ELECTRICAL WIRING REGULATIONS, 2012 (L.I. 2008)

ARRANGEMENT OF REGULATIONS

IN exercise of the power conferred on the Minister responsible for Energy by section 56 (1) of the Energy Commission Act, 1997 (Act 541) these Regulations are made this 19th day of December, 2011.

Purpose and application

Regulation 1—Purpose

The purpose of these Regulations is to

(a) establish the requirements, procedures and practices to ensure the enforcement of minimum standards of electrical wiring on premises; and

(b) ensure the safety of persons, livestock and other property from hazards that arise from the presence, distribution and use of electrical energy.

Regulation 2—Application

(1) These Regulations apply to

(a) electrical installations where the nominal voltages do not exceed

(i) 1000 Volts a.c. and 1500 Volts d.c. between conductors;

(ii) 600 Volts a.c and 900 Volts d.c. between conductors and earth; and

(iii) 50 Volts a.c or 120 Volts ripple free d.c whether between conductors or to earth; and

(b) an overhead interconnection between two or more buildings on the same premises.

(2) These Regulations do not apply to

(a) an overhead distribution installation located outside the premises;

(b) the internal wiring of a manufactured apparatus which is not wired on site;

(c) a part of or the whole of a telecommunication appliance, fire alarm, emergency lighting circuit or electrical equipment which is not fed directly from an electrical distribution network; or

(d) an installation in a mine, quarry, mobile offshore facility and fixed offshore facility which is provided for under an enactment.

Standards and requirements for electrical wiring

Regulation 3—General principles

(1) A person who is required to undertake electrical wiring on premises shall do so in accordance with the general principles referred to in sub-regulation (2) to (9).

(2) A conductor or equipment used for electrical wiring on premises shall be

(a) of a suitable construction and size to prevent excessive temperature rise while in use;

(b) installed and protected to prevent danger to persons, and property; and

(c) in a state capable of being maintained.

(3) Each live conductor including a conductor that forms part of an apparatus shall be suitably placed, protected and safeguarded to prevent danger.

(4) An enclosure or support capable of conducting electrical energy or metal work of an electrical equipment other than a current-carrying conductor, shall be connected to earth, to prevent danger.

(5) A circuit shall be protected against the persistence of excessive current which is likely to cause danger by the use of an appropriate circuit breaker or fuse.

(6) A protective device or switch shall not be connected in an earthed neutral conductor or in a protective earthed circuit.

(7) An effective means for isolation of supply of electricity, suitably placed for ready operation shall be used to facilitate the disconnection of electricity supply from each part of an electrical equipment to prevent danger.

(8) Each piece of electrical equipment which requires operation or attention in normal use shall be installed to ensure adequate means of access and working space.

(9) Each piece of electrical equipment which is exposed to the weather, corrosive atmosphere or other adverse condition shall be

(a) constructed or protected in the manner necessary to prevent danger; and

(b) protected by a flame proof enclosure of appropriate construction to prevent danger where the conditions include exposure to inflammable surroundings or an explosive environment.

Regulation 4—Quality of materials for electrical wiring

A person shall not use a material for electrical wiring unless that material is

(a) capable of maintaining the integrity of an electrical equipment or installation under environmental conditions stipulated by the manufacturer of the material for electrical wiring; and

(b) approved by the Standards Authority.

Regulation 5—Ghana Standards for electrical wiring

(1) The Ghana Standards for electrical wiring set out in the Schedule, consists of the following matters:

(a) requirements for control and distribution of electricity on premises;

(b) protective measures for safety;

(c) selection and erection of equipment;

(d) special installations, locations and structures; and

(e) inspection and testing

and shall be construed in accordance with the provisions of these Regulations.

(2) A person shall not undertake electrical wiring on premises unless the wiring is carried out in accordance with the requirements provided in the Schedule.

Regulation 6—Approval and notification for electrical wiring

(1) A person who intends to

(a) undertake a temporary or permanent alteration in respect of electrical wiring; or

(b) mount an installation of additional fixed electrical equipment which will require an alteration in respect of electrical wiring,

shall obtain approval in writing from an electricity distribution utility for the purpose.

(2) Sub-regulation (1) does not apply to premises which have not been connected to the electrical distribution network of the electricity distribution utility.

(3) A person responsible for the alteration or the installation of additional fixed electrical equipment shall

(a) submit to the electricity distribution utility in writing, notice of the commencement and completion in respect of the alteration or installation intended for connection to the electricity distribution network; and

(b) afford an authorised employee of the electricity distribution utility the opportunity for inspection and testing of the works for the alteration or the installation during and on completion of the works.

Qualification of electricians

Regulation 7—Qualified persons to undertake electrical wiring

A person shall not undertake electrical wiring on premises unless that person is certified by

(a) a licensed electricity distribution utility; or

(b) a recognised person appointed by the Energy Commission.

Regulation 8—Guidelines for certification of electricians

The Energy Commission shall issue guidelines for the certification of electricians within six months after the commencement of these Regulations.

Regulation 9—Register of electrical contractors

The Energy Commission shall keep and maintain a register of electrical contractors and persons certified to undertake electrical wiring.

Compliance requirements

Regulation 10—Connection of electricity supply to premises

(1) An electricity distribution utility shall not supply electricity to premises unless the requirements of these Regulations have been complied with and the electrical wiring or installation has been undertaken by a certified electrician as required under regulation 7.

(2) An electricity distribution utility shall disconnect electricity supply to premises where regulation 4 to 7 have not been complied with.

(3) Where the electricity supply to the premises of a person has been disconnected due to a contravention by that person of regulation 4 to 7, that person

(a) may apply to the electricity distribution utility for a reconnection of electricity supply to the premises; and

(b) shall obtain the written approval of the electricity distribution utility for the reconnection only if the defective wiring has been rectified.

(4) For the purposes of sub-regulation (3) (b), the electricity distribution utility or a person authorised by the electricity distribution utility may reconnect electricity supply to the premises.

Regulation 11—Inspection and testing

(1) A person who is authorised by an electricity distribution utility to carry out an inspection and test of an installation shall

(a) inspect and test that installation before use and carry out another inspection and test where an addition or alteration is made to the fixed wiring of the existing installation;

(b) take precautions during the inspection and testing to avoid causing danger to persons and damage to property including installed equipment;

(c) complete and sign the relevant Electrical Installation Certificate and the schedule of inspection and test results; and

(d) submit the documents referred to in paragraph (c) to the person who requested for the inspection and test if the inspection and test are satisfactory.

(2) A distribution utility that authorises an inspection and test of an installation shall ensure that a periodic inspection and test is carried out at the intervals indicated in subsection (3), taking into consideration the type of installation, its use, maintenance schedule and environmental influences.

(3) Periodic inspection and testing shall be carried out in accordance with the following schedule:

(a) ten years after the initial installation and use;

(b) every three to five years after ten years of the initial installation and use but before the expiration of thirty years; and

(c) every two years after thirty years of service.

Regulation 12—Powers of an inspector

(1) Pursuant to section 52 of the Energy Commission Act, 1997 (Act 541) an inspector may at any reasonable time enter any premises and inspect and examine the electrical wiring on the premises to establish that the electrical wiring was undertaken in accordance with these Regulations.

(2) A person who obstructs an inspector in the performance of official functions commits an offence and is liable on summary conviction to a fine of not more than one hundred penalty units and in the case of a continuing offence to a further fine of ten penalty units for each day during which the offence continues after written notice has been served on the offender by the inspector.

Regulation 13—Offences and penalties

A person who contravenes a provision of these Regulations for which a penalty is not provided, commits an offence and is liable on summary conviction to a fine of not more than two hundred and fifty penalty units or to a term of imprisonment of not more than two years or to both and in addition, the supply of electricity may be disconnected from the premises on which the electrical wiring was undertaken.

Regulation 14—Interpretation

In these Regulations, unless the context otherwise requires,

"a.c" means alternating electric current that reverses its direction of flow at periodic intervals, of fifty times per second;

"apparatus" means an electrical equipment designed to serve a specific function;

"circuit" means an unbroken path of a conductor along which an electric current exists or is intended or able to flow;

"conductor" means a material usually in the form of a wire or a bus-bar that permits electric current to flow easily;

"d.c" means direct electric current that flows continuously in one direction only, without substantial variation in magnitude;

"earth" means the conductive mass of the earth, whose electric potential at any point is conventionally taken as zero;

"electrical distribution network" means a system consisting of electricity lines, transformers, switchgear and other ancilliary equipment interconnected for the supply of electricity;

"electrical equipment" means an item used for the purposes of generation, conversion, transmission, distribution or utilisation of electrical energy, like a machine, transformer, apparatus, measuring instrument, protective device, wiring system, accessory, appliance and luminary;

"electricity distribution utility" means a person licensed under the Act to distribute or sell electricity without discrimination to consumers in an area or zone designated by the Energy Commission;

"emergency lighting circuit" means the lighting provided for use on premises when the supply from the normal electrical distribution network fails;

"electrical wiring" means an electrical installation composed of an assembly of cabling systems, protective devices and accessories to supply electricity on premises;

"fixed electrical equipment" means electrical equipment that is fixed to a support or device;

"fixed offshore facility" includes a drilling rig, production platform and processing facility;

"flame proof enclosure" means an enclosure resistant to fire or unable to catch fire or be damaged by fire;

"Ghana Standards" means the standards (GS FDGS 1009) prescribed by the Standards Authority in respect of these Regulations;

"metal work" means any item that is made of metal;

"mobile offshore facility" includes a ship, yacht, trawler and other maritime vessels;

"overhead interconnection" means a distribution system which carries electrical energy from one point to another point;

"premises" means land together with any building, structure or other installation like a residence, factory, construction site, kiosk, temporary installation; recreational ground, institutional building, commercial building and public access building;

"property" means movable or immovable property;

"protective device" means a particular type of equipment used in an electric power system to detect abnormal conditions and to initiate appropriate corrective action;

"ripple free d.c" means the d-c current without the small unwanted residual periodic variation of the direct current output of a power supply which has been derived from an alternating current source;

"Standards Authority" means the Authority established by section 1 of the Standards Authority Act, 1973 (N.R.C.D. 175); and

"voltage nominal" means the voltage by which an installation or part of an installation is designated in accordance with the following ranges of nominal voltage:

(a) extra-low, which is normally not exceeding 50 V a.c. or 120 V ripple-free d.c., whether between conductors or to earth; and

(b) low, which is normally exceeding extra-low voltage but not exceeding 1000 V a.c. or 1500 V d.c. between conductors, or 600 V a.c. or 900 V d.c. between conductors and earth.

SCHEDULE

(Regulation 5)

GHANA STANDARDS AUTHORITY

GHANA STANDARD GS 1009

ICS: 29.060.01; 29.020 Ref. No.
GS 1009

1 SCOPE

This Standard GS 1009 applies to the distribution of electrical energy in and around all types of dwelling houses, business premises, public buildings, factories, construction sites, kiosks, temporary installations and play grounds.

It states the main requirements for ensuring satisfactory results and safety including safety against electric shocks, burns and fire.

The primary purpose of this Standard therefore is to safeguard persons and property from hazards arising from the use of electricity.

The Standard primarily concerns installations, in which the declared voltages do not normally exceed 1000V a.c. or 1500V d.c. between conductors and 600V a.c. or 900V d.c. between conductors and earth.

This Standard is not intended either to take the place of detailed specifications and designs or to instruct untrained persons, and are supplementary to the Regulations.

Only proven and established materials, appliances and methods are considered here but this does not exclude the use of other materials and methods that may from time to time be permitted and authorised by the Ghana Standards Authority.

External distribution installations are not dealt with in this Standard; however interconnection between houses on premises is covered.

This Standard does not cover the following:

(a) internal wiring of manufactured apparatus which is not wired on site;

(b) parts of telecommunications (for example radio, telephone, bell, call and sound distribution, fire alarms; emergency lighting circuits and equipment which are not fed directly from a public or private power distribution source;

(c) electrical equipment of motor vehicles;

(d) electrical equipment on board ships and aircraft; and

(e) electrical installations at mines, quarries, mobile and fixed offshore facilities.

2 NORMATIVE REFERENCES

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document including amendments applies.

2.1 GS IEC 60320 - 1: 2007 - Appliances Couplers for household and similar general purposes — Part 1: General requirements.

2.2 GS IEC 60238 - Edison screw lamp holders.

2.3 GS IEC 61439-1 - Low-voltage switchgear and control gear assemblies — Part 1: General rules.

2.4 GS IEC 60898-1 - Electrical Accessories - Circuit-Breakers for Over-current Protection for Household and Similar Installations — Part 1: Circuit-Breakers for A.C. Operation.

2.5 GS IEC 60898-2 - Circuit-Breakers for Over-current Protection for Household and Similar Installations — Part 2: Circuit- Breakers for A.C. and D.C. Operation.

2.6 GS IEC 60755:2008 - General requirements for residual current operated protective devices.

2.7 GS IEC 61184: - Bayonet lampholders.

2.8 GS IEC 61558 - l: -Safety of transformers, reactors, power supply units and similar products — Part 1 - General requirement and test.

2.9 GS IEC 61558 - 2 - 4: -Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100 V — Part 2-4: Particular requirements and tests for isolating transformers and power supply units incorporating isolating transformers.

2.10 GS IEC 61558 - 2 - 6: -Part 2-6: Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers.

2.11 GS 1010:2010 - Memorandum- Construction of electrical equipment for protection against electric shock.

2.12 GS 1011:2010 — Electric cables- PVC insulated, armoured cables for voltages of 600/1,000 V and 1,900/3,000 V

3 DEFINITIONS

In this Standard, unless the context otherwise requires, the following definitions shall apply. Other terms not defined herein are used in the sense defined in GS IEC 60050.

3.1—accessory

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

3.2—ambient temperature

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

3.3—appliance

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

3.4—arm's reach

A zone of accessibility to touch, extending from any point on a surface where persons usually stand or move about to the limits which a person can reach with a hand in any direction without assistance. This zone of accessibility is illustrated by figure 1 in which the values refer to bare hands without any assistance, e.g. from tools or a ladder.

3.5—barrier

A part that provides a defined degree of protection against contact with a live part from any usual direction of access.

3.6—basic insulation

Insulation applied to live parts to provide basic protection against electric shock and which does not necessarily include insulation used exclusively for functional purposes.

3.7—bonding conductor

A protective conductor that provides equipotential bonding.

3.8—building void, accessible

A space within the structure or the component of a building accessible only at certain points. Such voids include the space within partitions, suspended floors, ceilings and certain types of window frame, door frame and architrave.

3.9—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 not separated from each other by a specified distance.

3.10—cable

An insulated current carrying conductor.

3.11—cable bracket

A horizontal cable support system, consisting of elements fixed at one end only, spaced at intervals along the length of the cable and on which the cable rests.

3.12—cable channel

An enclosure situated above or in the ground, ventilated or closed, and having dimensions which do not permit the access of persons but allow access to the conduits or cables throughout their

length during and after installation. A cable channel may or may not form part of the building construction.

3.13—cable cleat

A component of a support system, which consists of elements spaced at intervals along the length of the cable or conduit and which mechanically retains the cable or conduit.

3.14—cable coupler

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

3.15—cable ducting

An enclosure of metal or insulating material, other than a conduit or cable trunking, intended for the protection of cables which are drawn in after erection of the ducting.

3.16—cable ladder

A cable support consisting of a series of transverse supporting elements rigidly fixed to main longitudinal supporting members.

3.17—cable tray

A cable support consisting of a continuous base with raised edges and no covering. A cable tray may or may not be perforated.

3.18—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.

3.19—cable tunnel

A corridor containing supporting structures for cables and joints or other element of wiring systems and with dimensions that allow persons to pass freely throughout the entire length.

3.20—cartridge fuse link

A device comprising a fuse element or several fuse elements connected in parallel enclosed in a cartridge usually filled with an arc-extinguishing medium and connected to terminations (see fuse link).

3.21—catenary wire

A steel support wire, used to span the gap between two buildings, and from which electrical cables are then suspended.

3.22—circuit

An assembly of electrical equipment supplied from the same origin and protected against overcurrent by the same protective device.

3.23—circuit-breaker

A device capable of making, carrying and breaking normal load currents and also making and automatically breaking, under pre-determined conditions, abnormal currents like short-circuit currents. The Device usually required to operate infrequently although some types are suitable for frequent operation.

3.24—circuit-breaker, linked

A circuit-breaker the contacts of which are so arranged as to make or break all poles simultaneously or in a definite sequence.

3.25—circuit protective conductor (cpc)

A protective conductor connecting exposed-conductive-parts of equipment to the main earthing terminal.

3.26—class I equipment

Equipment in which protection against electric shock does not rely on basic insulation only, but which includes means for the connection of exposed-conductive-parts to a protective conductor in the fixed wiring of the installation (see GS IEC 60536).

3.27—class II equipment

Equipment in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions such as supplementary insulation are provided, there being no provision for the connection of exposed metalwork of the equipment to a protective conductor, and no reliance precautions to be taken in the fixed wiring of the installation (see GS IEC 60536).

3.28—class III equipment

Equipment in which protection against electric shock relies on supply at SELV and in which voltages higher than those of SELV are not generated (see GS IEC 60536).

3.29—conduit

A part of a closed wiring system for cables in electrical installations, that allow them to be drawn in or replaced, but not inserted laterally.

3.30—connector

The part of a cable coupler or of an appliance coupler which is provided with female contacts and is intended to be attached to the end of the flexible cable remote from the supply.

3.31—consumer unit (may also be known as a consumer control unit or electricity control unit)

A particular type of distribution board comprising a co-ordinated assembly for the control and distribution of electrical energy, principally in domestic premises, incorporating manual means of double-pole isolation on one or more of the incoming circuits and an assembly of one or more

fuses, circuit-breakers, residual current operated devices or signalling and other devices purposely manufactured for such use.

3.32—conductor

A material usually in the form of a wire or a bus-bar that permits electric current to flow easily.

3.33—current

The flow of free electrons in a conductor; measured in amperes.

3.34—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.

3.35—current-using equipment

The equipment which converts electrical energy into another form of energy like light, heat or motive power.

3.36—danger

Risk of injury to persons and livestock from:

(a) fire, electric shock and burns arising from the use of electrical energy, and

(b) mechanical movement of electrically controlled equipment, in so far as such danger is intended to be prevented by electrical emergency switching or by electrical switching for mechanical maintenance of non-electrical parts of such equipment.

3.37—design current (of a circuit)

The magnitude of the current (rms value for a.c.) to be carried by the circuit in normal service.

3.38—direct contact

Contact of persons or livestock with live parts.

3.39—disconnector

A mechanical switching device which, in the open position, complies with the requirements specified for isolation. A disconnector is otherwise known as an isolator.

3.40—distribution board

An assembly that contains switching or protective devices like fuses, circuit-breakers, residual current operated devices associated with one or more outgoing circuits fed from one or more incoming circuits, together with terminals for the neutral and protective circuit conductors. It may also include signalling and other control devices. Means of isolation may be included in the board or may be provided separately.

3.41—distribution circuit

A band II circuit connecting the origin of the installation to:

(b) an item of switchgear,

(c) an item of controlgear, or

(d) a distribution board

to which one or more final circuits or items of current-using equipment are connected (see also defination of final circuit).

A distribution circuit may also connect the origin of an installation to an outlying building or separate installation, when it is sometimes called a sub-main.

3.42—distributor

An entity that has been licensed by the Energy Commission under the Act as an electricity distributor and retailer.

3.43—double insulation

Insulation comprising both basic insulation and supplementary insulation.

3.44—duct

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

3.45—ducting (see Cable ducting)

3.46—earth

The conductive mass of the Earth, whose electric potential at any point is conventionally taken as zero.

3.47—earth electrode

A conductor or group of conductors in intimate contact with, and providing an electrical connection to earth.

3.48—earth electrode resistance

The resistance of an earth electrode to Earth.

3.49—earth fault current

A fault current which flows to Earth.

3.50—earth fault loop impedance

The dance of the earth fault current loop starting and ending at the point of earth fault. This impedance is denoted by the symbol Zs.

The earth fault loop comprises the following, starting at the point of fault:

- the circuit protective conductor,

- the consumer's earthing terminal and earthing conductor,

- for TN systems, the metallic return path,

- for TT and IT systems, the earth return path,

- the path through the earthed neutral point of the transformer,

- the transformer winding, and

- the phase conductor from the transformer to the point of fault.

3.51—earth leakage current. (see Protective conductor current)

3.52—earthed concentric wiring

A wiring system in which one or more insulated conductors are completely surrounded throughout their length by a conductor, for example a metallic sheath, which acts as a PEN conductor.

3.53—earthed equipotential zone

A zone within which exposed-conductive-parts and extraneous-conductive-parts are maintained at substantially the same potential by bonding, such that, under fault conditions, the differences in potential between simultaneously accessible exposed- and extraneous-conductive-parts will not cause electric shock.

3.54—earthing

Connection of the exposed-conductive-parts of an installation to the main earthing terminal of that installation.

3.55—earthing conductor

A protective conductor connecting the main earthing terminal of an installation to an earth electrode or to other means of earthing.

3.56—electric shock

A dangerous physiological effect resulting from the passage of an electric current through a human body or livestock.

3.57—electrical equipment (abbr: equipment)

Any item for purposes of generation, conversion, transmission, distribution or utilisation of electrical energy like a machine, transformer, apparatus, measuring instrument, protective device, wiring system, accessory, appliance and luminary.

3.58—electrical installation (abbr: installation)

An assembly of associated electrical equipment supplied from a common origin to fulfil a specific purpose and with certain co-ordinated characteristics.

3.59—electrically independent earth electrode

An earth electrode located at such a distance from one another that the maximum current likely to flow through one of them does not significantly affect the potential of the other.

3.60—electricity distribution utility

A person licensed under the Act to distribute and sell electricity without discrimination to consumers in an area or zone designated by the Energy Commission.

3.61—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.

3.62—emergency stopping

An emergency switching intended to stop an operation.

3.63—emergency switching

An operation intended to remove, as quickly as possible, danger, which may have occurred unexpectedly.

3.64—enclosure

A part that provides protection of equipment against certain external influences and in any direction protection against direct contact.

3.65—equipment (see electrical equipment)

3.66—equipotential bonding

Electrical Connection that maintains various exposed-conductive-parts and extraneous-conductive-parts at substantially the same potential.

3.67—equipotential zone (see earthed equipotential zone)

3.68—exposed-conductive-part

A conductive part of equipment which can be touched and which is not a live part but which may become live under fault conditions.

3.69—external influence

Any influence external to an electrical installation which affects the design and safe operation of that installation.

3.70—extra-low voltage (see voltage, nominal)

3.71—extraneous-conductive-part

A conductive part liable to introduce a potential, generally earth potential, and not forming part of the electrical installation.

