERAL):			
General	750	Pharmaceuticals manufacture:	
LAUNDRIES AND DRY CLEANING WORKS		Grinding	
		Granulating, mixing and drying, tableting, sterilizing and washing, preparations of solution and filling, labeling, capping, cartooning, wrapping	500
Receiving, sorting, washing, drying, ironing calendaring dispatch, dry cleaning, bulk machine work	300		
Hand ironing, pressing, inspection mending, spotting	500		
		Fine chemical manufacture plant processing	300
LEATHER:			
General	300	Fine chemical finishing	500
Pressing, glazing cutting, strafing, sewing	100	Raw materials stores	200
		Inspection	750
Grading, matching	1500	**PLASTIC WORK:**	
		Manufacture of plastic raw materials Plastic processing, Calendaring, extrusion, injection. Compression and blow moulding, sheet fabrication, shaping, machining, trimming, polishing cementing	500
MACHINE AND FITTING SHOPS:			
Casual work	200		
Rough bench and machine work	300		
Medium bench and machine work, ordinary automatic machine, rough grinding, medium buffing, polishing	500		
		PLATING SHOPS:	
Fine bench and machine work, fine automatic machine , medium grinding machine, fine butting and polishing	1000	Vats and baths	300
		Buffing, polishing, burnishing	500
		Final buffing and polishing	750
MILK & OTHER BOTTLING PLANTS:		**POTTERIES:**	
General work areas	300	Grinding, filter pressing, kiln room, molding, pressing, cleaning,.trimming, glazing, firing	300
Bottle filling	750		
Bottle inspection			
		Enameling, coloring, decorating	750
MOTOR VEHICLE PLANTS:			
General sub-assemblies, chassis assembly, car assembly, body sub-assemblies, body assembly	500	**PRINTING WORKS:**	
		Type foundries:	
		Matrix making, dressing type, hand and machine casting	300
Final inspection	750		
PAINT WORK:		Font assembly, sorting	750
Automatic processes	200	Composing rooms:	
General	300	Hand composing, Imposing, imposition and distribution	750
Special batch mixing	750		
Colour matching	1000	Machine composition - key board	750
		Machine composition - casting	300

AREA	LUX	AREA	LUX
Proof Presses	750	Machines	300
Proof reading	750	Edible product processing and packing	300
Illuminated table - General lighting	300		
Printing machine room presses	500		
Pre make-ready	500	**STRUCTURAL STEEL FABRICATION PLANTS:**	
Graphic reproduction:			
General	500	General	300
Precision proofing, retouching, etching	1000	Marking off	500
Colour reproduction and printing inspection colour and registration	1500		
		WAREHOUSE AND BULK STORE:	
		Large material, loading bays	150
RUBBER PROCESSING:		Small material, racks	300
FACTORIES:		Packing, despatch	300
Fabric preparation creels, dipping, molding, compounding, calendaring	300	Issue counters	500
Tyre and tube making	500	**WELDING AND SOLDERING SHOPS:**	
SHEET METAL WORKS:			
Bench work, scribing, inspection	750	Gas and arc welding, rough spot welding	300
Pressing, punching, shearing, stamping, spinning, folding	500		
		Medium soldering, brazing, spot welding, e.g. domestic hardware	500
		Fine soldering, spot welding, e.g. instruments	1000
		Very fine soldering spot welding, e.g. electronics	1500
SLAUGHTER HOUSES:			
General	500	**WOODWORKING SHOPS:**	
Inspection	750	Rough sawing bench work sizing, planning, rough sanding, medium machine and bench work gluing, cooperage	500
SOAP FACTORIES:			
General areas	300		
Automatic processes	200	Fine bench and machine work fine sanding, finishing	750
Control panels	300		

AREA	LUX	AREA	LUX
MULTI-PURPOSE SPORTS HALLS:		**GYMNASIA:**	
Athletics. Basketball, bowls, fencing, gymnastics, judo, volley ball	300 to 700	General	500
		ICE HOCKY AND SKATING (INDOOR RINKS):	
BADMINTON:			
National and international	300	National and international	750
Club	200	Club	500
Recreational	150	Recreational	300
BILLIARD AND SNOOKER:		**LAWN TENNIS (INDOOR COURTS):**	
National and international	500	National and international	750
Club	300	Club	500
Recreational	150	Recreational	300
BOXING:			
National and international	2000	**RIFLE AND PISTOL SHOOTING:**	
Club	1000	Firing zone	300
Recreational	300	Range	150
SQASH RACKETS:		**TABLE TENNIS**	
National and international	500	National and international playing area	500
Club	300		
Recreational	300	Spectator area	150
		Club playing area	300
SWIMMING:		Recreational playing area	150 - 300
National and international pool	500		
Spectator area	100		
Club and recreational pool	300	**GENERAL:**	
Spectator area	100	Changing rooms, showers, locker rooms	150
Training pool	300		
NOTE – Higher illumination will be required if events are televised in colour.			