3.72—fault

A circuit condition in which current flows through an abnormal or unintended path. This may result from an insulation failure or a bridging of insulation. Conventionally the impedance between live conductors or between live conductors and exposed or extraneous-conductive-parts at the fault position is considered negligible.

3.73—fault current

A current resulting from a fault.

3.74—final circuit

A circuit connected directly to current-using equipment, or to a socket-outlet or socket-outlets or other outlet points for the connection of such equipment.

3.75—fixed equipment

Equipment designed to be fastened to a support or otherwise secured in a specific location.

3.76—flexible cable

A cable with a structure and material that makes it suitable to be flexed while in service.

3.77—flexible cord

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

3.78—flexible wiring system

A wiring system designed to provide mechanical flexibility in use without degradation of the electrical components.

3.79—functional earthing

Connection to Earth necessary for the proper functioning of electrical equipment.

3.80—functional extra-low voltage (FELV)

An extra-low voltage system in which not all of the protective measures required for SELV or PELV have been applied.

3.81—functional switching

An operation intended to switch 'on' or 'off' or vary the supply of electrical energy to the whole or part of an installation for normal operating purposes.

3.82—fuse

A device which by the melting of one or more of its specially designed and proportioned components, opens the circuit in which it is inserted by breaking the current when this exceeds a given value for a sufficient time. The fuse comprises all the parts that form the complete device.

3.83—fuse carrier

The movable part of a fuse designed to carry a fuse link.

3.84—fuse element

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

3.85—fuse link

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

3.86—hazard

Any thing that can cause harm.

3.87—highway

Any way other than a waterway over which there is public passage and includes the highway verge and any bridge over which, or tunnel through which, the highway passes.

3.88—highway distribution board

A fixed structure or underground chamber, located on a highway, used as a distribution point, for connecting more than one highway distribution circuit to a common origin. Street furniture which supplies more than one circuit is defined as a highway distribution board. The connection of a single temporary load to an item of street furniture shall not in itself make that item of street furniture into a highway distribution board.

3.89—highway distribution circuit

A band II circuit connecting the origin of the installation to a remote highway distribution board or items of street furniture. It may also connect a highway distribution board to street furniture.

3.90—indirect contact

Contact between persons or livestock with exposed-conductive-parts which have become live under fault conditions.

3.91—installation (see Electrical installation)

3.92—instructed person

A person adequately advised or supervised by skilled persons to enable avoidance of dangers which electricity may create.

3.93—insulation

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

3.94—isolation

A function intended to cut off for reasons of safety the supply from all, or a discrete section, of the installation by separating the installation or section from every source of electrical energy.

3.95—isolator

A mechanical switching device which, in the open position, complies with the requirements specified for isolation. An isolator is otherwise known as a disconnector.

3.96—ladder (see Cable ladder)

3.97—leakage current

An electric current in an unwanted conductive path under normal operating conditions.

3.98—live part

A conductor or conductive part intended to be energised in normal use, including a neutral conductor but, by convention, not a PEN conductor.

3.99—low noise earth

An earth connection in which the level of conducted or induced interference from external sources does not produce an unacceptable incidence of malfunction in the data processing or similar equipment to which it is connected. The susceptibility in terms of amplitude or frequency characteristics varies depending on the type of equipment.

3.100—low voltage (see Voltage, nominal)

3.101—luminaire

Equipment which distributes, filters or transforms the light from one or more lamps, and which includes any parts necessary for supporting, fixing and protecting the lamps, but not the lamps themselves, and, where necessary, circuit auxiliaries together with the means for connecting them to the supply. For the purposes of the Regulations a lampholder, however supported, is deemed to be a luminaire.

3.102—luminaire supporting coupler (LSC)

A means, comprising an LSC outlet and an LSC plug, that provides mechanical support for a luminaire and the electrical connection to and disconnection from a fixed wiring installation.

3.103—Iv switchgear and controlgear assembly

A combination of one or more low voltage switching devices together with associated control, measuring, signalling, protective, regulating equipment, completely assembled under the responsibility of the manufacturer with all the internal electrical and mechanical interconnection and structural parts. The components of the assembly may be electromechanical or electronic. The assembly may be either type-tested or partially type-tested (see GS IEC 60439-1).

3.104—main earthing terminal

The terminal or bar provided for the connection of protective conductors, including equipotential bonding conductors, and conductors for functional earthing, if any, to the means of earthing.

3.105—mechanical maintenance

The replacement, refurbishment or cleaning of lamps and non-electrical parts of equipment, plant and machinery.

3.106—neutral conductor

A conductor connected to the neutral point of a system and contributing to the transmission of electrical energy. The term also means the equivalent conductor of an IT or d.c. system unless otherwise specified in the Standard and also identifies either the mid-wire of a three-wire d.c. circuit or the earthed conductor of a two-wire earthed d.c. circuit.

3.107—nominal voltage (see Voltage, nominal)

3.108—obstacle

A part preventing unintentional contact with live parts but not preventing deliberate contact.

3.109—overcurrent

A current that exceeds the rated value. For conductors the rated value is the current-carrying capacity.

3.110—overcurrent detection

A method of establishing that the value of current in a circuit exceeds a predetermined value for a specified length of time.

3.111—overload current

An overcurrent that occurs in a circuit which is electrically sound.

3.112—PELV (protective extra-low voltage)

An extra-low voltage system which is not electrically separated from earth, but which otherwise satisfies all the requirements for SELV.

3.113—PEN conductor

A conductor that combines the functions of both the protective conductor and neutral conductor.

3.114—phase conductor

A conductor of an a.c. system for the transmission of electrical energy other than a neutral conductor, a protective conductor or a PEN conductor. The term also means the equivalent conductor of a d.c. system unless otherwise specified in the Standard.

3.115—phase voltage

Voltage measured across a single component in a three-phase source or load.

3.116—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.

3.117—point (in wiring)

A termination of the fixed wiring intended for the connection of current-using equipment.

3.118—power factor

The number less than 1.0, used to represent the relationship between the apparent and true power of a circuit.

3.119—portable equipment

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

3.120—prospective fault current

The value of overcurrent at a given point in a circuit resulting from a fault of negligible impedance between live conductors having a difference of potential under normal operating conditions, or between a live conductor and an exposed-conductive-part.

3.121—protective conductor

A conductor used for some measures of protection against electric shock and intended for connecting together any of the following parts:

(a) exposed-conductive-parts;

(b) extraneous-conductive parts;

(c) the main earthing terminal;

(d) earth electrode(s); or

(e) the earthed point of the source, or an artificial neutral.

3.122—protective conductor current (earth leakage current)

Electric current which flows in a protective conductor under normal operating conditions.

3.123—protective multiple earthing (PME)

An earthing arrangement, found in TN-C-S systems, in which the supply neutral conductor is used to connect the earthing conductor of an installation with Earth.

3.124—reduced low voltage system

A system in which the nominal phase to phase voltage does not exceed 110 volts and the nominal phase to earth voltage does not exceed 63.5 volts.

3.125—Regulations

The Electrical Wiring Regulations that is, binding (in its entirety) on persons in the electrical wiring industry.

3.126—reinforced insulation

Single insulation applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in the relevant standard. The term 'single insulation' does not imply that the insulation must be one homogeneous piece. It may comprise several layers which cannot be tested singly as supplementary or basic insulation.

3.127—residual current

Algebraic sum of the currents in the live conductors of a circuit at a point in the electrical installation.

3.128—residual current device (RCD)

A mechanical switching device or association of devices intended to cause the opening of the contacts when the residual current attains a given value under specified conditions.

3.129—RCBO

A residual current circuit breaker with integral overcurrent protection, also used as an isolator.

3.130—residual operating current

A residual current which causes the residual current device to operate under specified conditions.

3.131—resistance

The opposition to the flow of electrons (current).

3.132—resistance area (for an earth electrode only)

The surface area of ground around an earth electrode on which a significant voltage gradient may exist.

3.133—restrictive conductive location

A location comprised mainly of metallic or conductive surrounding parts, within which it is likely that a person will come into contact through a substantial portion of the body with the conductive surrounding parts and where the possibility of preventing this contact is limited.

3.134—ring final circuit

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

3.135—risk

The chance of being harmed by a hazard.

3.136—safety service

An electrical system for electrical equipment provided to protect or warn persons in the event of a hazard, or essential to their evacuation from a location.

3.137—SELV (separated extra-low voltage)

An extra-low voltage system which is electrically separated from Earth and from other systems in such a way that a single fault cannot give rise to the risk of electric shock.

— IP2X, a code for protection to prevent access to hazardous parts with fingers and protects the equipments inside the enclosure against ingress of solid foreign objects having a diameter of 12.5mm and greater.

— IPXXB, a code for protection against ingress of solid foreign objects and water is not required and access to hazardous parts is protected for incidental contact with fingers.

3.138—shock (see Electric shock)

Figure 2 - Illustration of Earthing and Protective Conductor terms

1, 2, 3, 4, = protective conductors

1 = circuit protective conductor

2 = main equipotential bonding conductor

3 = earthing conductor

4 = supplementary equipotential bonding conductors (where required)

B = main earthing terminal

M = exposed-conductive-part

C = extraneous-conductive-part

P = main metallic water pipe (extraneous-conductive-part)

T = earth electrode (TT and IT systems)

E = other means of earthing (TN systems)

3.139—shock current

A current that passes through the body of a person or livestock so as to cause electric shock and that has characteristics likely to cause dangerous effects.

3.140—short-circuit current

An overcurrent resulting from a fault of negligible impedance between live conductors having a difference in potential under normal operating conditions.

3.141—simultaneously accessible parts

A conductor or conductive part which can be touched simultaneously by a person or, in a location specifically intended for it, by livestock. Simultaneously accessible parts may be: live

parts, exposed-conductive-parts, extraneous-conductive-parts, protective conductors or earth electrodes.

3.142—skilled person

A person with technical knowledge or sufficient experience to enable that person to avoid dangers which electricity may create.

3.143—socket-outlet

A device, provided with female contacts, which is intended to be installed with the fixed wiring, and intended to receive a plug. A luminaire track system is not regarded as a socket-outlet system.

3.144—spur

A branch from a ring final circuit.

3.145—stationary equipment

An electrical equipment which is either fixed, or equipment that has a mass that exceeds 18 kg and that is not provided with a carrying handle.

3.146—street furniture

A fixed equipment, located on a highway, the purpose of which is directly associated with the use of the highway.

3.147—street located equipment

A fixed equipment, located on a highway, the purpose of which is not directly associated with the use of the highway.

3.148—supplementary insulation

Independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of basic insulation.

3.149—switch

A mechanical 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 like those of short-circuit. It may also be capable of making, but not breaking, short-circuit currents.

3.150—switch linked

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

3.151—switchboard

An assembly of switchgear with or without instruments, but excludes groups of local switches in final circuits.

3.152—switchgear

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

3.153—system

An electrical system that consists of a single source of electrical energy and an installation. Types of systems depending on the relationship of the source, and of exposed-conductive-parts of the installation, to Earth:

• TN system

A system that has one or more points of the source of energy directly earthed, the exposed-conductive-parts of the installation being connected to that point by protective conductors.

• TN-C system

A system in which neutral and protective functions are combined in a single conductor throughout the system.

•TN-S system

A system that has separate neutral and protective conductors throughout the system.

• TN-C-S system

A system in which neutral and protective functions are combined in a single conductor in part of the system.

• TT system

A system that has one point of the source of energy directly earthed, the exposed-conductive-parts of the installation being connected to earth electrodes electrically independent of the earth electrodes of the source parts of the electrical installation being earthed.

3.154—temporary supply unit

An enclosure that contains equipment for the purpose of taking a temporary electrical supply safely from an item of street furniture.

3.155—trunking (see Cable trunking)

3.156—voltage

The difference in electrical charge between two points in a circuit, expressed in volts; force available to push current round a circuit.

3.157—voltage, nominal

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

(a) Extra-low — Normally not exceeding 50 V a.c. or 120 V ripple-free d.c., whether between conductors or to Earth,

(b) Low — Normally exceeding extra-low voltage but not exceeding 1000 V a.c. or 1500 V d.c. between conductors, or 600 V a.c. or 900 V d.c. between conductors and earth.

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

3.158—wiring system

An assembly made up of cable or busbars and parts which secure and, if necessary, enclose the cable or busbars.

Figure 3 : TN-C System

Neutral and protective functions combined in a single conductor throughout system.

All exposed-conductive-parts of an installation are connected to the PEN conductor.

An example of the TN-C arrangement is earthed concentric wiring but where it is intended to use this, special authorisation must be obtained from the appropriate authority.

Fig. 4: TN-S System

Separate neutral and protective conductors throughout the system.

The protective conductor (PE) is the metallic covering of the cable supplying the installations or a separate conductor.

All exposed-conductive-parts of an installation are connected to this protective conductor via the main earthing terminal of the installation.

Fig. 5: TN-C-S System

Neutral and protective functions combined in a single conductor in a part of the system.

The usual form of a TN-C-S system is as shown, where the supply is TN-C and the arrangement in the installations is TN-S.

This type of distribution is known also as protective multiple earthing and the PEN conductor is referred to as the combined neutral and earth an (CNE) conductor.

The supply system PEN conductor is earthed at several points and an earth electrode may be necessary at or near a consumer's installation.

All exposed-conductive-parts of an installation are connected to the PEN conductor via the main earthing terminal and the neutral terminal, these terminals being linked.

Fig. 6 : TT System

All exposed-conductive-parts of an installation are connected to an earth electrode which is electrically independent of the source earth.

4. SYMBOLS/FORMULAE USED IN THE CODE

Symbols/ formulae	Description	Units of measure	Symbols/formulae	Description	Units of measure
C	correction factor — general		Ia	current causing automatic operation of protective device within the time stated	A
Ca	correction factor for ambient temperature				
Cg	correction factor for grouping		Ib	design current of circuit	A
Ci	correction factor for conductors embedded in thermal insulation		In	nominal current or current setting of protective device	A
Ct	correction factor for operating temperature conductor			rated residual operating current of protective device in amperes	A
De	overall cable diameterg		It	tabulated current-carrying Capacity	A
gG	class 'gM' utilisation category of fuses to B88 motor circuit applications		Iz	current-carrying capacity of a cable for continuous service under the particular installation conditions concerned	A
f	frequency in cycles per second	Hz	I^2t	energy let-through value of device	A
I	current (general term)	A	I2	current causing effective operation of the overload	A
If	fault current (general term)	A		protective device	
k	thermal conductivity material factor taken from Tables 30 and 31	WK-1m-1			

As½mm tp maximum permitted normal operating conductor temperature °c

k^2S^2 energy withstand of cable A^2s Uo nominal phase voltage (to earth for TN systems) V

(mV/A m)r reactive voltage drop per ampere per meter mVA-1m-1 Uoc open circuit voltage at the distribution transformer V

(mV/A m)x reactive voltage drop per ampere per meter mVA-1m-1 U voltage between phases V

(mV/A m)z impedance voltage drop per ampere per meter mVA-1m-1 Ze that part of the earth fault loop impedance which is external to the installation

R resistance of supplementary bonding conductor

S conductor cross-sectional area mm^2 Zs earth fault loop impedance

t time s

U voltage between phases V

RA the sum of the resistance of the earth electrode and the protective conductor connecting it to the exposed conductive parts

5 REQUIREMENTS FOR THE CONTROL AND DISTRIBUTION OF ELECTRICITY SUPPLY ON PREMISES

5.1 Control of installation

5.1.1 Every installation supplied from an external source shall be adequately controlled as a whole by switchgear as described below:

(a) be combined in a consumer distribution board; or

(b) be in a form of an independent switchgear or fuses.

5.2 Arrangement of equipment at supply intake position

5.2.1 The equipment installed at the supply intake position shall be arranged in the following sequence (see Fig 7):

(a) service cable and sealing box, if any;

(b) service fuses and neutral link; or aerial cut-out fuses in case of overhead service connection;

(c) kilowatt hour meter;

(d) consumer main switch or circuit breaker;

(e) consumer final circuit fuses or breakers.

Fig. 7

5.2.2 The consumer main switch referred to above shall be readily accessible to the consumer and situated as near as practicable to the termination of the service cable.

5.2.3 The position of the incoming service, service fuses or breakers and meter shall be decided by the Electricity Distribution Utility.

5.2.4 Where a switchboard of the metallic clad type, having its busbars totally enclosed in a rigid metal case, supplies two or more circuits, means of disconnecting the busbars from the supply shall be provided.

5.2.5 Every distribution board shall be connected to either the main switch controlling the supply, or a separate way on a larger distribution board.

5.3 Switchgear arrangement within installation

5.3.1 The switchgear arrangement shall be as in Table 1:

Table 1-Switchgear arrangement

A. C. Single phase: Main Switchgear — 2-pole ganged switch with fused non-earthed conductor or 1-pole with fuse in the live or phase conductor with earthed neutral.

A.C. 3-phase 3-wire Main Switchgear — 3-pole (linked) fuses in each phase

A.C. 3-phase 4-wire Main Switchgear — 3-pole (linked) fuses in each phase earthed neutral systems.

Main switchgear 4 pole (linked) fuses in each phase and neutral for non-earthed neutral systems.

5.4 Labelling

5.4.1 Every switch, isolator or protective gear shall have the following identification on it:

(a) manufacturer's rating, and

(b) labels identifying the appliances or circuits they control.

5.5 Overcurrent protection

Throughout an installation every circuit shall be protected against the persistence of an overcurrent condition by the provision of rated fuses or circuit breakers appropriately (see Section 6).

5.6 Methods of isolation

5.6.1 For all installations, load or circuit isolations shall only be carried out in the live and non-earthed neutral conductors. All earth-linked conductors shall not be provided with any means of isolation.

5.6.2 For the purposes of performing certain tests, an exception to 5.6.1 should be made as follows: an isolating link of the same current carrying capacity as the earth conductor could be provided and remain permanently connected except and only when all the live and neutral connections have been disconnected example, earth testing.

5.6.3 In every 2-wire installation (phase and neutral) or circuit, all single pole switches shall be fitted in the phase conductor throughout.

5.6.4 In a 3-wire or 4-wire installation, all switches shall be 3 pole or 4 pole as appropriate.

5.7 Exposed conductive parts

Where two or more low-voltage circuits between which a voltage more than 250 volts or less than 600 volts may exist, are installed in the same room, corridor, staircase or other location, any live metal parts not permanently shrouded in insulating material shall be installed to comply with one of the following:

(a) they shall be enclosed in earthed metal marked to indicate the risk of dangerous shock;

(b) they shall be installed in a room accessible only to authorised persons; or

(c) they shall be fixed so that they are not less than 2.00m apart.

5.8 Final sub-circuits

5.8.1 Final sub-circuits shall be defined as separate and independent circuits or ways in distribution boards which are protected by fuses or circuit breakers.

Every installation shall be divided into circuits as necessary to

(a) avoid danger and minimize inconvenience in the event of a fault, and

(b) facilitate safe operation, inspection, testing and maintenance.

These circuits shall be described either as radial or ring circuits.

5.8.2 Radial circuits

Radial circuits shall meet the following requirements:

(a) the aggregate rating of the load shall not exceed the cable rating; and

(b) the rating of the protective fuse or circuit breaker shall not exceed the rating of the cable.

5.8.2.1 Lighting circuits

For residential installations it is recommended that the aggregate lighting load shall not exceed the fuse or circuit breaker rating of the lighting circuit. The fuse or circuit breaker rating shall be limited to 6A.

5.8.2.2 Power outlets

Recommended final circuits feeding 13 A sockets are as follows (subject to any derating factors for ambient temperature, grouping or voltage drop) (summary in Table 2):

(a) an unlimited number of socket outlets connected to a final circuit serving a floor area not exceeding 100m wired with 2.5mm² PVC insulated cables in the form of a ring protected by a 30A or 32A overcurrent protective device;

(b) an unlimited number of socket outlets connected to a final circuit serving a floor area not exceeding 50 m² with 4mm² PVC cables on a radial circuit and protected by an overcurrent device of 30 A or 32 A rating; and

(c) an unlimited number of socket outlets connected to a final circuit serving a floor area not exceeding 20m² with 2.5mm² PVC cables on a radial circuit and protected by an overcurrent device not exceeding 20 A.

Table 2

Type of circuit	Size of Room	Size Cable	No. of Socket Outlets (13 A)	Overcurrent Protection
Ring	<100 m²	2.5 mm² PVC insulated cables	unlimited number	30 A/32 A
Ring	<20 m²	2.5 mm² PVC insulated cables	unlimited number	20 A
Radial	<50 m²	4 mm² PVC cables	unlimited number	30 A/32 A

Note that if these standard circuits are used, the designer is still responsible for ensuring the circuit is suitable for the expected load. Also the voltage drop and earth fault loop impedance values are suitable and the breaking capacity of the overload protection is sufficiently high. However, if the estimated load for any given floor area exceeds that of the protective device given then the number of circuits feeding this area must be increased accordingly.

5.8.3 Ring circuits

A ring circuit is defined as the form of wiring of which both ends of the wiring are terminated into the terminal of the fuse or circuit breaker.

It is recommended that the total number of socket outlets do not exceed 8. The maximum rating of the fuse or circuit breaker shall not exceed 32 A. The cable size shall be not less than 2.5 mm².

5.9 Means of control

5.9.1 All lighting points shall be controlled individually or as a group by a switch or switches which shall be so placed as to be readily accessible.

5.9.2 All socket-outlets shall be controlled by a switch immediately adjacent thereto or combined therewith. Where practicable, all socket outlets in any one room must be connected to the same phase. In cases where this is not possible, there shall be a minimum distance of two meters (2m) between sockets fed from different phases.

(a) In residential installations, socket outlets with automatic shuttering on withdrawal of plugs shall be provided.

(b) The minimum distance of each socket from the floor or operating surface in case of kitchens shall be 0.5m.

5.10 Cables

5.10.1 Selection of cables

All cables shall meet the requirements of the relevant Ghana Standards or equivalent International standards or as recommended for use by the Electricity Distribution Utility.

For example the following:

(a) single core, PVC insulated and/or sheathed cables;

(b) multi core, PVC insulated and sheathed cables;

(c) mineral-insulated metal-sheathed cables; (MICC)

(d) vulcanized rubber insulated (VRI) cables; and

(e) tough rubber insulated (TRS) cables.

5.10.1.1 Cables shall be so selected and installed that they are not subjected to deterioration from mechanical damage, vibration, moisture, corrosive liquids, oil or heat. Where it is impossible practically to avoid such conditions, the cables shall be protected or shielded against these conditions of deterioration; otherwise only cables specially designed to withstand the conditions shall be used.

5.10.1.2 Flexible cables and cords, other than those protected by armour, tough-rubber or P.V.C sheath, shall not be used in places such as workshops where they may be subjected to abnormal risk of mechanical damage.

5.10.1.3 All electrical cables shall be of sufficient size and current carrying capacity for the purposes for which they are intended. The minimum size of a copper conductor for fixed installations shall be 1.5mm^2.

5.10.2 Identification of cables

All cables shall be marked in accordance with the requirements of GS IEC 60227:

(a) the maximum working voltage for which the cable is tested and/or approved;

(b) the manufacturers name, trade mark etc; and

(c) the size or cross sectional area.

5.10.3 Cable insulation

All cables shall be selected with the correct grade of insulation in accordance with the appropriate Ghana Standards to withstand a voltage not less than the highest to which they are likely to be subjected.

5.10.4 Colour identification for cables

Flexible or non-flexible cords or cables shall be identified by colours as shown in Table 3(A), 3(B) and 4 respectively.

Table 3(A)— Colour identification of cores of flexible cables and flexible cords

Number of cores	Function of core	Colour(s) of core
1	Phase	
	Neutral	
	Protective	Brown
		Blue
		Green and Yellow
2	Phase	
	Neutral	Brown
		BlueA
3	Phase	
	Neutral	
	Protective	BrownB
		BlueA
		Green and Yellow
4 or 5	Phase	
	Neutral	
	Protective	Brown or Blackc
		BlueA
		Green and Yellow

A The blue core may be used for functions other than the neutral in circuits which do not incorporate a neutral conductor, in which case its function shall be appropriately identified during installation; provided that the blue core shall not in any event be used as a protective conductor. If the blue core is used for other functions, the coding L1, L2, L3, or other coding where appropriate should be used.

B In three-core flexible cables or flexible cords not incorporating a green-and-yellow core brown core and a black core may be used as phase conductors.

C Where an indication of phase rotation is desired, or it is desired to distinguish the function of more than one phase core of the same colour, this shall be by the application of numbered or lettered (not coloured) sleeves to the cores, preferably using the coding using the coding[sic] L1, L2, L3 or other coding where appropriate.

Table 3B: Identification of Conductors

Function	Alphanumeric	Colour
Protective conductors		
Functional earthing conductor		Green-and-yellow
Cream		
a.c. power circui t(1)		
Phase of single-phase-circuit		
Neutral of single- or three phase circuit		
Phase 1of three-phase a.c. circuit		
Phase 2 of three-phase a.c. circuit		
Phase 3 of three-phase a.c. circuit		
L		
N		
L1		
L2		
L3		
Brown		
Blue		
Brown		
Black		
Grey		
Two-wire unearthed d.c. power circuit		
Positive of two-wire circuit		

Negative of two-wire circuit L+

L- Brown

Grey

Two-wire earthed d.c. power circuit

Positive (of negative earthed) circuit

Negative (of negative earthed) circuit(2)

Positive (of negative earthed) circuit(2)

Negative (of negative earthed) circuit L+ Brown

Three-wire d.c. power circuit

Outer positive of two-wire circuit derived from three-wire system

Outer Negative of two-wire circuit derived from three-wire system

Positive of three-wire circuit

Mid-wire of three-wire circuit(2)(3)

Negative of three-wire circuit

L-

L+

M

L-

L

Grey

Brown

Blue

Grey

Brown, Black, Red, Orange, Yellow, Violet, Grey, White, Pink or Turquoise

Control circuits, ELV and other applications

Phase conductor

Neutral or mid-wire(4) N or M Blue

NOTES:

(1) Power circuits include lighting circuits

(2) M identifies either the mid-wire of a three-wire d.c. circuit, or the earthed conductor of a two-wire earthed d.c. circuit.

(3) Only the middle wire of the three-wire circuits may be earthed.

(4) An earthed PELV conductor is blue.

Table 4: Colour identification of cores of non-flexible cables and bare conductors for fixed wiring

Function	Colour of identification
Protective (including earthing) conductor	green and yellow
Phase of a.c. single-phase circuit	Red/brown
Neutral of a.c. single-phase circuit	Black/blue
Neutral of 3-phase a.c. circuit	black
Phase R of 3-phase a.c. circuit	red
Phase Y of 3-phase a.c. circuit	yellow
Phase B of 3-phase a.c. circuit	blue
Positive of d.c. 2-wire circuit	red
Negative of d.c. 2-wire circuit	black
Outer (positive or negative) of d.c. 2-wire circuit	
Derived from 3-wire system	red
Positive of 3-wire d.c. circuit	red
Middle wire of 3-wire circuit	black
Negative of 3-wire d.c. circuit	blue

Notes:

A. Armoured p.v.c.- insulated auxiliary cables shall be identifiable by the use of core colours in accordance with the requirements of Table 5, or the application at terminations of tapes, sleeves or discs of the appropriate colours prescribed in the Table; or alternatively, by the use of numbered cores in accordance with GS IEC 60502-1 and GS IEC 60502-2.

B. For paper-insulated cables, identification shall be by the use of numbered cores in accordance with GS IEC 60055-1 and GS IEC 60055-2; provided that the numbers 1, 2 and 3 shall signify phase conductors, the numbers 0 the neutral conductor, and the number 4 the fifth ('special-purpose.') core if any.

These colours shall be used for marking all installations of conductors and/or in distribution fuseboard or busbars.

5.10.5 Cable connection

5.10.5.1 A soldered connection shall not be used.

5.10.5.2 Cable sockets or terminals used shall be of such a size as to contain all the strands of the conductors. The braid or other covering over the insulation shall be cut back at least 15mm from the end of the insulation and the insulation only removed so as to enable the conductor to enter fully into the socket or terminal.

5.10.5.3 Every connection between cable ends shall be made by means of a mechanical connector and shall be readily accessible, and mechanically and electrically sound.

5.10.6 Cable installation and protection

5.10.6.1 A cable shall be installed in a position where it will not be affected by the sun or rain or any other condition, except when specially designed for this purpose.

5.10.6.2 A cable shall not be buried directly in galvanized steel conduits for underground installations close to the sea or into any wall, floor or ceiling but may be concealed in one of the following ways:

(a) P.V.C. insulated and sheathed, in "Duct tube", in wood ducts or on the surface and may be drawn in the hollow flooring after the concrete has been laid.

(b) P.VC. insulated cable may be drawn in heavy gauge galvanized steel conduit or plastic conduit of a type approved by the Electricity Distribution Utility.

5.10.6.3 In every circuit and sub-circuit every cable including every flexible cord shall have a current rating not less than that of the fuse rating.

5.10.6.4 A cable for the distribution of power and lighting supplies shall not be installed in the same tube, groove, or section of casing as the wires of radio, telephone, electric bell, or similar signalling circuits.

5.10.6.5 A power signal and control cable may be ran together provided the insulation of each cable is adequate, for the highest voltage within cables running in the same conduit and provided the signal cables are adequately protected against magnetic influences.

5.10.6.6 Despite 5.10.6.1 and 5.10.6.2, power, signal and control cable may be run together provided the insulation of each cable is adequate for the highest voltage within cables running in the conduit.

5.10.6.7 In damp situations the supports for cables shall be of non-rusting material.

5.11 Spacing of cable cleats, saddles, clamps etc.

5.11.1 Where applicable, the spacing for the cleats, saddles, or clamps shall be as follows:

Table 5— Spacing of cable cleats, saddles, clamps etc.

Cable sizes(mm^2)	Maximum	
	Horizontal	Vertical
1.5	1(mm)	(mm)
230	380	
2.5	300	380
4.0	300	380
6.0	300	380
10.0	380	460
16.0	380	460
Above 16.0	400	530

Except where the cables are installed within partitions or under floors, or within the roof space in which case the maximum spacing may be increased up to 1 meter and that within the roof space the cables are run along the side of the joists or at right angles to them.

5.11.2 Every cable shall be prevented by spacing, insulation or otherwise from coming into contact, under any condition of service, with water pipes or non-earthed metal work other than the metal cleats and saddles used to support the cable.

5.12 Cable capacities of conduit and trunking systems

A number of variable factors affect any attempt to arrive at a standard method of assessing the capacity of conduit or trunking.

Some of these are:

(a) reasonable care (of drawing-in);

(b) acceptable use of the space available;

(c) tolerance in cable sizes; and

(d) tolerance in conduit and trunking sizes.

The following tables only give guidance to the maximum number of cables which should be drawn in. The sizes should ensure an easy pull with low risk of damage to the cables.

Only the ease of drawing-in is taken into account. The electrical effect of grouping is not addressed. As the number of cables increases, the current-carrying capacity of the cable decreases. Cable sizes have to be increased with consequent increase in cost of cable and conduit.

It will be more cost-effective to divide the number of cables concerned between two or more enclosures.

The following three cases are dealt with:

Single-core PVC-insulated cables

(a) in straight runs of conduit not exceeding 3 m in length (see tables 4 and 5);

(b) in straight runs of conduit exceeding 3 m in length, or in runs of any length; incorporating bends or sets (see tables 6 and 7).

For cables or conduits not covered in Tables 1-9 advice on the number of cables which can be drawn-in should be obtained from the manufacturers.

5.12.1 Single-core PVC-insulated cables in straight runs of conduit not exceeding 3 m in length.

For each cable size that is selected for use, obtain the factor from Table 6. Add the cable factors associated with each cable size together and compare the total with the conduit factors given in Table 7.

The minimum conduit size is that having a factor equal to or greater than the sum of the cable factors.

Table 6 —Cable factors for use in conduit in short straight runs

Type of Conductor	Conductor cross-sectional area mm²	Cable factor
Solid	1	
	1.5	
	2.5	22
	27	
	39	
Stranded	1.5	
	2.5	

4

6

10

16

25 31

43

58

88

146

202

385

Table 7 —Conduit factors for use in short straight runs

Conduit diameter	
Mm	Cable factor
16	
20	
25	
32	
38	
50	
63	290
460	
800	
1400	
1900	
3500	
5600	

5.12.2 Single-core PVC- insulated cables in straight runs of conduit exceeding 3 m in length or in runs of any length incorporating bends or sets

For each cable size that is selected for use, obtain the appropriate factor from Table 8.

Add the cable factors associated with each cable size together and compare the total with the conduit factors given in Table 9, taking into account the length of run it is intended for use and the number of bends and sets in that run.

The minimum conduit size is that size that has a factor equal to or greater than the sum of the cables factors. For the larger sizes of conduit multiplication factors are given relating them to 32 mm diameter conduit.

Table 8 —Cable factors for use in conduit in long straight runs over 3 m, or runs of any length incorporating bends

Type of conductor	Conductor cross-sectional area mm²	Cable factor
Solid or Stranded	1	
	1.5	
	2.5	
	4	
	6	
	10	
	16	
	25	16
	22	
	30	
	43	
	58	
	105	
	145	
	217	

Table 9 —Conduit factors for runs incorporating bends and long straight runs

Conduit diameter

Mm

Length or run

M 16 20 25 32

Straight 16 20 25 32

One bend 16 20 25 32

Two bends 16 20 25 32

Three bends 16 20 25 32

Four bends

1

1.5

2

2.5

3 188 303 543 947

182 294 528 923

177 286 514 900

171 278 500 878

167 270 487 857 177 286 514 900

167 270 587 857

158 256 463 818

150 244 442 783

143 233 422 750 158 256 463 818

143 233 422 750

130 213 388 692

120 196 358 643

111 182 333 300 130 213 388 692

111 182 333 600

97 159 292 529

86 141 260 474

3.5

4

4.5

5

6

7

8

9

10 179 290 521 911

177 286 514 900

174 282 507 889

171 278 500 878

167 270 487 857

162 263 475 837

158 256 463 818

154 250 452 800

150 244 442 783 162 263 475 837

158 256 463 818

154 250 452 800

150 244 442 783

143 233 422 750

136 222 404 720

130 213 388 692

125 204 373 667

120 196 358 643 136 222 404 720

130 213 388 692

125 204 373 667

120 196 358 643

111 182 333 600

103 169 311 563

97 159 292 529

91 149 275 500

86 141260 474 103 169 311 563

97 159 292 529

91 149 275 500

86 141 260 474

Additional Factors:

For 38 mm diameter use .....1.4 x (32 mm conduit factor)

For 50 mm diameter use .....2.6 x (32 mm conduit factor)

For 63 mm diameter use .....4.2 x (32 mm conduit factor)

5.12.3 Single-core PVC-insulated cables in trunking

For each cable selected for use, obtain the appropriate factor from Table 10.

Add all the cable factors so obtained and compare with the factors for trunking given in Table 11.

The minimum size of trunking is that size that has a factor equal to or greater than the sum of the cable factors.

Table 10—Cable factors for trunking

Type of Conductor Conductor cross-sectional area

mm² Cable factor

Solid 1.5

2.5 8.6

11.9

Stranded 1.5

2.5

4

6

10

16

25 9.1

13.9

18.1

22.9

36.3

50.3

75.4

Notes

(1) These factors are for metal trunking and may be optimistic for plastic trunking where the cross-sectional area available may be significantly reduced from the nominal by the thickness of the wall material.

(2) The provision of spare space is advisable; however, any circuits added at a later date must take into account grouping. Appendix 4.

Table 11—Factors for trunking

Dimensions of trunking(mm x mm) Factor Dimensions of trunking(mm x mm) Factor

50 x 38

50 x 50

75 x 25

75 x 38

75 x 50

75 x 75

100 x 25

100 x 38

100 x 50

100 x 75

100 x 100

150 x 38

150 x 50

150 x 75

150 x 100

150 x 150

200 x 38

200 x 50

200 x 75 767

1037

738

1146

1555

2371

993

1542

2091

3189

4252

2999

3091

4743

6394

9697

3082

4145

6359 200 x 100

200 x 150

200 x 200

200 x 38

225 x 50

225 x 75

225 x 100

225 x 150

225 x 200

225 x 225

300 x 38

300 x 50

300 x 75

300 x 100

300 x 150

300 x 200

300 x 225

300 x 300 8572

13001

17429

3474

4671

7167

9662

14652

19643

22138

4648

6251

9590

12929

19607

26285

29624

39428

Space factor — 45% with trunking thickness taken into account

5.12.4 For other sizes and types of cable or trunking

For sizes and types of cable trunking other than those given in Tables 8 and 9, the number of cables installed should be such that the resulting space factor does not exceed 45% of the net internal cross-sectional area of the trunking.

Space factor is defined as the ratio expressed as a percentage of the sum of the overall cross-sectional areas of cables insulation and any sheath to the internal cross-sectional area of the trunking or other cable enclosure in which they are installed. The effective overall 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.

Care should be taken to use trunking bends which do not impose bending radii on cables less than those required by table 10.

5.12.5 Every metal conduit and metal — sheathed system shall have the conduit or metallic sheath electrically bonded to the earth in a sound manner.

5.12.6 In a conduit system, the conduits for each circuit shall be erected completely before any cable is drawn in. The ends of lengths of conduit shall be so trimmed and the outlets shall be so bushed, as to obviate abrasion of cables. It is desirable that inspection boxes, drawn-in boxes and the like should remain accessible throughout the life of the installation for such purposes as the withdrawal of existing cables or the installation of additional cables.

5.13 Distribution between buildings

5.13.1 When it is necessary to extend a consumer's installation from the main supply point to one or more separate buildings or other points of utilisation, the wiring shall be in compliance with the rules set out in clauses 5.13.1.1. and 5.13.1.2.

5.13.1.1 The consumer's distribution wiring between buildings shall make use of one or more of the following systems:

(a) armoured underground cable of approved type. Cable must be installed at a depth of at least 500mm;

(b) suitable insulated cable supported on insulators like an iron piece or shackle on each building. The maximum span between the supports shall be 50m, and a minimum ground clearance of 4m;

(c) insulated and sheathed UV and moisture resistant cable supported by clips or cleats in an approved manner on the buildings;

(d) insulated conductors laid in suitably drained single length of galvanized conduit with a maximum distance between buildings of 3 meters.

5.13.1.2 In all cases, the cables shall be fixed so that they normally cannot be touched by any person, nor be liable to mechanical damage of any kind.

5.14 Temporary installations

5.14.1 Permission must be obtained from the Electricity Distribution Utility (EDU) before any temporary installation is connected to the supply mains and notice (from the contractor) must be given in writing (to the EDU) at least five working days before the installation is required.

5.14.2 Every temporary installation shall comply with this standard and any other relevant enactment that may be made by the Electricity Distribution Utility.

5.14.3 Every temporary installation shall be in accordance with any special requirements of the Electricity Distribution Utility and shall be maintained so as to avoid risk of fire and shock.

5.14.4 Where a temporary installation is required for more than three months, it shall be examined and tested by a competent person every three months or as determined by the Electricity Distribution Utility and be completely overhauled by the owner where necessary.

5.14.5 Every temporary installation shall be adequately protected against excess current and shall be controlled by a conveniently placed switch or other means whereby all wires can be and will be disconnected from the supply when not in use.

5.14.6 Every temporary installation shall be in the charge of a competent person, who shall accept full responsibility for the use and any alterations to it.

5.14.7 Every temporary installation shall be tested before being put into use and shall comply with the Regulations of the Electricity Distribution Utility.

6 PROTECTIVE MEASURES FOR SAFETY

6.1 General Requirements

6.1.1 Every installation, either as a whole or in its several parts, shall comply with the requirements of this section in accordance with protective measures described in clause 6.2 to 6.5.

6.1.2 The order in which the protective measures are listed shall not be taken to imply the relative importance of different measures.

6.1.3 Protective measures for the installations and locations of increased shock risk

For any installation or part of an installation where the risk of electric shock is increased by a reduction in body resistance or by contact with earth potential, the relevant requirements of this section shall apply in addition to the requirements contained in other sections of the Standard.

6.2 Protection against electric shock

General

Protection against electric shock shall be provided by

(a) the application of measures specified in clause 6.2.1 for protection against both direct contact and indirect contact, or

(b) the application of a combination of appropriate measures specified in clause 6.2.2 for protection against direct contact and clause 6.2.3 for protection against indirect contact.

6.2.1 Protection against both direct and indirect contact

General

For protection against both direct contact and indirect contact, one of the following basic protective measures shall be used:

(a) protection by SELV; or

(b) protection by limitation of discharge of energy.

Functional extra-low voltage alone shall not be used as a protective measure.

6.2.1.1 Protection by SELV

Sources for SELV

6.2.1.1.1 For protection by SELV, compliance with all the following requirements shall be provided:

(a) the nominal voltage of the circuit concerned shall not exceed extra-low voltage;

(b) the supply shall be from one of the safety sources listed in clause 6.2.1.1.2; and

(c) the conditions of clauses 6.2.1.1.2 to 6.2.1.1.7 shall be fulfilled.

6.2.1.1.2 The source for SELV shall be one of the following:

(a) a safety isolating transformer complying with the appropriate Ghana Standard in which there shall be no connection between the output winding and the body or the protective earthing circuit, if any, or

(b) a source of current such as a motor-generator with a windings providing electrical separation equivalent to that of the safety isolating transformer specified in (a) above, or

(c) an electrochemical source like a battery or another source independent of a higher voltage circuit like an engine driven generator or

(d) certain electronic devices that comply with appropriate standards where measures have been taken so that even in the case of an internal fault the voltage at the output terminals cannot exceed the value specified by clause 6.2.1.1.1(a). A higher voltage at the output terminals is, however, permitted if, in the case of direct or indirect contact, the voltage at the output terminals

is immediately reduced to the value specified by clause 6.2.1.1.1(a). Where such a higher voltage exists, compliance with this item (d) is considered to be met if the voltage at the output terminals is within the limit specified by clause 6.2.1.1.1(a) when measured with a voltmeter with an internal resistance of at least 3000 ohms.

A system supplied from a higher voltage system by other equipment which does not provide the necessary electrical separation, like an autotransformer, potentiometer, semiconductor device, shall not be deemed to be a SELV system.

Arrangement of circuits for SELV

6.2.1.1.3 A live part of a SELV system shall,

(a) be electrically separated from that of any other higher voltage system. Except for cables the electrical separation shall not be less than that between the input and output of a safety isolating transformer, and

(b) not be connected to Earth or to a live part or a protective conductor that forms part of another system.

6.2.1.1.4 An exposed-conductive-part of a SELV system shall not be connected to any of the following:

(a) Earth,

(b) an exposed-conductive-part of another system,

(c) a protective conductor of any system, or

(d) an extraneous-conductive-part, except that where electrical equipment is inherently required to be connected to an extraneous-conductive-part, measures shall be incorporated so that the parts cannot attain a voltage that exceeds extra low voltage.

6.2.1.1.5 If the nominal voltage of a SELV system exceeds 25 V a.c. rms or 60 V ripple-free d.c., protection against direct contact shall be provided by one or more of the following:

(a) a barrier or an enclosure that affords at least the degree of protection IP2X or IPXXB, or

(b) insulation capable of withstanding a type-test voltage of 500 V a.c. rms for 60 seconds.

If the nominal voltage does not exceed 25 V a.c. rms or 60 V ripple-free d.c., protection as described in items (a) and (b) above is unnecessary.

6.2.1.1.6 A socket-outlet in a SELV system shall require the use of a plug which is not dimensionally compatible with those used for any other system in use in the same premises and shall not have a protective conductor contact.

6.2.1.1.7 A luminaire supporting coupler with a protective conductor contact shall not be installed in a SELV system.

6.2.1.1.8 Application of protection by SELV

This measure is generally applicable except that for some installations and locations of increased shock risk

(a) it is the only measure against electric shock permitted,

(b) a reduction in the nominal voltage is prescribed, and

(c) protection against direct contact, as prescribed in clause 6.2.1.1.5, shall be provided irrespective of the nominal voltage.

For some installations and locations, see the particular requirements of clause 8.

6.2.1.2 Other extra-low voltage systems including functional extra-low voltage

Where, for functional reasons, extra-low voltage is used but not all of the requirements relating to SELV are fulfilled, other measures shall be applied to provide protection against direct and indirect contact.

6.2.1.3 Protection by limitation of discharge of energy

For equipment that complies with the appropriate Ghana Standard, protection against both direct and indirect contact shall be considered to be provided when the equipment incorporates means of limiting the current which can pass through the body of a person or livestock to a value lower than that considered likely to cause danger.

A circuit relying on this protective measure shall be separated from any other circuit in a manner equivalent to that specified in clause 6.2.1.1.3 for a SELV circuit.

6.2.1.3.1 Application of protection by limitation of discharge of energy

This measure shall be applied only to an individual item of current-using equipment that complies with an appropriate Ghana Standard, where the equipment incorporates means of limiting to a safe value the current that can flow from the equipment through the body of a person or livestock. The application of this measure may be extended to a part of an installation derived from such items of equipment, where the Ghana Standard concerned provides specifically for this, for example to electric fences supplied from electric fence controllers complying with appropriate international standard.