TABLE 4.3 GRAPHIC SYMBOLS	
Symbol	Description
	Pendant or ceiling light
	Bracket light
	Weather proof bracket light
	Fluorescent light
	Flood light on pole
	Ceiling fan
	Bracket or wall fan
	Fan regulator with switch adjacent
	Extract fan on wall or glass
	Extract fan on ceiling
	13 Amps 3 Pin switch socket
	High level 13 Amps 3 Pin socket controlled by separate switch
	Weather proof 13 Amps 3 Pin socket controlled by separate switch
	Three phase or three phase and neutral switch socket outlet
	Three phase or three phase and neutral weather proof switch socket outlet
CCU	Cooker control unit
JB	Junction box with connector
	One way switch
	Two way switch

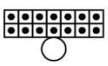
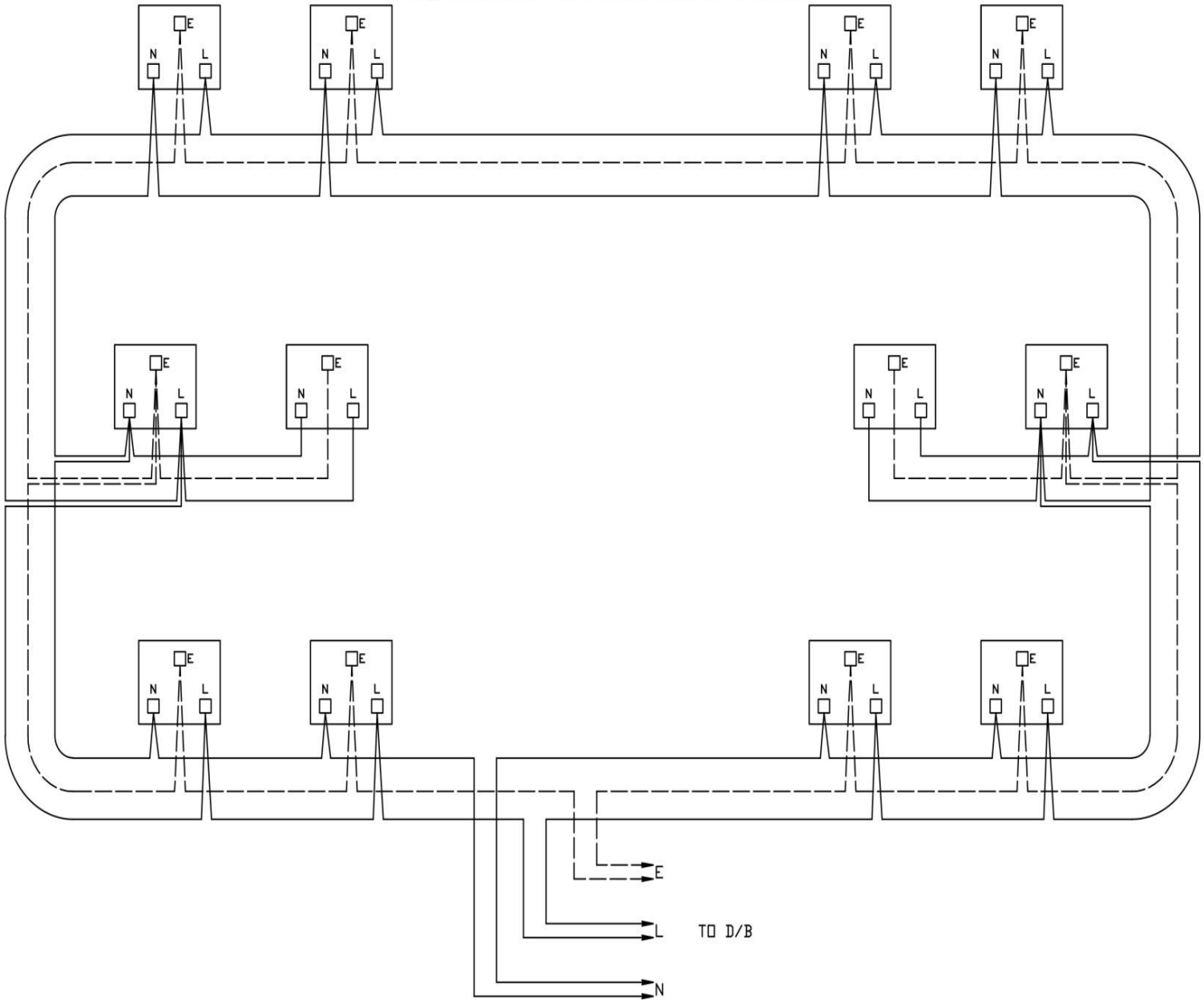
Symbol	Description
	Ceiling switch （cord pull operated)
	One way weather proof switch
	Fuse
	Moulded case circuit breaker
	Miniature circuit breaker
	Current operated earth leakage circuit breaker
ELR	Earth leakage relay
M	Kilowatt hour meter
D.B.	Distribution board
	Switch fuse
	Change over switch
	Main switch board assembly （ for details see schematic diagram）
	Submain switch board assembly （ for details see schematic diagram）
	Under ground cables
	Duct for cable entry
	Earth electrode
	Bell push
	Bell indicator with bell （dots show no. of ways)
	TV Aerial socket