6.2.2 Protection against direct contact

One or more of the following basic protective measures described below shall be used for protection against direct contact:

6.2.2.1 Protection by insulation of live parts

Live parts shall be completely covered with insulation which can only be removed by destruction and which is capable of durably withstanding the electrical, mechanical, thermal and chemical stresses to which it may be subjected in service.

6.2.2.1.1 Application of protection by insulation of live parts

This measure relates to basic insulation, and is intended to prevent contact with a live part. It is generally applicable for protection against direct contact, in conjunction with a measure for protection against indirect contact.

6.2.2.2 Protection by barriers or enclosures

Live parts shall be inside enclosures or behind barriers providing at least the degree of protection IP2X or IPXXB except that, where an opening larger than that permitted for IP2X or IPXXB is necessary to allow the replacement of parts or to avoid interference with the proper functioning of electrical equipment both of the following requirements apply:

(a) suitable precautions shall be taken to prevent persons or livestock from touching a live part unintentionally, and

(b) it shall be established, as far as practicable, that a person will be aware that a live part can be touched through the opening and should not be touched.

6.2.2.2.1 The horizontal top surface of a barrier or an enclosure which is readily accessible shall provide a degree of protection of at least IP4X.

6.2.2.2.2 Every barrier and enclosure shall be firmly secured in place and have sufficient stability and durability to maintain the required degree of protection and appropriate separation from any live part in the known conditions of normal service.

6.2.2.2.3 Where it is necessary to remove a barrier or to open an enclosure or to remove a part of an enclosure, one or more of the following requirements shall be satisfied:

(a) the removal or opening shall be possible only by use of a key or tool,

(b) the removal or opening shall be possible only after disconnection of the supply to the live part against which the barrier or enclosure affords protection, restoration of the supply being possible only after replacement or reclosure of the barrier or enclosure and

(c) an intermediate barrier shall be provided to prevent contact with a live part, such a barrier affording a degree of protection of least IP2X and IPXXB and removable only by the use of a tool.

These measures are intended to prevent or deter any contact with a live part. They are generally applicable for protection against direct contact in conjunction with a measure for protection against indirect contact.

6.2.2.3 Protection by obstacles

An obstacle shall be so secured as to prevent unintentional removal, but may be removable without using a key or tool. An obstacle shall prevent, as appropriate, either of the following:

(a) unintentional bodily approach to a live part; or

(b) unintentional contact with a live part when operating energized equipment.

Protection by obstacles shall be limited to areas accessible only to skilled persons, or to instructed persons under the direct supervision of a skilled person. However, this protective measure shall not be used for locations or installations of increased shock risk.

6.2.2.4 Protection by placing out of reach

A bare or insulated overhead line for distribution between buildings and structures shall be installed in compliance with any relevant enactment.

6.2.2.4.1 A bare live part other than an overhead line shall not be within arm's reach or 2.5 m of any of the following:

(a) an exposed conductive part,

(b) an extraneous conductive part, or

(c) a bare live part of any other circuit.

6.2.2.4.2 If access to live equipment from a normally occupied position is restricted in the horizontal plane by an obstacle like a handrail, mesh, a screen, the extent of arm's reach shall be measured from that obstacle.

6.2.2.4.3 In each place where any bulky or long conducting object is normally handled, the distances required by clauses 6.2.2.4.1 and 6.2.2.4.2 shall be increased accordingly.

6.2.2.5 Supplementary protection by residual current devices

The use of a residual current device is recognised as reducing the risk of electric shock where the following conditions are complied with:

(a) one of the protective measures specified in clause 6.2.2.1 to .6.2.2.4 shall be applied; and

(b) the residual current device shall have rated residual operating current not exceeding 30mA and an operating time not exceeding 40 ms, as provided by GS IEC61009-1, GS IEC 61009-2-1, GS IEC61009-2-2, GS IEC61540, GS IEC60309-1, or GS IEC 61008-1.

A residual device shall not be used as a sole means of protection against direct contact.

6.2.3 Protection against indirect contact

For protection against indirect contact, one of the following basic measures shall be used in accordance with the relevant requirements of this section and the application rules specified in clause 6.2:

(a) protection against electric shock,

(b) protection by Class II equipment,

(c) non-conducting location,

(d) earth-free local equipotential bonding, or

(e) electrical separation.

6.2.3.1 Protection by earthed equipotential bonding and automatic disconnection of supply.

This measure shall depend on the use of any of the following earthing systems:

(a) TN, or

(b) TT

This measure is generally intended to prevent the occurrence of a voltage of such magnitude and duration between simultaneously accessible conductive parts that danger could arise. For installations and locations of increased shock risk, as those in section 8, additional measures may be required, including:

(i) automatic disconnection of supply by means of a residual current device having a rated residual operating current () not exceeding 30mA;

(ii) supplementary equipotential bonding; and

(iii) reduction of maximum fault clearance time.

6.2.3.1.1 In each installation, connect the main earthing terminal to the installation's extraneous-conductive-parts including the following:

(a) metallic service pipes and ducting and

(b) exposed metallic structural parts the building.

6.2.3.1.2 In premises with multiple installations, simultaneously accessible exposed-conductive-parts shall be connected to the same earthing system individually, in groups or collectively.

6.2.3.1.3 For an installation, each protective device, the earthing arrangement for the installation and the circuit shall be such that the protective device shall operate to clear an earth fault fast enough to avoid danger.

Conventional means of compliance with this regulation are given in clauses 6.2.3.1.9 to 6.2.3.1.24 inclusive according to the earthing but not excluding any other effective means.

Where the conditions for automatic disconnection of clauses 6.2.3.1.13 to 6.2.3.1.19 (TN systems), clause 6.2.3.1.24 (TT systems) cannot be fulfilled by using overcurrent protective devices, then either:

(a) local supplementary equipotential bonding shall be applied, but the use of bonding does not remove the need to disconnect the supply for reasons other than protection against electric shock, like overheating, or

(b) protection shall be provided by means of residual current device.

6.2.3.1.4 A socket-outlet rated at 32A or less which may reasonably be expected to supply portable equipment for use outdoors shall be provided with supplementary protection to reduce the risk associated with direct contact by means of a residual current device having the characteristics specified in clause 6.2.2.5.

This Standard does not apply to a socket-outlet supplied by a circuit incorporating one or more of the protective measures specified in items (a) to (b) below and complying with the Regulations indicated:

(a) protection by SELV;

(b) protection by electrical separation; and

(c) protection by automatic disconnection and reduced low voltage systems.

6.2.3.1.5 A circuit supplying portable equipment for use outdoors connected by means of a flexible cable or cord having a current-carrying capacity of 32A or less, other than through a socket-outlet, shall have supplementary protection to reduce the risk associated with direct contact by means of a residual current device having the characteristics specified in clause 6.2.2.5.

6.2.3.1.6 Where the measure is used in an installation forming part of a TT system, every socket-outlet circuit shall be protected by a residual current device and shall comply with clause 6.2.3.1.14.

6.2.3.1.7 Automatic disconnection using a residual current device shall not be applied to a circuit incorporating a PEN conductor.

6.2.3.1.8 In every installation which provides for protection against indirect contact by automatic disconnection of supply, a circuit protective conductor shall be run to and terminated at each point in wiring and at each accessory except a lamp holder with no exposed-conductive-parts and suspended from such a point.

TN system

6.2.3.1.9 Each exposed-conductive-part of the installation shall be connected by a protective conductor to the main earthing terminal of the installation and that terminal shall be connected to the earth point of the supply source in accordance with clauses 7.4.2.1.2, 7.4.2.1.3 and 7.4.2.1.5, as appropriate.

6.2.3.1.10 One or more of the following types of protective devices shall be used:

(a) an overcurrent protective device,

(b) a residual current device.

Where a residual current device is used in a TN-C-S system, a PEN conductor shall not be used on the load side. Connection of the protective conductor shall be made on the source side of residual current device.

6.2.3.1.11 For an installation which is part of a TN system, the limiting values of earth fault loop impedance and of circuit protective conductor impedance specified by clauses 6.2.3.1.7 and 6.2.3.1.9 to 6.2.3.1.14 are applicable only where the exposed-conductive-parts of the equipment concerned and any extraneous-conductive-parts are situated within the earthed equipotential zone (see also clause 6.2.3.1.2). Where the disconnection times specified by clause 6.2.3.1.7 cannot be met by the use of an overcurrent protective device, clause 6.2.3.1.4 applies.

6.2.3.1.12 Where a circuit supplies fixed equipment outside the earthed equipotential zone and the equipment has exposed-conductive-parts which may be touched by a person in contact directly with the general mass of Earth, the earth fault loop impedance shall be such that disconnection occurs within the time stated in Table 12.

6.2.3.1.13 Clause 6.2.3.1.4 is considered to be satisfied if the characteristic of each protective device and earth fault loop impedance of each circuit protected by it are of a nature so that automatic disconnection of the supply will occur within a specified time when a fault of negligible impedance occurs between a phase conductor and a protective conductor or an exposed-conductor-part anywhere in the installation. This is met when the following condition is fulfilled:

where:

Zs is the earth fault loop impedance

Ia is the current causing the automatic operation of the disconnecting protective device within the time stated in Table 12 as a function of the nominal voltage Uo or, under the conditions stated in clause 6.2.3.1.17 and clause 6.2.3.1.18, within a time not exceeding 5s .

Uo is the nominal voltage.

Table 12 — Maximum Disconnection Times for TN systems (see Clause 6.2.3.1.14)

Installation nominal voltage Uo (Volts)	Maximum disconnection time t (seconds)
230	0.4
400	0.2

6.2.3.1.14 The maximum disconnection time of Table 12 applies to a circuit supplying socket-outlet and to other final circuits which supply portable equipment intended for manual movement during use, or hand-held class 1 equipment.

6.2.3.1.15 Where a fuse is used to satisfy the requirements of clause 6.2.3.1.14, maximum values of earth fault loop impedance (Zs) corresponding to a disconnection time of 0.4s are stated in Table 13 for a nominal voltage to Earth (Uo) of 230 V. For types and rated currents of general purpose (gG) fuses other than those mentioned in Table 13, and for motor circuit fuses (gM), reference should be made to the appropriate Ghana Standard to determine the value of Ia for compliance with clause 6.2.3.1.13.

Table 13 —Maximum earth fault loop impedance (Zs) for fuses, for 0.4s disconnection time with Uo of 230 V (see clause 6.2.3.1.15)

(a) General purpose (gG) fuses to GS IEC 60269-Parts 2 and 3

Rating (amperes)

Zs (ohms) 6

8.89 10

5.33 16

2.62 20

1.85 25

1.50 32

1.09 40

0.886 50

0.63

(b) Fuses to GS IEC 60269-1

Rating (amperes)

Zs (ohms) 5

10.9 15

3.43 20

1.78 30

1.20 45

0.06

(c) Fuses to GS IEC 60269-2

Rating (amperes)

Zs (ohms) 5

10.0 15

2.67 20

1.85 30

1.14 45

0.63

(d) Fuses to GS IEC 60269-1

Rating (amperes)

Zs (ohms) 13

2.53

Note: The circuit loop impedances given in the table should not be exceeded when the conductors are at their normal operating temperature. If the conductors are at a different temperature when tested, the reading should be adjusted accordingly.

6.2.3.1.16 Where a circuit-breaker is used to satisfy the requirements of clause 6.2.3.1.14, the maximum value of earth fault loop impedance (Zs) shall be determined by the formula of clause 6.2.3.1.13. Alternatively, for a nominal voltage to earth of 230 V and a disconnection time of 0.4 s, the values specified in Table 14 for the types and ratings of circuit-breaker listed may be used instead of calculation.

Table 14 —Maximum earth fault loop impedance (Zs) for circuit-breakers with Uo of 230V, for instantaneous operation giving compliance with the 0.4 second disconnection time of clause 6.2.3.1.16 and the 5 second disconnection time of clause 6.2.3.1.17.

(e) Type 1 miniature circuit-breakers to GS IEC 60898

Rating (amperes)	5	6	10	15	16	20	25	30	32	40	45	50	63	In
Zs (ohms)	12	10	6	4	3.75	3	2.4	2	1.5	1.88	1.33	1.2	0.95	60/In

(f) Type 2 miniature circuit-breakers to GS IEC 60898

Rating (amperes)	5	6	10	15	16	20	25	30	32	40	45	50	63	In
Zs (ohms)	6.86	5.71	3.43	2.29	2.14	1.71	1.37	1.14	1.07	0.86	0.76	0.69	0.54	34.3/ In

(g) Type B circuit-breakers to GS IEC 60898

Rating (amperes)	6	10	16	20	25	32	40	45	50	63	In
Zs (ohms)	8.0	4.8	3.0	2.40	1.92	1.50	1.20	1.07	0.96	0.76	48/In

(h) Type 3 miniature circuit-breakers to GS IEC 60898 and Type C circuit-breakers to GS IEC 60898

Rating (amperes)	5	6	10	15	16	20	25	30	32	40	45	50	63	In
Zs (ohms)	4.80	4.00	2.40	1.60	1.50	1.20	0.96	0.80	0.75	0.60	0.53	0.48	0.38	24/In

(i) Type D circuit-breakers to GS IEC 60898

Rating (amperes)	5	6	10	15	16	20	25	30	32	40	45	50	63	In
Zs (ohms)	2.40	2.00	1.20	0.80	0.75	0.60	0.48	0.40	0.38	0.30	0.27	0.24	0.19	12/In

NOTE: The circuit loop impedances given in the table should not be exceeded when the conductors are at their normal operating temperature. If the conductors are at a different temperature when tested, the reading should be adjusted accordingly.

6.2.3.1.17 For a final circuit which supplies a socket-outlet or portable equipment intended for manual movement during use, or hand held Class 1 equipment, it shall be permissible to increase the disconnection time to 5s provided the impedance of the current protective conductor does not exceed the corresponding value shown in Table 15. The impedance of the protective conductor shall be between the output position and outlet point to nearest equipotential bonding.

Table 15 — Maximum impedance of circuit protective conductor related to the final circuit protective device (see clause 6.2.3.1.17)

(a) General purpose (gG) fuses to IEC 60269-Part 2 and 3

Rating (amperes)	6	10	16	20	25	32	40	50

Zs (ohms)	2.48	1.48	0.83	0.55	0.43	0.34	0.26	0.19

(b) Fuses to GS IEC 60269-1

Rating (amperes)	5	15	20	30	45
Zs (ohms)	3.25	0.96	0.55	0.36	0.18

(c) Fuses to GS IEC 60269-2

Rating (amperes)	5	15	20	30	45
Zs (ohms)	3.25	0.69	0.63	0.43	0.24

(d) Fuses to GS IEC 60269-1

Rating (amperes)	13
Zs (ohms)	2.53

(e) Type 1 miniature circuit-breakers to GS IEC 60898

Rating (amperes)	5	6	10	15	16	20	30	32	40	45	50	63	In
Zs (ohms)	2.50	2.08	1.25	0.83	0.78	0.63	0.42	0.39	0.31	0.28	0.25	0.2	12.5/In

(f) Type 2 miniature circuit-breakers to GS IEC 60898

Rating (amperes)	5	6	10	15	16	20	30	32	40	45	50	63	In
Impedance (ohms)	1.43	1.19	.071	0.48	0.45	0.36	0.24	0.22	0.18	0.16	0.14	0.11	7.14/In

(g) Type B circuit-breakers to GS IEC 60898

Rating (amperes)	6	10	16	20	32	40	45	50	63	In

Impedance (ohms)	1.67	1.00	0.63	0.50	0.31	0.25	0.22	0.20	0.16	10/In

(h) Type 3 miniature circuit-breakers to GS IEC 60898 and Type C circuit-breakers to GS IEC 60898

Rating (amperes)	5	6	10	15	16	20	30	32	40	45
50	63	In								
Impedance (ohms)	1.00	0.83	0.50	0.33	0.31	0.25	0.17	0.16	0.13	0.11
0.10	0.08	5/In								

(i) Type D circuit-breakers to GS IEC 60898

Rating (amperes)	5	6	10	15	16	20	32	40	45	50
63	In									
Impedance (ohms)	0.5	0.42	0.25	0.16	0.12	0.10	0.08	0.06	0.06	0.05
0.04	2.5/In									

NOTE: The circuit loop impedances given in the table should not be executed when the conductors are at their normal operating temperature. If the conductors are at a different temperature when tested, the reading should be adjusted accordingly.

6.2.3.1.18 For a distribution circuit a disconnection time not exceeding 5s is permitted.

For a distribution board supplying circuits for which a disconnection time of 0.4s is required as well as circuits for which disconnection time of 5s is permitted, one of the following conditions shall be satisfied:

(a) the impedance of the protective conductor between the distribution board and the point at which the protective conductor is connected to the main equipotential bonding shall not exceed the value given in Table 15 for the appropriate protective device in the final circuit, or, for protective devices not included in Table 15, 50VxZs/Uo ohms (where Zs is the earth fault loop impedance corresponding to a disconnection time of 5s), or

(b) there shall be equipotential bonding at the distribution board, which involves the same types of extraneous-conductive-parts the main equipotential bonding according to clause 6.2.3.1.1 and is sized in accordance with clause 7.4.4.1

6.2.3.1.19 Where a circuit-breaker is used to satisfy the requirements of Clause 6.2.3.1.18, the maximum value of earth fault loop impedance (Zs) shall be determined by the formula of clause 6.2.3.1.13. Alternatively, the values specified in Table 14 may be used instead of calculation for a nominal voltage to Earth (Uo) of 230 V for the types and ratings of circuit-breaker listed in Table 15.

Where a fuse is used to satisfy the requirements of clause 6.2.3.1.18, maximum values of earth fault loop impedance (Zs) corresponding to a disconnection time of 5 s are stated in Table 16 for a nominal voltage to Earth (Uo) of 230 V.

For types and rated currents of general purpose (gG) fuses other than those mentioned in Table 16 and for motor circuit fuses (gM) reference should be made to the appropriate Ghana Standard to determine the value of Ia for compliance with clause 6.2.3.1.13.

6.2.3.1.20 If protection is provided by a residual current device the following condition shall be fulfilled:

$Zs < 50\ V$

Where: Zs is the earth fault loop impedance in ohms; and

is the rated residual operating current of the protective device in Amperes.

6.2.3.1.21 If a residual current device is used for automatic disconnection for a circuit which extends beyond the earthed equipotential zone, exposed-conductive-parts need not to be connected to the TN system protective conductors provided that they are connected to an earth electrode affording a resistance appropriate to the operating current of the residual current device. The circuit thus protected is to be treated as a TT system and clauses 6.2.3.1.22 to 6.2.3.1.24 apply.

Table 16—Maximum earth loop impedance (Zs) for 5s disconnection time with Uo of 230 V

see Clauses 6.2.3.1.18 and 6.2.3.1.1.9

(a) General purpose (gG) fuses to GS IEC 60269-Parts 2 and 3

Rating (amperes)	6	10	16	20	25	32	40	50
Zs (ohms) 14.1	7.74	4.36	3.04	2.40	1.92	1.41	1 .09	
Rating (amperes)	63	80	100	125	160	200		
Zs (ohms) 0.86	0.60	0.44	0.35	0.27	0.20			

(b) Fuses to GS IEC 60269-1

Rating (amperes)	5	15	20	30	45	60	80	100
Zs (ohms) 17.1	5.22	2.93	1.92	1.00	0.73	0.52	0.38	

(c) Fuses to GS IEC 60269-1

Rating (amperes)	5	15	20	30	45	60	100

Zs (ohms)	18.5	5.58	4.00	2.76	1.66	1.17	0.56

(d) Fuses to GS IEC 60269-1

Rating (amperes)	13
Zs (ohms)	4

NOTE: The circuit loop impedances given in the table should not be exceeded when the conductors are at their normal operating temperature. If the conductors are at a different temperature when tested, the reading should be adjusted accordingly.

TT system

6.2.3.1.22 Every exposed-conductive-part which is to be protected by a single protective device shall be connected, via the main earthing terminal, to a common earth electrode. However if several protective devices are in series, the exposed-conductive-parts may be connected to separate earth electrodes corresponding to each protective device.

6.2.3.1.23 One or more of the following types of protective device shall be used, the residual current device being preferred:

(a) a residual current device, or

(b) an overcurrent protective device .

6.2.3.1.24 The following condition shall be fulfilled for each circuit:

where:

RA is the sum of the resistances of the earth electrode and the protective conductor connecting it to the exposed-conductive-part.

Ia is the current causing the automatic operation of the protective device within 5s

When the protective device is a residual current device, Ia is the rated residual operating current

Supplementary equipotential bonding

6.2.3.1.25 Where supplementary equipotential bonding is necessary for compliance with section 6.2.3.1.3 or section 8, it shall connect together the exposed-conductive-parts of equipment in the circuits concerned including the earthing contacts of socket-outlets and extraneous-conductive-parts in accordance with clause 6.5.3.

6.2.3.1.26 The resistance (R) of the supplementary bonding conductor between simultaneously accessible exposed-conductive-parts and extraneous-conductive-parts shall fulfil the following condition:

where:

Ia is the operating current of the protective device:

(a) for a residual current device, the rated residual operating current,

(b) for an overcurrent device, it is the minimum current which disconnects the circuit within 5s.

6.2.3.2 Protection by use of Class II Equipment or by equivalent insulation

6.2.3.2.1 Protection shall be provided by one or more of the following:

(a) electrical equipment of the following types, type-tested and marked to the relevant standards:

(i) electrical equipment having double or reinforced insulation (Class II equipment)

(ii) low voltage switchgear and control gear assemblies having total insulation (see GS IEC 61439-1) ;

(b) supplementary insulation applied to electrical equipment having basic insulation only, as a process in the erection of an electrical installation, providing a degree of safety equivalent to that of electrical equipment according to item (a) above and in accordance with clauses 6.2.3.2.3 to 6.2.3.2.9 or

(c) reinforced insulation applied to uninsulated live parts, as a process in the erection of an electrical installation, providing a degree of safety equivalent to electrical equipment according to item (a) above and in accordance with clauses 6.2.3.2.3 to 6.2.3.2.9, such insulation being recognised only where constructional features prevent the application of double insulation .

6.2.3.2.2 The installation of equipment described in item (a) of clause 6.2.3.2.1 shall be effected in a manner as not to impair the protection afforded in compliance with the equipment specification. Class II equipment shall be so installed that basic insulation is not the only protection between live parts of the installation and exposed metal work of that equipment.

6.2.3.2.3 The enclosure provided for this measure shall not adversely affect the operation of the equipment protected.

6.2.3.2.4 When the electrical equipment is ready for operation, all conductive parts separated from live parts only by basic insulation shall be contained in an insulating enclosure affording at least the degree of protection IP2X or IPXXB.

6.2.3.2.5 The insulating enclosure shall be capable of resisting mechanical, electrical and thermal stresses likely to be encountered.

6.2.3.2.6 If the insulating enclosure has not been tested previously, a suitable test shall be carried out. (refer to section 9)

6.2.3.2.7 Where the insulating enclosure has to be pierced by conductive parts like for operating handles of built-in equipment, and for screws, protection against indirect contact shall not be impaired.

6.2.3.2.8 Where a lid or door in an insulating enclosure can be opened without the use of a tool or key, every conductive part which is accessible if the lid or door is open shall be behind an insulating barrier which prevents a person from coming into contact with those parts; this insulating barrier shall provide a degree of protection of at least IP2X or IPXXB and be removable only by use of a tool.

6.2.3.2.9 A conductive part enclosed in an insulating enclosure shall not be connected to a protective conductor.

Where provision is made within the enclosure for a protective conductor which necessarily runs through the enclosure in order to serve another item of electrical equipment whose supply circuit also runs through the enclosure, any such protective conductor and its terminals and joints shall be insulated as though they were live parts and terminals shall be appropriately marked.

6.2.3.3 Protection by electrical separation

6.2.3.3.1 The source of supply to the circuits shall be either:

(a) an isolating transformer complying with appropriate Ghana standards, or a source of current like a motor-generator set providing a degree of safety equivalent to the isolating transformer referred to above;

(b) a mobile or fixed source of supply selected and installed in accordance with clause 6.2.3.2; or

(c) the voltage of the electrically separated circuit shall not exceed 500V.

6.2.3.3.2 The separated circuit shall comply with the following:

(a) a live part of the separated circuit shall not be connected to another circuit or to earth;

(b) a flexible cable or cord liable to mechanical damage shall not be used; and

(c) every cable of the circuit shall be ran separately from all other circuits.

6.2.3.3.3 For a circuit supplying a single item of equipment, an exposed-conductive-part of the separated circuit shall not be connected either to the protective conductor of the source or to any exposed conductive part of any other circuit.

6.3 Protection against thermal effects

Persons, fixed equipment and fixed materials adjacent to electrical equipment shall be protected against harmful effects of heat developed by electrical equipment, or radiation, particularly the following effects: combustion or degradation of materials; risk of burns; impairment of the safe function of installed equipment.

6.3.1 Protection against fire and harmful thermal effects

Fixed electrical equipment shall be selected and installed so that heat generated thereby does not cause danger or harmful effects to adjacent fixed material or to material which may foreseeably be in proximity to such equipment. In addition, any relevant installation instruction of the equipment manufacturer shall be observed.

Electrical equipment shall not present a fire hazard.

6.3.1.1 Where fixed electrical equipment is installed having, in normal operation, a surface temperature sufficient to cause a risk of fire or harmful effects to adjacent materials, one or more of the following installation methods shall be adopted:

(a) mounting on a support with a low thermal conductance or within an enclosure which will withstand, without risk of fire or harmful effect, temperatures that may be generated;

(b) screening by material which can withstand without risk of fire or harmful effect the heat emitted by the electrical equipment; or

(c) mounting so as to allow safe dissipation of heat and at a sufficient distance from adjacent material.

6.3.1.2 Where an arc or high temperature particles may be emitted by fixed equipment one or more of the following installation methods shall be adopted:

(a) total enclosure in arc-resistant material that shall be non-ignitable and of adequate thickness to provide mechanical stability,

(b) screening by arc-resistant material,

(c) mounting so as to allow safe extinction of the emissions at a sufficient distance,

(d) every termination of live conductors or joint between them shall be contained within an enclosure selected in accordance with the appropriate Ghana Standards,

(e) where electrical equipment in a single location contains, in total, flammable liquid, adequate precautions shall be taken to prevent the spread of burning liquid, flame and the products of combustion,

(f) fixed equipment causing a concentration of heat shall be at a sufficient distance from any fixed object to prevent a dangerous temperature in the fixed object, or

(g) materials used for the construction of enclosures shall be heat and fire resistant according to the appropriate product standard.

Where no product standard exists, the materials of an enclosure constructed during erection shall withstand the highest temperature likely to be produced by the electrical equipment in normal use.

6.3.2 Protection against burns

6.3.2.1 Provided there is no specified limiting temperature, an accessible part of fixed electrical equipment within arm's reach shall not attain a temperature in excess of the appropriate limit stated in Table 17. Each part of the fixed installation likely to attain under normal load

conditions, even for a short period, a temperature that exceeds the appropriate limit in Table 17 shall be guarded so as to prevent accidental contact.

Table 17— The temperature limit under normal load conditions for are accessible part of equipment within arm's reach

Part	Material of accessible surface	Maximum temperature (0C)
A hand-held means of operation	Metallic	
	Non-metal	55
		65
A part intended to be touched		
but not hand-held	Metallic	
	Non-metal	70
		80
A part which need not be		
touched for normal operation	Metallic	
	Non-metal	80
		90

6.3.3 Protection against overheating

6.3.3.1 Forced air heating systems

6.3.3.1.1 Forced air heating systems shall be in a form that their electric heating elements, other than those of central-storage heaters, cannot be activated until the prescribed air flow has been established and are deactivated when the air flow is reduced or stopped. In addition, they shall have two temperature limiting devices independent of each other which prevent permissible temperatures from being exceeded.

6.3.3.1.2 The frame and enclosure of electric heating elements shall be of non-ignitable material.

6.3.3.2 Appliances producing hot water or steam

6.3.3.2.1 Every electric appliance that produces hot water or steam shall be protected by design or method of erection against overheating in every service condition.

6.4 Protection against overcurrent

Every live conductor shall be protected by an over current device except for the situation as described in clause 6.4.3.4.

6.4.1 Types of protective devices

The devices are described generally as offering protection for overload current (clause 6.4.2.) and fault current (clause 6.4.3).

6.4.2 Protection against overload

All circuits shall be provided with a device to prevent overload persisting for long d3 urations. This measure is to provide protection against temperature rise detrimental to insulation, joints, terminations, and the like.

6.4.2.1 The characteristics of each protective device shall satisfy the following conditions illustrated in figure 07(a):

Figure 8 (a)

6.4.2.2 Type of protective devices

The following devices satisfy clause 6.4.2.1:

(a) fuses

(i) general purpose fuse (gG) to GS IEC 60269-2

(ii) fuse to GS IEC 60269-3

Fuse to GS IEC 60269-1 or Circuit breaker to GS IEC 60898

(b) for semi-enclosed fuse to GS IEC 60269-2, clause 6.4.2.1 (c) is satisfied if In < 0.7251z.

(c) Ring circuits (Ref. Fig 08(b)).

For Ring Circuits with 30/32-A protective devices as described in Clause 6.4.2.2 (a), the minimum cross-sectional area of copper conductors to be used shall be as follows:—

Single core non-mineral insulation: 2.5mm² 2 core mineral insulated to GS IEC60702-1 and GS IEC60702-2: 1.5mm²

In general the requirements of Clause 6.4.2.1 shall be considered to be satisfied if Iz e> 0.67 In

(d) Parallel Circuits (Ref. Fig 08(c))

The value of Iz is the sum of the current-carrying capacities of all conductors in parallel except for a final ring circuit.

Except for a final ring circuit where a single device provides protection for conductors in parallel, IZ shall be the sum of the current carrying capacities of the conductors.

Conductors in parallel shall have the following common characteristics:

Construction

Cross-sectional area

Length and disposition

No branch circuits throughout their lengths.

Figure 08(b) Figure 08(c)

6.4.3 Protection against fault current

A circuit shall be provided with a protective device that offers protection against thermal and mechanical effects arising from a fault current (If) due to a short circuit and earth fault condition. The current carrying capacity of the circuit being protected may be less than the nominal current of the protective device.

6.4.3.1 Determination of prospective fault current

The value of the prospective fault current of a circuit shall be determined by measurement and calculation.

6.4.3.2 Characteristics of the protective devices

(a) The breaking and making capacities (Ib) shall not be less than the fault current at the point of operation:

$If < Ib$

(b) However, for protective devices connected in series, the one closer to the load could have its breaking capacity lower than the If if the device nearer the supply side could operate such that:—

(i) the operating device has the capacity as defined in clause 6.4.3.2 (a)

(ii) the energy let through of these devices is not exceeded.

(c) The clearance time of a fault protective device (t) shall be determined as follows:—

$$t = \frac{k^2S^2}{I^2}$$ where;

t - time in seconds

S - cross-sectional area of conductor in mm^2

I - fault current

k - a cable factor provided by cable manufacturers that takes into account resistivity, temperature coefficient and heat capacity of the conductor material and the initial and final operating temperatures.

Typical k values for common conductor materials are given in Table 29.

Figure 02

NON UNIFORM CABLE SIZE

Figure 9

6.4.3.3 Location of protective devices

A protective device against fault current shall be located at the point in the circuit wherever there is a change in the current-carrying capacity, for example due to change in cross-sectional area of the conductor or method of installation (refer to Fig 9).

6.4.3.4 Conditions for omission of protective devices

Protective devices against overload and fault currents can be omitted in the following situations:

(a) Where unplanned disconnections could cause danger, for example circuits for:

(i) lifting magnets,

(ii) secondary or current transformer, or

(iii) fire fighting equipment /extinguisher.

(b) The source supply has a limiting value of current such that its maximum is less than the current carrying capacity of the conductor (Iz)

(c) The zone of protection of a protective device that is the protection offered at the supply end can be guaranteed at the point of change.

6.4.3.5 Protection according to the nature of circuits and distribution systems

(a) Phase conductors

(i) In a three phase system, each phase must incorporate a protective device against overcurrent and fault. A fault or overcurrent in a phase must result in the disconnection of that conductor only where it is undesirable to disconnect only one phase, as in the case of a three phase motor circuit in which all these phases must be disconnected.

(ii) A protective device could be eliminated in a TT system with an undistributed neutral conductor provided a differential system of protection is available to disconnect the three phases in the event of a fault in a phase.

(b) Neutral conductors

A protective device can only be provided in a neutral conductor provided:

(i) its cross-sectional area is less than that of the phase conductors, and

(ii) the operation of the protective device in the neutral conductor shall cause the disconnection of all phases.

6.4.3.6 Coordination of overload current and fault current protection

For general coordination, the overload current and fault current protective devices shall be so selected that the energy let-through arising from the fault current can be withstood by the overload current protective device.

NB: For circuits incorporating motor starters, this clause, conditions described in GS IEC 60947- 4-1 and the manufacturer's advice shall be taken into consideration.

6.5 Isolation and switching

6.5.1 A means shall be provided for non-automatic isolation and switching to prevent or remove hazards associated with the electrical installation or electrically powered equipment and machines.

6.5.2 A main linked switch or linked circuit-breaker shall be provided as near as practicable to the origin of every installation as a means of switching the supply on load and as a means of isolation.

For a.c. systems, clause 6.5.4 applies. For d.c. systems, all poles shall be provided with a means of isolation.

Where an installation is supplied from more than one source, a main switch shall be provided for each source of supply and a durable warning notice shall be permanently fixed in such a position that any person seeking to operate any of these main switches is warned of the need to operate every switch to achieve isolation of the installation. Alternatively, a suitable interlock system shall be provided.

6.5.3 Except as provided by in clause 6.5.5, neither an isolator (disconnector) nor a switch shall break a protective conductor or a PEN conductor.

6.5.4 In TN-C systems, the PEN conductor shall not be isolated or switched except as required by clause 6.5.3, in TN-S or TN-C-S systems the neutral conductor need not be isolated or switched, where the neutral conductor can reliably be regarded as being at earth potential.

6.5.5 Where an installation is supplied from more than one source of energy, one of which requires a means of earthing independent of the means of earthing of other sources and it is necessary to ensure that not more than one means of earthing is applied at any time, a switch may be inserted in the connection between the neutral point and the means of earthing, provided that the switch is a linked switch arranged to disconnect and connect the earthing conductor for the appropriate source, at substantially the same time as the related live conductors.

6.5.6 Provision shall be made for disconnecting the neutral conductor. Where this is a joint it shall be such that it is in an accessible position, can only be disconnected by means of a tool, is mechanically strong and will reliably maintain electrical continuity.

6.5.7 Isolation

6.5.7.1 Every circuit shall be capable of being isolated from each of the live supply conductors, except as detailed in clause 6.5.4.

Provision may be made for isolation of a group of circuits by a common means, if the service conditions allow this.

6.5.7.2 Suitable provision shall be made so that precautions can be taken to prevent any equipment from being inadvertently or unintentionally energized.

6.5.7.3 Where an item of equipment or enclosure contains live parts that are not capable of being isolated by a single device, a durable warning notice shall be permanently fixed in such a position that any person before gaining access to live parts will be warned.

6.5.7.4 Where necessary to prevent danger, adequate means shall be provided for the discharge of capacitive or inductive electrical energy.

6.5.7.5 Each device used for isolation shall be clearly identified by position or durable marking to indicate the installation or circuit which it isolates.

6.5.8 Switching off for mechanical maintenance

6.5.8.1 A means of switching off for mechanical maintenance shall be provided to avoid risk of injury from mechanical movement.

6.5.8.2 Each device for switching off for mechanical maintenance shall be suitably located and identified by durable marking where necessary.

6.5.8.3 Precautions shall always be taken to prevent any equipment from becoming unintentionally or inadvertently reactivated during mechanical maintenance.

6.5.9 Emergency switching

6.5.9.1 A means of emergency switching shall be provided for every part of an installation for which it may be necessary to cut off rapidly from the supply in order to prevent or remove danger.

Except as provided in clause 6.5.4, where a risk of electric shock is involved, the means shall interrupt all live conductors.

6.5.9.2 A means of emergency switching shall act as directly as possible on the appropriate supply conductors, and shall be such that only a single initiative action is required.

6.5.9.3 The arrangement of emergency switching shall be in a form that its operation does not introduce a further hazard or interfere with the complete operation necessary to remove the hazard.

6.5.9.4 Each device for emergency switching shall be readily accessible and durably marked.

6.5.9.5 A means of emergency stopping shall be provided where mechanical movement of electrically actuated equipment may give rise to danger.

6.5.10 Functional switching (Control)

6.5.10.1 A functional switching device shall be provided for each part of a circuit which may require to be controlled independently of other parts of the installation.

6.5.10.2 Functional switching devices need not necessarily control all live conductors of a circuit

A switching device shall not be placed solely in the neutral conductor.

6.5.10.3 All current-using equipment requiring control shall be controlled by an appropriate functional switching device.

A single functional switching device may control several items of equipment intended to operate simultaneously.

6.5.10.4 Except for use on d.c. where this purpose is specifically excluded, a plug and socket-outlet of rating of not more than 16 A may be used for functional switching.

6.5.10.5 Functional switching devices enabling the change-over of supply from alternative sources shall switch all live conductors and shall not be capable of connecting the sources in parallel, unless the installation is specifically designed for this condition.

Where alternative sources of supply are provided, provision shall not be made for isolation of the PEN or protective conductors, unless the design specifically requires the isolation.

6.5.11 Control circuits (auxiliary circuits)

6.5.11.1 Control circuits shall be designed, arranged and protected to limit dangers resulting from a fault between the control circuit and other conductive parts liable to cause malfunction like inadvertent operation of the controlled equipment.

6.6 Protection against over or under-voltage

6.6.1 Suitable measures shall be taken to prevent over or under-voltages whose occurrences will cause:

(a) damage to a current carrying equipment or any part of an installation; and

(b) danger to personnel.

6.6.2 A combination of automatic disconnections and time delay relay switches should be incorporated to ensure safety of equipment and prevention of danger.

6.6.3 Any enclosure of a protective device or otherwise should not be automatic if the situation leading to the disconnections are still persisting.

7 SELECTION AND ERECTION OF EQUIPMENT

7.1 Selection and erection of equipment

The selection of equipment, its installation to meet safety and environmental standards as well as the requirements for its proper functioning are dealt with in this section. Each equipment shall be selected and installed so as to allow compliance with the requirements of this Standard and relevant enactments.

7.1.1 Compliance with Standards

Any equipment selected shall comply with the relevant requirements of the applicable Standard.

7.1.2 Operational conditions and external Influences

7.1.2.1 Voltage

Any equipment selected shall be suitable for the nominal voltage (Uo), highest or lowest voltage likely to occur in the installation during normal service.

7.1.2.2 Current

7.1.2.2.1 Any equipment selected shall be suitable for the design current and the fault current likely to flow for the periods of time as determined by the characteristics of the protective devices utilised.

7.1.2.2.2 Switchgear, protective devices, accessories and other types of equipment shall not be connected to conductors intended to operate at a temperature that exceeds 70°C in normal service, unless the equipment manufacturer has confirmed that the equipment is suitable for such conditions.

7.1.2.3 Frequency

The rated frequency of equipment shall correspond to the nominal frequency of the supply to the circuit concerned, provided that the frequency has an influence on the characteristics of the equipment.

7.1.2.4 Power

Any equipment selected on the basis of its power characteristics shall be suitable for the duty demanded of the equipment.

7.1.2.5 Compatibility

Equipment shall be selected and installed so that it neither causes harmful effects to other equipment nor impairs the supply during normal service including switching operations.

7.1.2.6 External Influences

7.1.2.6.1 Equipment shall be designed to be compatible with the external environment or their modes of operation and shall take account of the conditions likely to be encountered.

7.1.2.6.2 Additional relevant protection shall be provided for equipment of an installation which by construction may not be compatible with the external environment.

7.1.2.6.3 Where different external influences occur simultaneously, the degree of protection provided shall take account of any mutual effect.

7.1.3 Accessibility

Equipment shall be arranged so as to facilitate its operation, inspection, testing, maintenance and access to connections except for cable joints which are required to be inaccessible for safety and mechanical protection purposes.

7.1.4 Identification and Notices

7.1.4.1 A label or other suitable means of identification shall be provided to indicate the purpose of each item of switchgear and control gear.

Where the operator cannot observe the operation of switchgear and control gear, a suitable indicator shall be fixed in a position visible to the operator.

7.1.4.2 As far as is reasonably practicable, wiring shall be so arranged or marked such that it can be identified for inspection, testing, repair or alteration of the installation.

7.1.4.3 Conduit

Where an electrical conduit is required to be distinguished from a pipeline or another service, red shall be used as the basic identification colour.

7.1.4.4 Conductors

Every core of a cable shall be identifiable at its terminations and preferably throughout its length in accordance with Tables 3A and 3B.

7.1.4.4.1 Omission of identification by colour or marking

Identification by colour or marking is not required for:

(a) concentric conductors of cables,

(b) metal sheath or armour of cables when used as a protective conductor,

(c) bare conductors where permanent identification is not practicable,

(d) extraneous-conductive-parts used as a protective conductor, or

(e) exposed-conductive-parts used as a protective conductor.

7.1.4.5 Identification of Switchboards

Any identification of a switchboard busbar or conductor shall comply with the requirements of Table 21 so far as these are applicable.

7.1.4.6 Identification of a Protective Device

A protective device shall be arranged and identified so that the circuit protected can be easily recognised.

7.1.4.7 Diagrams

A durable copy of the schedule relating to a distribution board shall be provided within or adjacent to each distribution board. The schedule shall be a legible diagram using symbols that comply with the appropriate Ghana standard, chart or table indicating the following information:

(a) the type of circuit and its composition,

(b) the type of protection against indirect contact, and

(c) the information necessary for the identification of each protective device and its location.

7.1.4.8 Warning Notices

7.1.4.8.1 Voltage

Equipment or enclosure within which a nominal voltage (Uo) exceeding 230 volts exists, shall be so arranged that before access is gained to a live part, a warning of the maximum voltage present is clearly visible.

Means of access to all live parts of switchgear and other fixed live parts where different nominal voltages exist shall be marked to indicate the voltages present.

7.1.4.8.2 Isolation

A notice of durable material in accordance with clause 6.5.7.3 shall be fixed in each position where there are live parts which are not capable of being isolated by a single device. The location of each isolator (disconnector) shall be indicated.

7.1.4.8.3 Periodic inspection and testing

7.1.4.8.3.1 A notice of durable material shall be fixed in a prominent position at or near the installation distribution board on completion of work carried out in accordance with clauses 9 or 9.3.

The notice shall be inscribed in indelible characters not smaller than font size 16 of Times New Roman here illustrated and shall read as follows:

IMPORTANT

This installation should be periodically inspected and tested and a report on its condition obtained, as prescribed by the Electrical Wiring Regulations.

Date of last inspection …….

Recommended date of next inspection …….

7.1.4.8.3.2 Where an installation incorporates a residual current device, a notice shall be fixed in a prominent position at or near the installation distribution board. The notice shall be in indelible characters not smaller than font size 16 of Times New Roman and shall read as follows:

This installation, or part of it, is protected by a device which automatically switches off the supply if an earth fault develops. Test quarterly by pressing the buttion marked 'T' or 'Test'. The device should switch off the supply and should then be switched on to restore the supply. If the device does not switch off the supply when the button is pressed, seek expert advice.

7.1.4.8.4 Earthing and Bonding Connections

A permanent legible label with the words "Safety Electrical Connection — Do Not Remove" shall be permanently fixed in a visible position at or near:

(a) the point of connection of every earthing conductor to an earth electrode,

(b) the point of connection of every bonding conductor to an extraneous-conductive-part, and

(c) the main earth terminal, where separate from main switchgear.

7.1.4.9 Mutual Detrimental Influence

7.1.4.9.1 Prevention of mutual detrimental influence

Electrical equipment shall be selected and erected so as to avoid any harmful influence between the electrical installation and any non-electrical installations envisaged.

Where equipment carrying current of different types or at different voltages is grouped in a common assembly like a switchboard, a cubicle or a control desk or box, all the equipment belonging to any one type of current or any one voltage shall be effectively segregated wherever necessary to avoid mutual detrimental influence.

7.1.4.9.2 Electromagnetic Compatibility

Equipment shall be chosen with sufficiently low emission levels so that it cannot cause unacceptable electromagnetic interference with other electrical equipment by electrical conduction or propagation in the air. If necessary, measures shall be taken to minimize the effects of the emission.

7.2 Selection and Erection of Wiring Systems

7.2.1 Selection of type of wiring system

7.2.1.1 Cables and Conductors for Low Voltage

7.2.1.1.1 Every non-flexible or flexible cable or flexible cord for use at low voltage shall comply with the approved Ghana standard.

For aerial use or suspension, any non-flexible cable sheathed with lead, PVC or an elastomeric material may incorporate a catenary wire or include hard-drawn copper conductors.

Insulated flexible cable and flexible cord shall incorporate a flexible metallic armour, braid or screen and shall be used for fixed wiring only.

7.2.1.1.2 A busbar trunking system shall comply with the appropriate Ghana Standard.

7.2.1.1.3 Every conductor, other than a cable, for use as an overhead line operating at low voltage shall be of the appropriate Ghana Standard.