TABLE 4.4
CONNECTION OF 13 AMPS SOCKETS
IN RING CIRCUIT IN NON-METALLIC CONDUIT



APPENDIX 5

Testing of PVC insulated single core non-armoured electrical cables before installation

Before starting the installation of cables, the following tests shall be carried out:

ELECTRICAL TEST REQUIREMENTS:

Test shall be made with alternating voltage of approximately sine-wave form, having a frequency in the range 50 Hz to 60 Hz, and of r.m.s. values as given in table 5.2. The required elec. tests to be applied at the cable shall be of time and temp. as shown in table 5.2. The tests are :-

a) Conductor resistance of 20°C (Ω/Km)
b) Voltage test on complete able (No breakdown of the insulation shall occur during the test).
c) Insulation resistance at 70°C must have the minimum values as shown in table – 5.1
d) Resistance of insulation to d.c. (the exterior of insulation shall show no damage)

TABLE 5.1

Nominal cross-sectional area of conductor	Number & diameter of wires per conductor	Maximum conductor resistance - plain annealed copper Km	Radial thickness of insulation	Mean overall diameter (upper limit)	Minimum insulation resistance at 70°C
mm^2	No./mm	Ω/Km	mm	mm	M Ω/Km
1.5	1/3.38	12.1	0.7	3.3	0.011
1.5	7/0.50	12.1	0.7	3.4	0.010
2.5	1/1.78	7.41	0.8	3.9	0.010
2.5	7/0.67	7.41	0.8	4.2	0.009
4	7/0.85	4.61	0.8	4.8	0.0077
6	7/1.04	3.08	0.8	5.4	0.0065
10	7/1.35	1.83	1	6.8	0.0065
16	7/1.7	1.15	1	8	0.0050
25	7/2.14	0.727	1.2	9.8	0.0050
35	19/1.53	0.524	1.2	11	0.0040
50	19/1.78	0.387	1.4	13	0.0045
70	19/2.14	0.268	1.4	15	0.0035
95	19/2.52	0.193	1.6	17	0.0035
120	37/2.03	0.153	1.6	19	0.0032
	37/2.25	0.124	1.8	21	0.0032
185	37/2.52	0.0991	2	23.5	0.0032
240	61/2.26	0.0754	2.2	26.5	0.0032
300	61/2.52	0.0601	2.4	29.5	0.0030
400	61/2.85	0.0470	2.6	33.5	0.0028
500	61/3.2	0.0366	2.8	37	0.0028
630	27/2.52	0.0283	2.8	41	0.0025

TABLE 5.2

ELECTRICAL TESTS TO BE APPLIED

Test	Unit		Test Requirement
Voltage test on complete cable :			
Length of sample (minimum)	Meter	20	No Break-down of the insulation
Period of immersion (minimum)	Hours	24	
Temperature of Water	°C	20±5	
Applied voltage (A.C)	V.	2500	
Time of Application	Mins.	15	
Conductor resistance at 20°C.: Length of sample	Meter	1	Not more than the Maximum value shown in Table 1.
Insulation resistance :			
Length of sample	Meter	5	Not less than the minimum value Shown in Table 1.
Period of Immersion (minimum) Temperture as water	Hours °C	2 70±2	
Resistance of insulation to D.C. Length of sample	Meter	5	No damage at the insulation
Period of Immersion	Days	10	
Temperature of solution	°C	60±5	
Duration of applied voltage	Days	10	
Test voltage	Volts D.C	220	

TABLE 5.3

PHYSICAL TEST REQUIREMENTS

The insulation shall be subjected to the tests and methods as detailed table 5.3

Test Method	Property Under Test	Test Requirements
A,B	Minimum tensile strength (N/mm²) Minimum elongation at break (%)	12.5 mm² 125%
C1, C2	Cold bent test : Temperature at which specimen shall not crack (°C)	-15±2°C
E3	Less of mass after ageing 10 days at 115±2°C (Max.) (mg/cm²)	1.5 mg/cm²
E1	Number of days ageing Ageing temperature (°C) Tensile strength after ageing (Min. value N/mm²) Maximum variation from unaged value (%) Elongation at break after ageing – minimum value % Max. variation from unaged value %	10 135±2°C 12.5 N/mm² 25% 125% 25 %
F1, F2	Hot pressure test temperature (°C)	95±2°C
F3	Maximum deformation %	50%
G1, G2	Heat shock test: Temperature at which specimen shall not crack (°C)	150±2°C
H	Minimum insulation resistance constant (K value) at 20 °C (M/Km)	180 M/km.

TEST CERTIFICATE SHALL BE APPROVED BY M.E.W.