7.2.1.2 Cables for a.c. Circuits — Electromagnetic Effects

7.2.1.2.1 Single-core cables armoured with steel wire or tape shall not be used for a.c. circuits. Conductors of a.c. circuits installed in ferromagnetic enclosures shall be appropriately arranged to prevent eddy (induced) currents.

7.2.1.3 Electromechanical Stresses

7.2.1.3.1 Every conductor or cable installed shall have adequate strength to withstand electromechanical forces that may arise from current carried during service or fault.

7.2.1.4 Conduits, Conduit Fittings and Lighting Track Systems

A conduit, conduit fitting or lighting track system shall comply with the appropriate Ghana Standard.

7.2.1.5 Methods of installation of cables and conductors

7.2.1.5.1 The methods of installation of a wiring system for which the Code specifically provides are indicated in Annex B.

7.2.1.5.2 A bare live conductor shall be installed on insulators.

7.2.1.5.3 Non-sheathed cables for fixed wiring shall be enclosed in conduit, ducting or trunking.

Where cables with different temperature ratings are installed in the same enclosure, all the cables shall be considered to have the lowest temperature rating.

7.2.2 Current-Carrying Capacity of Conductors

7.2.2.1 Conductor Operating Temperature.

The current to be carried by any conductor for sustained periods during normal operation shall be such that the conductor operating temperature given in Table 19 is not exceeded.

7.2.2.2 Conductors in Parallel

For conductors in parallel, measures shall be taken to ensure that the load current is shared equally between them. This requirement is considered to be fulfilled if the conductors are of the same construction, material, cross-sectional area, same length, have no branch circuits along their lengths and have appropriate phase disposition.

The exception to this clause shall be for ring final circuits, where two or more conductors are connected in parallel in the same phase or pole of a system.

7.2.2.3 Cables connected to bare conductors or busbars

Where a cable is to be connected to a bare conductor or busbar, its type of insulation or sheath must be suitable for the maximum operating temperature of the bare conductor or busbar.

7.2.2.4 Cables in thermal insulation

The derating factors of Table 18 shall apply where a cable has to be run through a thermally insulated enclosure for a portion of its run.

Table 18 — Cable surrounded by thermal insulation

Length in insulation
(mm) Derating Factor
-
50
100
200
400
0.89
0.81
0.68
0.55

Table 19 — Maximum conductor operating temperatures

Conductor material Insulation material Conductor operating temperature (°C)
Limiting
final
temperature
(°C)
Copper 70 °C PVC (general purpose)
90 °C PVC
90 °C thermosetting 70
90
90 160/140*
160/140*
250
Copper Mineral — plastic covered or exposed to touch

- bare and neither exposed to touch nor in contact with combustible materials 70 (sheath)

105 (sheath) 160

250

Aluminium 70 °C PVC (general purpose)

90 °C PVC

90 °C thermosetting 70

90

90 160/140*

160/140*

250

*above 300 mm²

Table 20 — Minimum nominal cross-sectional area of conductor

Type of wiring system	Use of circuit	Conductor	
		Material	Minimum permissible nominal Cross-sectional area (mm2)
Cables and insulated Conductors	Power circuits	Copper	1.5
	Lighting circuits	Copper	1.5
	Signalling and control circuits	Copper	0.5 (see NOTE below)
Bare conductors	Power circuits	Copper	10.0
	Signalling and control circuits	Copper	4.0
Flexible connections with insulated conductors and cables	For a specific appliance	Copper	As specified in the relevant Ghana Standard
	For any other application		0.5 (see NOTE below)

Extra-low voltage

Circuits for special

applications 0.5

Note: In multicore flexible cables containing 7 or more cores and in signalling control circuits intended for electronic equipment a minimum nominal cross-sectional area of 0.1 mm2 is permitted.

7.2.2.5 Metallic Sheaths or Non-Magnetic Armour of Single-Core Cables

The metallic sheaths or non-magnetic armour of single-core cables in the same circuit shall normally be bonded together at both ends of their run (solid bonding). Alternatively, the sheaths or armour of such cables with conductors of cross-sectional area that exceed 50 mm2 and a non-conducting outer sheath may be bonded together at one point in their run (single point bonding) with suitable insulation at the un-bonded ends, in which case the length of the cables from the bonding point shall be limited so that, at full load, voltages from sheaths or armour to Earth:

(a) do not exceed 25 volts,

(b) do not cause corrosion when the cables are carrying their full load current, and

(c) do not cause danger or damage to property when the cables are carrying short-circuit current.

7.2.3 Cross-Sectional Areas of Conductors

7.2.3.1 Phase Conductors in a.c. circuits and live conductors in d.c. circuits

The nominal cross-sectional area of phase conductors in a.c. circuits and of live conductors in d.c. circuits shall be not less than the values specified in Table 20.

7.2.3.2 Neutral conductors

7.2.3.2.1 In a polyphase or single-phase circuit, the neutral conductor

7.2.3.2.1 In a polyphase or single-phase circuit, the neutral conductor shall have a cross-sectional area not less than that of the phase conductor.

7.2.3.2.2 In a polyphase circuit the neutral conductor shall have a current-carrying capacity adequate to afford compliance with clause 7.2.3.1.

When assessing the maximum likely neutral current, account shall be taken of

(a) inequality of phase loading,

(b) inequality of power factor in each phase, and

(c) harmonic currents in the neutral conductor.

7.2.4 Voltage Drop in Consumers' Installations

7.2.4.1 Under normal service conditions, the voltage at the terminals of any fixed current-using equipment shall be greater than the lower limit corresponding to the Ghana Standards relevant to the equipment.

Where the fixed current-using equipment concerned is not the subject of Ghana Standard, the voltage at the terminals shall so as not to impair the safe functioning of that equipment.

7.2.4.2 The requirements of clause 7.2.4.1 are in a form considered to be satisfied for a supply given in accordance with the Electricity Supply and Distribution (Technical and Operational) Rules, 2005 (L.I. 1816) if the voltage drop between the origin of the installation usually the supply terminals and a socket-outlet or the terminals of the fixed current-using equipment does not exceed 4% of the nominal voltage of the supply.

7.2.5 Electrical connections

7.2.5.1 Connections between conductors and between a conductor and equipment

Every connection between conductors and between a conductor and equipment shall provide durable electrical continuity and adequate mechanical strength.

The introduction of a joint or a termination shall be in a form that the integrity of the circuit shall not be compromised.

7.2.5.2 Selection of means of connection

The selection of the means of connection shall take account, as appropriate, of the following:

(a) the material of the conductor and its insulation;

(b) the number and shape of the wires forming the conductor;

(c) the cross-sectional area of the conductor;

(d) the number of conductors to be connected together;

(e) the temperature attained by the terminals in normal service so that the effectiveness of the insulation of the conductors connected to them is not impaired; and

(f) the provision of adequate locking arrangements in situations subject to vibration or thermal cycling.

7.2.5.3 Enclosed connections

7.2.5.3.1 Where a connection is made in an enclosure, the enclosure, shall provide adequate mechanical protection and protection against relevant external influences.

7.2.5.3.2 Every termination and joint in a live conductor or a PEN conductor shall be made within one of the following or a combination thereof:

(a) a suitable accessory and an equipment enclosure complying with the appropriate Ghana Standards, or

(b) a suitable enclosure of materials considered to be non-ignitable and non-combustible according to the relevant Ghana Standards.

7.2.5.4 Accessibility of connections

Except for the following, every connection and joint shall be accessible for inspection, testing and maintenance:

(a) a compound-filled or encapsulated;

(b) a connection between a cold tail and a heating element (For example a ceiling and floor heating system); and

(c) a joint made by welding, brazing or compression tool.

7.2.6 Selection and erection to minimize the spread of fire

7.2.6.1 The risk of spread of fire shall be minimized by selection of an appropriate material and erection in accordance with clauses 7.2.6.2 to 7.2.6.5

7.2.6.2 The wiring system shall be installed in a manner so that the general building structural performance and fire safety are not compromised.

7.2.6.3 Cables that meet the requirements for flame propagation may be installed without special precautions. Where the risk of fire is high, special precautions shall be taken.

7.2.6.4 Cables that do not meet with the flame propagation requirements, shall be limited to short lengths for connection of appliances to the permanent wiring system and shall not pass from one fire-segregated compartment to another.

7.2.6.5 Conduit and trunking that meet the resistance to flame propagation requirements may be installed without special precautions. Other products that meet the standards that have similar requirements for resistance to flame propagation may be installed without special precautions.

7.2.7 Sealing of wiring system penetrations

Where a wiring system including conduit, cable ducting, cable trunking, busbar or busbar trunking penetrates elements of building construction that have specified fire resistance, it shall be internally sealed so as to maintain the degree of fire resistance of the respective element as well as being externally sealed to maintain the required fire resistance.

7.2.8 Proximity to other services

7.2.8.1 Consideration shall be given to electrical interference, both electromagnetic and electrostatic in the case of telecommunication circuits, data transfer circuits and the like.

7.2.8.2 Fire alarm, emergency lighting and telecommunication circuits shall be segregated from each other and also from all other cables.

7.2.8.3 Where a wiring system is to be installed in proximity to a non-electrical service it shall be so arranged that any foreseeable operation carried out on either service will not cause damage to the other.

7.2.8.4 A cable shall not be run in a lift or hoist shaft unless it forms part of the lift installation.

7.3 Switchgear for protection, isolation and switching

7.3.1 Where an item of switchgear is required in in[sic] this Schedule to disconnect all live conductors of a circuit, it shall be of a type so that the neutral conductor cannot be disconnected before the phase conductors and is reconnected before, or at the same time as, the phase conductors.

7.3.2 A fuse or, except where ganged, switch or circuit-breaker shall be inserted in the neutral conductor of TN or TT systems.

7.3.3 Devices for protection against electric shock

7.3.3.1 Overcurrent protective devices

For a TN or a TT system, every overcurrent protective device which is to be used also for protection against electric shock (indirect contact) shall be selected so that its operating time is appropriate to the value of fault current that would flow in the event of a fault of negligible impedance between a phase conductor and exposed-conductive-parts such that the permissible final temperature of the phase conductor and the associated protective conductor is not exceeded.

7.3.3.2 Residual Current Devices

7.3.3.2.1 A residual current device shall be capable of disconnecting all the phase conductors of the circuit at substantially the same time.

7.3.3.2.2 The residual operating current of the protective device shall comply with the requirements of clause 6.2.3 as appropriate to the type of system earthing.

7.3.3.2.3 A residual current device shall be so selected and the electrical circuits so subdivided that any protective conductor current which may be expected to occur during normal operation of the connected load will be unlikely to cause unnecessary tripping of the device.

7.3.3.2.4 The use of a residual current device associated with a circuit normally expected to have a protective conductor, shall not be considered sufficient for protection against indirect contact.

7.3.3.2.5 A residual current device shall be located so that its operation will not be impaired by magnetic fields caused by other equipment.

7.3.3.2.6 Where a residual current device for protection against indirect contact is used with, but separately from, an overcurrent protective device, it shall be mandatory for the residual current operated device to be capable of withstanding, without damage, the thermal and mechanical stresses it is likely to be subjected to as a result of fault current passing through it.

7.3.3.2.7 Where a residual current device may be operated by a person other than a skilled or instructed person, it shall be selected and installed so that it is not possible to modify or adjust its settings.

7.3.3.3 Residual Current Devices in a TN System

7.3.3.3.1 In a TN system, where, for certain equipment in a certain part of the installation, one or more of the conditions in clause 6.2.3.1.13 cannot be satisfied, that part may be protected by a residual current device. The exposed-conductive-parts of that part of the installation shall be connected to the TN earthing system protective conductor or to a separate earth electrode which affords an impedance appropriate to the operating current of the residual current device.

In this latter case the circuit shall be treated as a TT system and clause 6.2.3.1.21 will apply.

7.3.4 Overcurrent protective devices

7.3.4.1 Overcurrent protective devices

7.3.4.1.1 For every fuse and circuit-breaker there shall be provided on or adjacent to it an indication of its intended nominal current as appropriate to the circuit it protects. For a semi-enclosed fuse the intended nominal current to be indicated is the value to be selected in accordance with clause 7.3.4.1.4.

7.3.4.1.2 A fuse link likely to be replaced by a person other than a skilled person or an instructed person shall either:

(a) have marked on or adjacent to it an indication of the type of fuse link intended to be used, or

(b) be of a type such that there is no possibility of inadvertent replacement by a fuse link having the intended nominal current but a higher fusing factor than that intended.

7.3.4.1.3 A fuse which is likely to be removed or replaced whilst the supply is connected shall be of a type so that it can be removed or replaced without danger.

7.3.4.1.4 A fuse shall preferably be of the cartridge type. Where a semi-enclosed fuse is selected, it shall be fitted with an element in accordance with the manufacturer's instructions if any. In the absence of the instructions, it shall be fitted with a single element of tinned copper wire of the appropriate diameter specified in Table 21.

Table 21— Sizes of tinned copper wire for use in semi-enclosed fuses

Nominal current of fuse element (A)	Nominal diameter of wire(mm)
3	
5	
10	
15	
20	
25	
30	

45

60

80

100 0.15

0.2

0.35

0.5

0.6

0.75

1.85

1.25

1.53

1.8

2.0

7.3.4.1.5 Where a circuit-breaker may be operated by a person other than a skilled or instructed person, it shall be designed or installed so that it is not possible to modify the setting or the calibration of its overcurrent release without a deliberate act involving the use of either a key or a tool and resulting in a visible indication of its setting or calibration.

7.3.4.2 Selection of a device for the protection of a wiring system against overload

The nominal current or current setting of the protective device shall be chosen in accordance with clause 6.4.2.

7.3.4.3 Selection of a device for the protection of a wiring system against fault current

The application of the rules of clause 6.4 shall take into account minimum and maximum fault current conditions.

7.3.5 Isolating and Switching Devices

7.3.5.1 Is olating and switching devices installed in accordance with clauses 6.5.7 to 6.5.10 shall comply with the appropriate requirements of clauses 7.3.5.2 to 7.3.5.5. A common device may be used for more than one of these functions if the appropriate requirements for each function are met.

7.3.5.2 Devices for isolation

7.3.5.2.1 Except as detailed by clause 6.5.4, the devices for isolation shall effectively isolate all live supply conductors from the circuit concerned. Equipment used for isolation shall comply with clauses 7.3.5.2.2 to 7.3.5.2.10.

7.3.5.2.2 The isolating distance between contacts or other means of isolation when in the open position shall be not less than that determined for an isolator (disconnector) in accordance with the requirement of the relevant Ghana Standard.

7.3.5.2.3 A semiconductor device shall not be used as an isolating device.

7.3.5.2.4 The position of the contacts or other means of isolation shall be either externally visible or clearly and reliably indicated. An indication of the isolated position shall occur only when the specified isolation has been obtained in each pole.

7.3.5.2.5 Where a link is inserted in the neutral conductor, the link shall be accessible to skilled persons only and cannot be removed without the use of tools.

7.3.5.2.6 A device for isolation shall be selected or installed in a manner that will prevent unintentional closure.

7.3.5.2.7 Provision shall be made for securing an off-load isolation device against inadvertent and unauthorised operation.

7.3.5.2.8 Means of isolation shall preferably be provided by a multipole switching device which disconnects all poles of the relevant supply but single-pole devices situated adjacent to each other may also be used.

7.3.5.2.9 Each device used for isolation shall be clearly identified by position or durable marking, to indicate the installation or circuit it isolates.

7.3.5.2.10 A plug and socket-outlet or similar device may be used as a means of isolation.

7.3.5.3 Devices for switching off for mechanical maintenance

7.3.5.3.1 A device for switching off for mechanical maintenance shall be inserted where practicable in the main supply circuit.

7.3.5.3.2 A device for switching off for mechanical maintenance, or a control switch for such a device, shall be manually initiated and shall have an externally visible contact gap or a clearly and reliably indicated OFF or OPEN position. Indication of that position shall occur only when the OFF or OPEN position on each pole has been fully attained.

7.3.5.3.3 A device for switching off for mechanical maintenance shall be selected or installed in a way so as to prevent unintentional re-closure.

7.3.5.3.4 Where a switch is used as a device for switching off for mechanical maintenance, it shall be capable of cutting off the full load current of the relevant part of the installation.

7.3.5.3.5 A plug and socket-outlet or similar device of rating not exceeding 16A may be used as a device for switching off for mechanical maintenance.

7.3.5.4 Devices for emergency switching

7.3.5.4.1 A means of interrupting the supply for the purpose of emergency switching shall be capable of cutting off the full load current of the relevant part of the installation.

7.3.5.4.2 Means for emergency switching shall consist of a single switching device directly cutting off the incoming supply. A plug and socket-outlet or similar device shall not be selected as a device for emergency switching.

7.3.5.4.3 Where practicable a device for emergency switching shall be manually operated directly interrupting the main circuit.

7.3.5.4.4 The operating means like a handle or pushbutton for a device for emergency switching shall be clearly identifiable and preferably coloured red. It shall be installed in a readily accessible position where the hazard might occur.

7.3.5.4.5 The operating means of the device for emergency switching shall be of the latching type or capable of being restrained in the OFF or STOP position.

Other requirements for switching for safety

7.3.5.4.6 A fireman's switch provided for compliance with clause 6.5.9 shall:

(a) be coloured red and have fixed on or near it a permanent durable nameplate marked with the words 'FIREMAN'S SWITCH' the plate being the minimum size 150 mm by 100 mm, in lettering easily legible;

(b) have its ON and OFF positions clearly indicated by lettering legible to a person standing on the ground at the intended site, with the OFF position at the top;

(c) be provided with a device to prevent the switch being inadvertently returned to the ON position; and

(d) be arranged to facilitate operation by a fireman.

7.3.5.5 Devices for functional switching

7.3.5.5.1 Functional switching devices shall be suitable for the most onerous duty intended.

7.3.5.5.2 Functional switching devices like semiconductor switching devices may control the current without necessarily opening the corresponding poles.

7.3.5.5.3 Off-load isolators (disconnectors), fuses and links shall not be used for functional switching.

7.3.5.5.4 A plug and socket-outlet of rating not exceeding 16A may be used as a switching device.

7.4 Earthing arrangements and protective conductors

7.4.1 Every metal work of electrical equipment other than current carrying part, every metal conduit or ducts, every catenary wire, whether external or embedded in a cable and used for its support, and all close-fitting metal sheath and armour of cables, shall be earthed. All metal sinks and cold water pipes shall be electrically bonded to earth. All conductors to be used for

protection and every means of earthing shall be selected and installed to ensure safe operation of the associated equipment.

7.4.1.1 The earthing system of the installation may be subdivided; in which case each part thus divided shall comply with the requirements of clause 7.4.

7.4.1.2 Where, in an installation, there is also a lightning protection system due account shall be taken of the requirements prescribed in the relevant Ghana Standards.

7.4.1.3 Exemptions to earthing of equipment:

(a) short isolated lengths of conduit used for mechanical protection of cables and short isolated lengths of catenary wires used for the support of cables;

(b) metal parts of electrical apparatus, where such parts are so enclosed or shrouded by insulating material that contact to human body is not possible;

(c) metal parts on, or screw in or through non-conducting materials which are separated by such material from both current-carrying parts and from earthed non-current carrying parts; provided that metal hooks and clips intended for the support of flexible cords shall be covered with insulating materials;

(d) metallic cleats, clips, saddles, clamps;

(e) lamp caps;

(f) shades, reflectors and guards supported on lamp holders or lighting fittings of non-conducting materials, and

(g) metal work, other than the current-carrying parts of the equipment of extra-low voltage circuits.

7.4.2 Connections to Earth

7.4.2.1 Earthing arrangements

7.4.2.1.1 The main earthing terminal shall be connected with Earth by one of the methods described in clause 7.4.2.1.2 to 7.4.2.1.5, as appropriate to the type of system of which the installation is to form a part.

The earthing lead of the installation shall be connected to an effective earth electrode like copper rod, copper tube or metal plate or earth mat buried in the ground.

7.4.2.1.2 For a TN-S system, means shall be provided for the main earthing terminal of the installation to be connected to the earthed point of the source of energy. The supplier's lines and equipment may form part of the connection.

7.4.2.1.3 For a TN-C-S system, where protective multiple earthing is provided; means shall be provided for the main earthing terminal of the installation to be connected by the supplier to the neutral of the source of energy.

7.4.2.1.4 For a TT system, the main earthing terminal shall be connected via an earthing conductor to an earth electrode in accordance with clause 7.4.2.2.

7.4.2.1.5 For a TN-C system, means shall be provided for the connection of the PEN conductors to the main earthing terminal.

7.4.2.1.6 The earthing arrangements may be used jointly or separately for protective and functional purposes, according to the requirements of the installation.

7.4.2.1.7 The earthing arrangements shall be of a form so that:

(a) the value of impedance from the consumer's main earthing terminal to the earthed point of the supply for TN systems, or to Earth for TT systems, is in accordance with the protective and functional requirements of the installation, and considered to be continuously effective,

(b) earth fault currents and earth leakage currents which may occur are carried without danger, particularly from thermal, thermomechanical and electromechanical stresses, and

(c) they are adequately robust or have additional mechanical protection appropriate to the assessed conditions of external influence.

7.4.2.1.8 Precautions shall be taken against the risk of damage to other metallic parts through electrolysis.

7.4.2.1.9 Where a number of installations have separate earthing arrangements, any protective conductor common to any of the installations shall either be capable of carrying the maximum fault current likely to flow through them or be earthed within one installation only and insulated from the earthing arrangements of any other installation.

7.4.2.2 Earth Electrodes

7.4.2.2.1 Regulations apply to the following types of earth electrode:

(a) earth rods or pipes,

(b) earth tapes or wires,

(c) earth plates,

(d) underground structural metal work embedded in foundations,

(e) metallic reinforcement in concrete structures,

(f) underground metallic pipe systems, excluding public gas and water systems, and

(g) lead sheaths and metallic covering of underground cables.

7.4.2.2.2 The type and embedded depth of an earth electrode shall be such that soil drying will not increase its resistance above the required value.

7.4.2.2.3 The earth electrode shall be designed and constructed so as to withstand damage and to take account of the possible increase in resistance due to corrosion.

7.4.2.2.4 The metalwork of a gas, water or other service shall not be used as a protective earth electrode. This requirement does not preclude the bonding of the metalwork as required by clause 6.2.3.1.

7.4.2.2.5 Lead sheath or other metal covering shall be used as earth electrode subject to the following conditions:

(a) adequate precautions to prevent excessive deterioration by corrosion,

(b) the sheath or covering shall be in effective contact with earth,

(c) the consent of the owner of the cable shall be obtained, and

(d) arrangements shall exist for the owner of the electrical installation to be warned of any proposed change to the cable which might affect its suitability as an earth electrode.

7.4.2.3 Earthing conductors

7.4.2.3.1 Every earthing conductor shall comply with clause 7.4.3 and in addition where buried in the ground, shall have a cross-sectional area of not less than that stated in Table 22. For a tape or strip conductor, the thickness shall be of a nature to withstand mechanical damage and corrosion.

Table 22— Minimum cross-sectional areas of a buried earthing conductor

	Protected against mechanical damage	Not protected against mechanical damage
Protection against corrosion by a sheath	As required by clause 7.4.3.1	16 mm² copper
		16 mm² coated steel
Not protected against corrosion	25 mm2 copper	
	50 mm2 steel	25 mm2 copper
		50 mm2 steel

7.4.2.3.2 Protection of bare earthing wire shall be afforded by passing it through a conduit tube from the building to the point of connection to the electrode.

7.4.2.3.3 The connection of an earthing conductor to an earth electrode or other means of earthing shall be soundly made and be electrically and mechanically satisfactory, and labelled in accordance with clause 7.1.4.8.4. It shall be suitably protected against corrosion.

7.4.2.4 Main Earthing Terminals or Bars

7.4.2.4.1 In every installation, a main earthing terminal shall be provided to connect the following to the earthing conductor:

(a) the circuit protective conductor,

(b) the main bonding conductor, and

(c) functional earthing conductors (if required).

7.4.2.4.2 Accessible position and means for disconnecting the earth conductor shall be provided to facilitate measurement of the resistance of the earthing arrangement. These means may conveniently be combined with the main earthing terminal or bar.

Any joint shall be capable of disconnection only by means of a tool and shall be mechanically strong and ensure the maintenance of electrical continuity.

7.4.3 Protective Conductors

7.4.3.1 Cross-Sectional Areas

7.4.3.1.1 The cross-sectional area of a protective conductor shall be determined in accordance with Table 28. Where the requirements of Table 28 produces a non-standard size, a conductor with the nearest larger standard cross-sectional area shall be used.

If the protective conductor:

(a) is not an integral part of a cable,

(b) is not formed by conduit, ducting or trunking, or

(c) is not contained in an enclosure formed by a wiring system

(d) the cross-sectional area shall be not less than 2.5 mm2 copper equivalent if protection against mechanical damage is provided, and 4 mm2 copper equivalent if mechanical protection is not provided.

For a protective conductor buried in the ground, clause 7.4.2.3 for earthing conductors also applies. The cross-sectional area of an equipotential bonding conductor shall comply with clause 7.4.4.

7.4.3.1.2 Where a protective conductor is common to several circuits, the cross-sectional area of the protective conductor shall be selected in accordance with clause 7.4.3.1.1.

Table 23— Values of k for insulated protective conductor not incorporated in a cable and not bunched with cables, or for a separate bare protective conductor in contact with cable covering but not bunched with cables where the assumed initial temperature is 30 °C

Material of conductor Insulation of protective conductor or cable covering

70°C

PVC 90 °CPVC

PVC 90 °C

Thermosetting

Copper

Aluminium

Steel 143/133*

95/88*

52 143/133*

95/88*

52 176

116

64

Assumed initial temperature

Final temperature 30 °C

160 °C/ 140°C* 30 °C

160 °C/ 140°C* 30 °C

250°C

* Above 300 mm²

Table 24— Values of k for protective conductor incorporated in a cable or bunched with cables, where the assumed initial temperature is 70 °C or greater

Material of conductor

Copper

Aluminium Insulation of protective conductor or cable covering

70°C

PVC 90 °C

PVC 90 °C

thermosetting

115/103*

95/88* 100/86*

66/57* 143 94

Assumed initial temperature

Final temperature 70°C

160°C/ 140°C* 90°C

160°C/ 140°C* 90°C

250°C

* Above 300 mm²

Table 25— Values of k for protective conductor as a sheath or armour of a cable

Material of conductor Insulation of protective conductor or cable covering

Aluminium

Steel

Lead 70°C

PVC 90°C

PVC 90°C

thermosetting

93

51

26 85

46

23 85

46

23

Assumed initial temperature

Final temperature 60°C

200°C 80°C

200°C 80°C

200°C

Table 26— Values of k for steel conduit, ducting and trunking as the protective conductor

Material of conductor

conductor conduit Insulation material

Steel Conduit,

Ducting and trunking 70°C

PVC 90 °C

PVC 90 °C

thermosetting

47

50°C 44

60°C 58

60°C

Assumed initial temperature

Final temperature 50°C

160°C 60°C

160°C 60°C

250°C

Table 27— Values of k for bare conductor where there is a risk of damage to any neighbouring material by the temperatures indicated

Material of conductor

conductor conduit Conditions

Visible and in restricted areas Normal conditions Fire risk

Copper

Aluminim

Steel 228

125

82 159

105

85 138

91

50

Assumed initial temperature

Final temperature

Aluminium conductors

Steel conductors 30°C

500°C

300°C

500°C 30°C

200°C

200°C

200°C 30°C

150°C

150°C

150°C

The temperatures indicated are valid only where they do not impair the quality of the connections.

Table 28— Minimum cross-sectional area of protective conductor in relation to the cross-sectional area of associated phase conductor

Cross-sectional area of phase conductor		
S	Minimum cross-sectional area of the corresponding protective conductor	
	If the protective conductor is of the same material as the phase conductor	If the protective conductor is not the same material as the phase conductor
(mm²)		
S> 35 (mm²)		
S		
16		
	(mm²)	

Where:

k1 Is the value of k for the phase conductor selected from Table 28 according to the materials of both conductor and insulation

k2 Is the value of k for the protective conductor, selected from tables 21, 22, 23, 24 or 25, as applicable.

Table 29— Values of k for common materials, for calculation of the effects of fault current

Conductor Material	Insulation Material	Assumed initial temperature (°C)	Limiting final temperature (°C)	k
Copper	70 °C PVC (general purpose)			
	90 °C PVC			
	90 °C thermosetting	70		
		90		
		90	160/140*	
			160/140*	
		250	115/103*	
			100/86*	
				143
Copper	Mineral			
	— plastic covered or exposed to touch			
	— bare and neither exposed to touch nor in contact with combustible materials			
				70 (sheath)
				105 (sheath)
				160
				250
				115

135

Aluminium 70 °C PVC (general purpose)

90 °C PVC

90 °C thermosetting 70

90

60 160/140*

160/140*

250 76/68*

66/57

94

• These data are applicable only for disconnection times up to 5 seconds. For longer times the cable manufacturer shall be consulted.

• Where two values of limiting final temperature and of k are given, the lower value relates to cables having conductors of greater than 300 mm2 cross-sectional area.

7.4.3.2.1 Flexible or pliable conduit, gas or oil pipe shall not be selected as a protective conductor.

7.4.3.2.2 A protective conductor may consist of one or more of the following:

(a) a single-core cable or a conductor in a cable;

(b) an insulated or bare conductor in a common enclosure with insulated live conductors;

(c) a fixed bare or insulated conductor;

(d) a metal covering, for example, the sheath, screen or armouring of a cable; and

(e) a metal conduit or electrically continuous support system for conductors.

7.4.3.2..3 A protective conductor of the types described in items (a) to (c) of clause 7.4.3.2.2 and of cross-sectional area 10 mm2 or less shall be of copper.

7.4.3.2.4 The metal covering including the sheath (bare or insulated) of a cable, in particular the sheath of a mineral insulated cable, trunking and ducting for electrical purposes and metal conduit, may be used as a protective conductor for the associated circuit, if it satisfies the following requirements:

(a) its electrical continuity shall be assured, either by construction or by suitable connection, in such a way as to be protected against mechanical, chemical or electrochemical deterioration, and

(b) its cross-sectional area shall be at least equal to that resulting from the application of clause 7.4.3.1.

7.4.3.2.5 Where the protective conductor is formed by conduit, trunking, ducting or the metal sheath or armour of a cable, the earthing terminal of each accessory shall be connected by a separate protective conductor to an earthing terminal incorporated in the associated box or other enclosure.

7.4.3.2.6 An exposed-conductive-part of equipment shall not be used to form a protective conductor for other equipment.

7.4.3.2.7 The circuit protective conductor of every ring final circuit shall also be run in the form of a ring having both ends connected to the earthing terminal at the origin of the circuit.

7.4.3.2.8 A separate metal enclosure for cable shall not be used as a PEN conductor.

7.4.3 Preservation of electrical continuity of protective conductors

A protective conductor shall be suitably protected against mechanical and chemical deterioration and electrodynamic effects.

7.4.4 Protective bonding conductors

7.4.4.1 The main equipotential bonding conductor required for the earthing of an installation shall have a cross-sectional area not less than 6 mm2.

Table 30— Minimum cross-sectional area of the main equipotential bonding conductor in relation to the neutral of the supply.

Copper equivalent cross-sectional area of the supply neutral conductor	Minimum copper equivalent cross-sectional area of the main equipotential bonding conductor
35 mm² or less	16 mm²
Over 35 mm² up to 50 mm²	25 mm²
Over 50 mm² Up to 95 mm²	35 mm²
Over 95 mm² up to 150 mm²	50 mm²
Over 150 mm² 10 mm²	

NOTE: Local distributor's network conditions may require a larger conductor. Where PME conditions apply, the main equipotential bonding conductor shall be selected in accordance with the neutral conductor of the supply and Table 30.

7.4.4.2 The main equipotential bonding connection to any gas, water or other service shall be made as near as practicable to the point of entry of that service into the premises. Where there is an insulating section or insert at that point or there is a meter, the connection shall be made to the consumer's hard metal pipework and before any branch pipework. Where practicable, the connection shall be made within 600 mm of the meter outlet union or at the point of entry to the building if the meter is external.

7.4.4.3 Supplementary bonding conductors

Where supplementary or additional bonding becomes necessary, the cable size shall not be less than $4mm^2$.

7.5 Other Equipment

7.5.1 Generating Sets

7.5.1.1 This section applies to low voltage and extra-low voltage installations which incorporate generating sets intended to supply, either continuously or occasionally, all or part of an installation like in the following cases:

(a) supply to permanent installations;

(b) supply to temporary installations; and

(c) supply to portable equipment which is not connected to a permanent fixed installation.

Requirements are included for supply to an off-grid installation or an alternative supply to an installation connected to a distributor's network.

Requirements of the distributor shall be ascertained before a generating set is installed in an installation which is connected to the distributor's network.

7.5.1.2 Generating sets with the following prime movers are considered:

(a) combustion engines,

(b) turbines;

(c) electric motors;

(d) photovoltaic cells;

(e) electrochemical sources; and

(f) other suitable sources.

7.5.1.3 The prospective short-circuit current and prospective earth fault current shall be assessed for each source of supply or combination of sources which can operate independently of other sources or combinations. The short-circuit rating of protective devices within the

installation and, where appropriate, connected to the distributor's network, shall not be exceeded for any of the intended methods of operation of the sources.

7.5.1.4 Where the generating set is intended to provide a supply to an installation which is not connected to the distributor's network or to provide a supply as a switched alternative to the distributor's network, the capacity and operating characteristics of the generating set shall be such that danger or damage to equipment does not arise after the connection or disconnection of any intended load as a result of the deviation of the voltage or frequency from the intended operating range. Means shall be provided to automatically disconnect the parts of the installation as that may be necessary if the capacity of the generating set is exceeded.

7.5.2 Extra-low voltage systems supplied from more than one source

7.5.2.1 Where a SELV or PELV system may be supplied by more than one source, the requirements of clause 6.2.1.1.2 shall apply to each source. Where one or more of the sources is earthed, the requirements of clause 6.2.1.2 shall apply.

If one or more of the sources does not meet the requirements of clause 6.2.1.1, the system shall be treated as a FELV system and the requirements of clause 6.2.1.2 shall apply.

7.2.2.2 Where it is necessary to maintain the supply to an extra-low voltage system following the loss of one or more sources of supply, each source of supply or combination of sources of supply which can operate independently of other sources or combinations shall be capable of supplying the intended load of the extra-low voltage system.

Provisions shall be made so that the loss of low voltage supply to an extra-low voltage source does not lead to danger or damage for other extra-low voltage equipment.

7.5.3 Protection against indirect contact

Protection against indirect contact shall be provided for the installation in respect of each source of supply or combination of sources of supply which can operate independently of other sources or combinations of sources.

7.5.3.1 Protection by automatic disconnection of supply

Protection by automatic disconnection of supply shall be provided in accordance with clause 6.2.3.1, except as modified for particular circumstances by clauses 7.5.3.2, 7.5.3.3 or 7.5.3.4.

7.5.3.2 Additional requirements for standby systems

Protection by automatic disconnection of supply shall not rely on the connection to the earthed point of the distributor's network when the generator is operating as a switched alternative to a TN system. A suitable earth electrode shall be provided.

7.5.3.3 Additional requirements for installations incorporating static inverters

Where the conditions for automatic disconnection of clause 6.2.3.1 cannot be achieved for parts of the installation on the load side of the static inverter, supplementary equipotential bonding shall be provided on that side in accordance with clauses 6.2.3.1.24 and 6.2.3.1.25.

The resistance (R) of the supplementary equipotential bonding conductor between simultaneously accessible exposed-conductive-parts and extraneous-conductive-parts shall fulfil the following condition:

where:

I is the maximum fault current which can be supplied by the static inverter alone for a period of up to 5 s.

Where a static inverter is intended to operate in parallel with a distributor's network the requirements of clause 7.5.5 also apply.

7.5.3.4 Additional requirements for protection by automatic disconnection where the installation and generating set are not permanently fixed.

For portable generating sets and generating sets which are intended to be moved to unspecified locations for temporary or short-term use, the following requirements apply:

(a) between separate items of equipment, protective conductors shall be provided which are part of a suitable cord or cable and which comply with Table 23.

(b) in TN, TT and systems a residual current device with a rated residual operating current (Im) not exceeding 30 mA shall be installed in accordance with the requirements for automatic disconnection in clause 6.2.3.1.

7.5.4 Protection against overcurrent

7.5.4.1 Where means of detecting overcurrent of the generating set is provided, this shall be located as near as practicable to the generator terminals.

7.5.4.2 Where a generating set is intended to operate in parallel with a distributor's network, or where two or more generating sets may operate in parallel, circulating harmonic currents shall be limited so that the thermal rating of conductors is not exceeded.

The effects of circulating harmonic currents shall be limited by one or more of the following:

(a) the selection of generating sets with compensated windings;

(b) the provision of a suitable impedance in the connection to generator star points;

(c) the provision of switches which interrupt the circulatory circuit but which are interlocked so that at all times protection against indirect contact is not impaired;

(d) the provision of filtering equipment; or

(e) other suitable means.

7.5.4.3 Additional requirements for standby systems

Precautions complying with the relevant requirements of clause 6. 4 shall be taken, so that the generator cannot operate in parallel with the distributor's network. Suitable precautions shall include one or more of the following:

(a) an electrical, mechanical or electromechanical inter-lock between the operating mechanisms or control circuits of the changeover switching devices;

(b) a system of locks with a single transferable key;

(c) a three-position change over switch (on-off-on);

(d) an automatic changeover switching device with a suitable interlock; and

(e) other means providing equivalent security of operation.

7.5.4.4 For TN-S systems where the neutral is not isolated, any residual current device shall be positioned to avoid incorrect operation due to the existence of any parallel neutral earth path.

7.5.5 Additional requirements for installations where the generating set may operate in parallel with the Distributor's Network

7.5.5.1 In selecting and using a generating set to run in parallel with a distributor's network, care shall be taken to avoid adverse effects to the supply network and to other installations in respect of power factor, voltage changes, harmonic distortion, unbalance, starting, synchronizing or voltage fluctuation effects. The distributor shall be consulted in respect of particular requirements. Where parallel operation is required, the use of automatic synchronizing systems which consider frequency, phase and voltage is preferred.

7.5.5.2 Protection shall be provided to disconnect the generating set from the distributor's network in the event of loss of that supply or deviation of the voltage or frequency at the supply terminals from values declared for normal supply.

The type of protection and the sensitivity and operating times depend upon the protection of the distributor's network and shall be in accordance with the distributor's requirements.

7.5.5.3 Means shall be provided to prevent the connection of a generating set to the distributor's network if the voltage and frequency of the distributor's network are outside the limits of operation of the protection required by clause 7.5.5.2.

7.5.5.4 Means shall be provided to enable the generating set to be isolated from the distributor's network. The means of isolation shall be accessible to the distributor at all times, so far as is reasonably practicable.

7.5.5.5 Where a generating set may also operate as a switched alternative to the distributor's network, the installation shall also comply with clause 7.5.4.3.

7.5.6 Rotating Machines

7.5.6.1 Every electric motor having a rating exceeding 0.37 kW shall be provided with control equipment incorporating means of protection against overload of the motor. This

requirement does not apply to a motor incorporated in an item of current-using equipment complying as a whole with the appropriate Ghana Standard.

7.5.6.2 Except where failure to start after a brief interruption would be likely to cause greater danger, every motor shall be provided with means to prevent automatic restarting after a stoppage due to a drop in voltage or failure of supply, where unexpected restarting of the motor might cause danger.

7.5.6.3 Where safety depends on the direction of rotation of a motor, provision shall be made for the prevention of reverse operation due, for example, to the loss of one phase.

7.5.7 Accessories

7.5.7.1 Plugs and socket-outlets

7.5.7.1.1 Every plug and socket-outlet shall comply with all the requirements of items (a) and (b) below, and in addition, shall comply with the appropriate requirements of clause 7.5.7.1.2 to 7.5.7.1.8:

(a) except for SELV circuits, it shall not be possible for any pin of a plug to make contact with any live contact of its associated socket-outlet while any other pin of the plug is completely exposed, and

(b) it shall not be possible for any pin of a plug to make contact with any live contact of any socket-outlet within the same installation other than the type of socket-outlet for which the plug is designed.

7.5.7.1.2 Except for SELV or a special circuit from clause 7.5.7.1.4, every plug and socket-outlet shall be of the non-reversible type, with provision for the connection of a protective conductor.

7.5.7.1.3 Except where clause 7.5.7.1.4 applies, in a low voltage circuit every plug and socket-outlet shall conform to the applicable standard listed in Table 31.

Table 31— Plugs and socket-outlets for low voltage circuits

Type of plug and socket-outlet	Rating (amperes)	Applicable Standard
Fused plugs and shuttered socket-outlets, 2-pole and earth, for a.c.	13	GS IEC 60669-1
Plugs, fused or non-fused, and socket-outlets, 2-pole and earth	2, 5, 15, 30	GS IEC 60884-2-6 (fuses, if any, to GS IEC 60127-1 and GS IEC 60127-2)
	10, 16, 32	GS IEC 60884-1

Plugs, 2-pole (non-rewirable only) 2.5 GS IEC 60884-1

Plugs, 2-pole 6 GS IEC 60884-1

Plugs, fused or non-fused, and socket-outlets, protected type, 2-pole with earthing contact 5, 15, 30 GS IEC 60309-1

Plugs and socket-outlets (industrial type) 16, 32, 63, 125 GS IEC 60309-2

7.5.7.1.4 A plug and socket-outlet not complying with GS IEC60669-1, GS IEC60884-2-6, GS IEC 60309-1 or GS IEC 60309-2, may be used in single-phase a.c. or two-wire d.c. circuits operating at a nominal voltage not exceeding 250 volts for:

(a) the connection of an electric clock, provided that the plug and socket-outlet are designed specifically for that purpose, and that each plug incorporates a fuse of rating not exceeding 3 amperes complying with GS IEC 60127-1, GS IEC 60127-2 or GS IEC 60269-l as appropriate;

(b) the connection of an electric shaver, provided that the socket-outlet is either incorporated in a shaver supply unit complying with GS IEC 61558-2-4 and GS IEC 61558-2-6 or and in a room other than a bath-room, is a type complying with GS IEC 60309-1; and

(c) a circuit having special characteristics such that danger would otherwise not arise or it is necessary to distinguish the function of the circuit.

7.5.7.1.5 A socket-outlet on a wall or similar structure shall be mounted at a height above the floor or any working surface to minimize the risk of mechanical damage to the socket-outlet or to an associated plug and its flexible cord which might be caused during insertion, use or withdrawal of the plug.

7.5.7.1.6 Where portable equipment is likely to be used, provision shall be made so that the equipment can be fed from an adjacent and conveniently accessible socket-outlet, taking account of the length of flexible cord normally fitted to portable appliances and luminaires.

7.5.7.1:7 The switch controlling any single pole socket-outlet shall be connected in the live or phase conductor.

7.5.7.1.8 The terminals of the socket-outlet shall be connected as follows:

The terminal marked "L" shall be connected to the phase conductor or the non-earthed conductor.

The terminal marked "N" shall be connected to the common return or neutral conductor.

The terminal marked "E" shall be connected to the protective earth system.

7.5.7.2 Cable Couplers

7.5.7.2.1 Except for a SELV or a Class II circuit, a cable coupler shall comply where appropriate with GS IEC 60309-1, GS IEC 60309-2 or GS IEC 60320-1, shall be non-reversible and shall have provision for the connection of a protective conductor.

7.5.7.2.2 A cable coupler shall be arranged so that the connector of the coupler is fitted at the end of the cable remote from the supply.

7.5.7.3 Lampholders

7.5.7.3.1 A lampholder shall not be connected to any circuit where the rated current of the overcurrent protective device exceeds the appropriate value stated in Table 32.

Table 32— Overcurrent protection of lampholders

Type of lampholder Maximum rating (amperes) of overcurrent protective device protecting the circuit

Bayonet (GS IEC 61184) : B 15 SBC

B 22 BC 6

16

Edison screw (GS IEC 60238) : E 14 SES

E 27 ES

E40 GES 6

16

16

7.5.7.3.2 A lampholder for a filament lamp shall not be installed in a circuit operating at a voltage exceeding 250 volts.

7.5.7.4 Lighting Points

7.5.7.4.1 At each fixed lighting point one of the following accessories complying with the appropriate Ghana Standard shall be used:

(a) a ceiling rose;

(b) a luminaire supporting coupler;

(c) a batten lampholder;

(d) a luminaire designed to be connected directly to the circuit wiring; or

(e) a suitable socket-outlet.

A lighting installation shall be appropriately controlled, by a switch or combination of switches, or by a suitable automatic control system, which where necessary shall be suitable for discharge of lighting circuits.

7.5.7.4.2 A ceiling rose shall not be installed in any circuit operating at a voltage that normally exceeds 250 volts and shall also not be used for the attachment of more than one outgoing flexible cord.

7.5.7.5 Current-using equipment

7.5.7.5.1 Luminaires

7.5.7.5.1.1 Where a pendant luminaire is installed, the associated accessory shall be suitable for the mass suspended.

7.5.7.5.1.2 Luminaire supporting couplers shall not be used for the connection of any other equipment.

7.5.7.5.1.3 An extra-low voltage luminaire without provision for the connection of a protective conductor shall be installed only as part of a SELV system.

7.5.7.6 High Voltage Discharge Lighting installations

7.5.7.6.1 Every high voltage electric sign and high voltage luminous discharge tube installation shall be constructed, selected and erected in accordance with the requirements of the relevant Ghana Standard.

7.5.7.6.2 Every switch selected to control a discharge lighting circuit shall have its current rating to be at least twice the total steady current of the discharge lighting equipment.

7.5.7.7 Electrode Water Heaters and Boilers

7.5.7.7.1 Every electrode boiler and electrode water heater shall be connected to an a.c. system only, and shall be selected add erected in accordance with the appropriate requirements of this section.

7.5.7.7.2 The supply to the heater or boiler shall be controlled by a linked circuit-breaker arranged to disconnect the supply from all electrodes simultaneously and provided with an overcurrent protective device in each conductor feeding an electrode.

7.5.7.7.3 The earthling of the heater or boiler shall comply with the requirements of clause 7.4 and, in addition, the shell of the heater or boiler shall be bonded to the metallic sheath and armour, if any, of the incoming supply cable. The protective conductor shall be connected to the shell of the heater or boiler and shall comply with clause 7.4.3.

7.5.7.7.4 Where an electrode water heater or electrode boiler is directly connected to a supply at a voltage exceeding low voltage, the installation shall include a residual current device arranged to disconnect the supply from the electrodes on the occurrence of a sustained protective conductor current in excess of 10% of the rated current of the heater or boiler under normal conditions of operation, except that if in any instance a higher value is essential to ensure stability of operation of the heater or boiler, the value may be increased to a maximum of 15%. A time delay may be incorporated in the device to prevent unnecessary operation in the event of imbalance of short duration.

7.5.7.7.5 Where an electrode water heater or electrode boiler is connected to a three-phase low voltage supply, the shell of the heater or boiler shall be connected to the neutral of the supply as well as to the earthing conductor.

The current-carrying capacity of the neutral conductor shall be not less than that of the largest phase conductor connected to the equipment.

7.5.7.7.6 Except as provided by clause 7.5.7.7.7, where the supply to an electrode water heater or electrode boiler is single-phase and one electrode is connected to a neutral conductor earthed by the distributor, the shell of the water heater or boiler shall be connected to the neutral of the supply as well as to the earthing conductor.

7.5.7.7.7 Where the heater or boiler is not piped to a water supply or in physical contact with any earthed metal, and where the electrodes and the water in contact with the electrodes are so shielded in insulating material that they cannot be touched while the electrodes are live, a fuse in the phase conductor may be substituted for the circuit-breaker required under clause 7.5.7.7.2 and the shell of the heater or boiler need not be connected to the neutral of the supply.

7.5.7.8 Heaters for liquids or other substances having immersed heating elements

Every heater for liquid or other substance shall incorporate or be provided with an automatic device to prevent a dangerous rise in temperature.

7.5.7.9 Autotransformers and Step-Up Transformers

7.5.7.9.1 Autotransformers

Where an autotransformer is connected to a circuit having a neutral conductor, the common terminal of the winding shall be connected to the neutral conductor.

7.5.7.9.2 Step-Up Transformers

Where a step up transformer is used, a linked switch shall be provided for disconnecting the transformer from all live conductors of supply.

7.5.7.10 Flexible Cords

7.5.7.10.1 A flexible wiring system shall be installed so that excessive tensile and tensional stress to the conductors and connections are avoided.

7.5.7.10.2 The minimum recommended size of flexible cord is 0.75 mm^2.

7.5.7.10.3 Where a length of flexible cord is connected to a ceiling rose or lighting fitting, care shall be taken that any hooks, clips or cleats, etc, used for support do not compress the insulation and that every part of such hook, clip or cleat, which is likely to come into contact with the flexible cord, shall be made of insulating material.

7.5.7.10.4 The use of portable appliances requiring supplies at voltages exceeding 250 volts shall be avoided as far as practicable, but where this practice is unavoidable every flexible cord or cable operating at a voltage exceeding 250 volts shall be effectively protected against mechanical damage.

7.5.7.10.5 Where a lighting fitting is supported by one or more flexible cords, the maximum weight to which anyone of the twin

Table 33— Current-carrying Capacity (Amperes) and Mass Supportable (kg)

Conductor Cross-sectionalarea

(m^2) Current-carrying capacity Maximum mass supported by twin flexible cord

(kg)

Single-phase a.c.

(A) Three-phase a.c.

(A)

0.5

0.75

1

1.25

1.5

2.5

4 3

6

10

13

16

25

32 3

6

10

-

16

20

25 2

3

5

5

5

5

5

7.5.8 Protection of accessories in hazardous locations

In damp situations,

(a) every accessory and light fitting shall be suitable for the location with a minimum enclosure rating of IPX5;

(b) installation of accessories shall be avoided as far as possible; and

(c) accessories shall not have exposed parts.

7.5.8.1 In kitchen and sculleries and in every room containing a fixed bath, all flexible cords, shall be of the water proof type. The use of flexible cords for any purpose in bathrooms is not recommended.

flexible cords shall be subjected to shall be as stipulated in Table 33.

For the purpose of the above requirements on fluorescent fittings or any type where more than one flexible cable is needed for support, the weight must be regarded as being equally divided between the cables used to suspend the fitting. Where a greater weight than 5kg has to be supported, other means of support shall be provided.

7.5.8.2 In places where inflammable or explosive dust, vapour or gas is likely to be present under normal conditions, every accessory and lighting fitting irrespective of the voltage used, shall be protected by a flame proof enclosure to prevent danger.

7.5.8.3 In locations where inflammable material is stored, accessories shall be limited as much as possible to items necessary for use in that place.

7.5.8.4 In places where petrol-driven vehicles are stored or repaired, every accessory, other than those of the portable type, unless of the flame proof type, shall be fixed at a height of at least 105m above the general floor level.

7.5.9 Electric discharge lighting circuits

7.5.9.1 Every switch not specifically designed to break an inductive load of its full rated capacity shall, if used to control a discharge-lighting circuit, have a current rating not less than twice the total steady current which it is required to carry or, if used to control filament lighting and discharge lighting, have a current rating not less than the sum of the current flowing in the filament lamps and twice the total steady current flowing in the electric discharge lamps.

7.5.9.2. Circuits shall be capable of carrying the total steady current, viz. that of the lamps and any associated gear and also their harmonic currents. Where more exact information is not available, the demand in volt-amperes my be taken for the purpose of this code as the rated lamp watts multiplied by not less than 1.8. the neutral conductor in every discharge lighting circuit shall have a cross-sectional area not less than that of the phase conductors

7.5.9.3 Every ballast or control gear shall be installed as near as practicable to its associated electric discharge lamp.

7.5.9.4 All live parts, including all apparatus and conductors but excluding the lamps except in the neighbourhood of their terminals, shall be provided with effective screens of earthed metal or insulating material, of mechanical strength adequate to withstand the condition; of normal service, or alternatively, for installations on the exterior of a building. Such live parts may be so situated as to be accessible only to authorized persons. Screens of insulating material used for this purpose shall be non-hygroscopic, anti-tracking, and substantially non-combustible.

7.6 Grid connected PV system

7.6.1 A typical residential Grid connected PV system is as shown in Fig 10 and consists of the following:

(a) a PV Module which is an environmentally protected unit consisting of solar cells and optics designed to generate d.c. power when exposed to sunlight ;

(b) a DC disconnect safety switch which is to provide a safe means of isolating the PV module from the inverter;

(c) an inverter capable of converting electricity produced by the system from DC to AC power;

(d) an AC disconnect safety switch which is to provide a safe means of isolating the inverter and the PV module from the Utility grid ;

(e) a PV meter which is used to measure the amount of energy generated from the PV module;

(f) a double pole main breaker (of the main service panel) with the correct ampere rating which is used to isolate

7.7 Lightning protection

7.7.1 Premises intended to be protected from lightning shall be composed of materials inherently resistant to corrosion or properly protected against corrosion and have its installation as shown in Fig. 11

(a) Lightning Rod (Air Terminal) —Solid Copper Points made from high conductivity copper rod with tapered point attached to the roof of the building to intercept a direct lightning strike and shall be 0.95 cm minimum diameter with a projection of at least 25.4cm but not more than 91.44cm;

(b) Lightning Rod Mounting Base — Copper point base for use on ridged roof, sloping or vertical surfaces with positive single bolt tension cable clamping;

(c) Copper Cable (Conductor) — Smooth weave cable consists of 29 strands of 17 gauge copper wire with area of conductivity 59.45 cm (#2 AWG);

(d) Copper Cable Strap — for securing all main-size cable;

(e) Ground Rod Clamp — of high conductivity red bronze provides 7.62cm direct contact — two 0.79cm set screws for positive contact;

(f) GEM: (Ground Enhancement Material) — A superior material to improve grounding where soil conductivity is poor or where ground rods cannot be driven; and

(g) Ground Rod (Terminations) — Metal rods driven into the earth to guide the lightning current harmlessly to ground and the minimum acceptable standard of composition must be solid copper, 1.27cm in diameter, 3m long and buried at least 3m deep.

8 SPECIAL INSTALLATIONS, LOCATIONS AND STRUCTURES

The requirements for special installations, locations and structures are additional to the general requirements contained in this Standard.

8.1 Locations containing a Bath Tub or Shower Basin

8.1.1 This section's requirements are applicable to installations or locations containing bath tubs, shower basins and their surroundings, with increased risk of electric shock.

8.1.2 Protection against electric shock

Electrical equipment shall not be installed in the interior of a bath tub or shower basin.

8.1.3 Protection against both direct and indirect contact

Every power source shall be installed out of the reach of any person using a bath or shower. A power source shall incorporate protection against direct contact by insulation capable of withstanding 500V a.c r.m.s for 60 seconds.

8.1.3.1 Protection against indirect contact

8.1.3.1.1 Every circuit supplying equipment in a room that contains a fixed bath or shower shall have protective devices and earth arrangements with characteristics such that in the event of fault to earth, the disconnection should occur within 0.4 s.

8.1.3.1.2 In a room that contains a fixed bath or shower, supplementary equipotential bonding shall be provided simultaneously between accessible exposed-conductive parts of equipment and any extraneous-conductive part.

8.1.3.1.3 The protective conductors of all power and lighting points in a room that contains a fixed bath or shower shall be supplementarily bonded to all extraneous-conductive-parts in the room.

8.1.4 Application of protective measures against electric shock

8.1.4.1 Protection against direct contact.

Protection by means of obstacles and protection by placing out of reach shall not be used as protection against direct contact.

8.1.4.2 Protection against indirect contact

Protection by use of non-conducting location and protection by means of earth-free local equipotential bonding as a protection against indirect contact shall not be used.

8.1.5 Selection and erection of equipment

8.1.5.1 Wiring systems

Metallic conduit or metallic trunking or an exposed metallic cable sheath or an exposed earth or bonding conductor shall not be used for surface wiring systems.

8.1.5.2 Devices for isolation and switching

Every switch or other means of electrical control or adjustment shall be so situated as to be normally inaccessible to a person who uses a fixed bath or shower.

8.1.5.3 Transformers

A shaver outlet shall have an independent circuit and earthed.

8.1.5.4 Plugs and socket outlets

In a room that contains a fixed bath or shower, there shall be no socket outlet provision for the purpose of connecting portable equipment.

8.1.5.5 Luminaires

Parts of a lampholder installed within a distance of 2.5m from a bath or shower cubicle shall be covered in insulating materials or totally enclosed luminaries shall be used.

8.1.5.6 Other fixed equipment

Stationary appliances having heating elements shall not be installed within the reach of a person using a bath or shower.

8.2 Swimming pools

These particular requirements provide for swimming pools and other similar recreational areas where the risk of electric shock is high.

8.2.1 The areas of concern in respect of swimming pools are demarcated into the following zones for the purpose of protection for safety:

(a) Zone A: The area immediately covered by water

(b) Zone B : The area immediately close to Zone A

(c) Zone C: The area remote to zone A but which forms part of the scope.

The zones are further defined by the vertical and horizontal planes for the following:

(a) Pool below ground (Figure. 12)

(b) Pool above ground (Figure. 13)

8.2.2 Protection against electric shock

(a) Protection against direct contact shall be provided by:

(i) Barriers or enclosures according to the degree of protection IP2X or IPXXB; or

(ii) Insulation that can withstand 500V ac r.m.s for 60 seconds.

(b) Supplementary equipotential bonding shall be provided for all extraneous conductive parts in zones A, B and C as well as metal grids in the solid floor.

8.2.3 Applications

8.2.3.1 In zones A and B the only protective measures shall be provided by SELV at a nominal voltage not exceeding 12V a.c r.m.s or 30Vdc with the source of supply being outside zones A, B, and C.

The exceptions to the above are as follows:

(a) Floodlights installed shall be supplied from their own transformers or circuits with open circuit voltages less than or equal to 18V a.c. rms.

(b) Socket outlets installed shall be protected by residual current devices as indicated in clause 6.2.2.5.

8.2.3.2 Unapproved measures

The following protective measures shall not be applied in any of the zones:—

(a) protection by means of obstacles;

(b) protection by placing out of reach;

(c) protection by means of a non-conducting location; or

(d) protection by means of earth-free local equipotential bonding.

8.2.4 Equipment selection

8.2.4.1 Degree of protection

Installed equipment shall have the following minimum degrees of protection:

(a) Zone A -IPX 8;

(b) Zone B - IPX 5; and

(c) Zone C - IPX 2 for indoor pools ; IPX 4 for outdoor pools

8.2.4.2 Wiring systems

Within Zone A and B

(a) wiring shall be allowed only for equipment located within the zones.

(b) no metallic conduit, trunking, exposed bonding or earthing conductor or an exposed metallic cable sheath shall be employed.

8.2.4.3 Distribution and control gear

Within Zone A and B

(a) a switchgear, control gear and their accessories shall not be installed; and

(b) where a socket outlet cannot be located outside zone B the following measures shall be adopted:

(i) the socket outlet shall comply with GS IEC 60309 — 2;

(ii) it shall be installed 1.25m outside zone A and 0.3m above finished floor level; and

(iii) protection shall be provided by either the use of a residual current device (clause 6.2.2.5) or by employing electrical separation (clause 6.2.3.3) for which the safety isolating transformer is located outside Zones A, B and C.

8.2.5 Other equipment

(a) For zones A and B only equipment intended for use in swimming pools shall be installed.

(b) In Zone C, equipment shall be protected by the use of one of the following:

(i) individually by electrical separation;

(ii) SELV; or

(iii) a residual current device.

8.3 Agricultural and horticultural premises

This clause covers outdoor and indoor premises intended for the purposes of agricultural and horticultural activities.

8.3.1 Protection against both direct and indirect contact

8.3.1.1 Protection against direct contact

Protection against direct contact shall be provided by at least one of the following:

(a) Barriers or enclosures to at least IP2X or IPXXB degree of protection; or

(b) Insulation capable of withstanding 500V a.c rms for 60 seconds.

Any circuit supplying a socket outlet shall be protected by a residual current device with characteristics specified in Clause 6.2.2.5.

8.3.1.2 Protection against indirect contact

In premises where livestock is kept, clause 8.3.2 to 8.3.4 shall apply where protection against indirect contact is provided by earthed equipotential bonding and automatic disconnection of supply.

8.3.2 TN System

Table 34— Maximum disconnection times for TN systems

Installation nominal Voltage Uo (volts)	Maximum disconnection time t* (seconds)
120	
220 to 277	
400, 480	
580	0.35
0.2	
0.05	
0.02	

Where: Uo is the nominal voltage

* if such a disconnection time cannot be guaranteed it may be necessary to take other protection measures, such as supplementary equipotential bonding.

8.3.2.1 Where fuses are used to protect socket outlets, the maximum values of earth fault loop impedance (Zs) corresponding to a disconnection time of 0.2 s are stated in Table 35 for a nominal voltage to Earth (Uo) of 230 V. For types and rated currents of general purpose (gG) fuses other than those mentioned in Table 35, reference shall be made to the appropriate Ghana Standard to determine the value of Ia.

Table 35—Maximum earth fault loop impedance (Zs) for fuses, for 0.2 s disconnection time with Uo of 230 V

(a) General purpose (gG) fuses to GS IEC 60269-Parts 2 and 3

Rating(amperes)	6	10	16	20	25	32	40	50
Zs (ohmns)	7.74	4.71	2.53	1.60	1.33	0.92	0.71	0.53

(b) Fuses to GS IEC 60269-1

Rating (amperes)	5	15	20	30	45
Zs (ohmns)	9.60	3.0	1.55	1.0	0.51

(c) Fuses to GS IEC 60269-2

Rating (amperes)	5	15	20	30	45
Zs (ohmns)	7.50	1.92	1.33	0.80	0.41

(d) Fuses to GS IEC 60269-1

Rating (amperes)	13
Zs (ohmns)	2.14

Note: The circuit loop impedance given in the table should not be exceeded when the conductors are at their normal operating temperatures. If the conductors are at a different temperature when tested, the reading should be adjusted accordingly.

8.3.2.2 Where circuit breakers are used to protect socket outlets, the maximum values of earth fault loop impedance (Zs) shall be determined by the formula of clause 6.2.3.1.13. Alternatively, for a nominal voltage to Earth (Uo) of 230 V and a disconnection time of 0.2s, the values specified in Table 36 for the types and ratings of circuit breakers listed may be used instead of calculation.

Table 36—Maximum earth fault loop impedance (Zs) for circuit-breakers, for disconnection times of both 0.2 s with Uo of 230V

(e) Type 1 miniature circuit-breakers to GS IEC 60898

Rating(amperes)	5	6	10	15	16	20	30	32	40	45	50	63	In
Zs (ohmns)	12.0	10.0	6.00	4.00	3.75	3.00	2.00	1.80	150	1.33	1.20	0.95	60/In

(f) Type 2 miniature circuit-breakers to GS IEC 60898

Rating (amperes)	5	6	10	15	16	20	30	32	40	45	50	63	In
Zs (ohmns)	6.68	5.61	3.43	2.29	2.14	1.71	1.14	1.07	0.86	0.76	0.69	0.54	34.3/In

(g) Type B circuit-breakers to GS IEC 60898

Rating (amperes)	6	10	16	20	32	40	45	50	63	In
Zs (ohmns)	8.00	4.80	3.00	2.40	1.50	1.20	1.07	0.96	0.76	48/In

(h) Type 3 miniature circuit-breakers to GS IEC 60898 and Type C circuit-breakers to GS IEC 60898

Rating (amperes)	5	6	10	15	16	20	30	32	40	45	50	63	In
Zs (ohmns)	4.80	4.00	2.40	1.60	1.50	1.20	0.80	0.75	0.60	0.53	0.48	0.38	24/In

Note: The circuit loop impedance given in the table should not be exceeded when the conductors are at their normal operating temperatures. If the conductors are at a different temperature when tested, the reading should be adjusted accordingly.

8.3.2.3 A disconnection time not exceeding 5s is permitted for a distribution circuit and a final circuit supplying only stationary equipment.

8.3.2.4 In clause 6.2.3.1.20, the formula is replaced by:

8.3.3 TT Systems

This applies to installations which are part of a TT system. In clause 6.2.3.1.24, the formula is replaced by:

8.3.4 Supplementary Equipotential Bonding

In clause 6.2.3.1.26, the formula is replaced by

8.3.4.1 Supplementary bonding shall connect all exposed and extraneous conductive parts which can be touched by livestock.

8.3.5 Protection against fire and thermal effects

8.3.5.1 For protection against fire, a residual current device having a rating of not more than 50mA shall be installed for the supply to equipment other than that essential to the welfare of livestock.

8.3.5.2 Heating appliances shall be kept at an appropriate distance from livestock and combustible material to minimize fire or risk of burns to livestock.

8.3.6 Selection and erection of equipment

8.3.6.1 External influences

Electrical equipment for normal use shall have at least IP44 degree of protection.

8.3.6.2 Devices for isolation and switching

A device for emergency switching shall be installed where it is inaccessible to livestock and will not be impeded by livestock. Account must be taken of conditions likely to arise in the event of panic by livestock.

8.3.6.3 Other Equipment

8.3.6.3.1 Electric fence controllers

(a) Mains operated electric fence controller shall comply and be installed in accordance with GS IEC 61011 and account shall be taken of the effects of induction when in the vicinity of overhead power lines.

(b) A mains-operated fence controller shall not be fixed to any supporting pole of an overhead power or telecommunication line, provided that, where a low voltage supply to an electric fence controller is carried by an insulated overhead line from a distribution board, the controller may be fixed to the pole carrying the supply.

(c) Every earth electrode which is connected to the earthing terminal of an electric fence controller shall be separate from the earthing system of any other circuit and shall be situated outside the resistance area of any electrode used for protective earthing.

(d) Not more than one controller shall be connected to each electric fence or similar system of conductors.

(e) Every electric fence or similar system of conductor and the associated controller shall be installed so that it is not liable to come into contact with any other equipment or conductor.

8.4 Restrictive conductive locations

The requirements of this Clause shall apply to installations within or intended to supply equipment or appliances to be used within a location that is conducting and in which freedom of movement is restricted.

8.4.1 Protection against direct and indirect contact

8.4.1.1 Protection against direct contact shall be provided only by

(a) barriers or enclosures to at least IP2X or IPXXB degree of protection; or

(b) insulation capable of withstanding 500V a.c rms for 60 seconds.

8.4.1.2 Protection against indirect contact shall be provided by one of the following:

(a) automatic disconnection in accordance with clause 6.2.3;

(b) electrical separation (clause 6.2.3.3) in which case only one socket or piece of equipment shall be connected to each secondary winding of the isolating transformer; or

(c) the use of Class II equipment adequately protected to an IP code in which case the circuit shall be further protected by a residual current device having the characteristics specified in clause 6.2.2.5.

8.4.1.3 A supply to or a socket intended to supply a hand lamp or hand-held tool shall be protected by SELV or electrical separation (clause 8.4.1.2(b)).

8.4.1.4 If a functional earth is required for certain equipment, for example measurement or control apparatus, equipotential bonding shall be provided between all exposed-conductive-parts, all extraneous-conductive-parts inside the restrictive conductive location, and the functional earth.

8.4.1.5 A supply to fixed equipment shall be protected by one of the methods listed in clause 8.4.1.2.

8.4.1.6 All sources of supply shall be situated outside the restrictive conductive location, unless it is part of a fixed installation which complies with clause 8.4.1.2 within a permanent restrictive conductive location.

8.5 Highway power supplies and street furniture

This section applies to installations that comprise of road distribution circuits, street furniture like road signs, street lights, and equipment located on roads, paths and public passages other than a part of a building.

8.5.1 Protection against electric shock

8.5.1.1 Where a measure for the protection against direct contact in accordance with clause 6.2.2 is used then protection against direct contact shall be provided in accordance with the following:

(a) clause 6.2.2 excepting protection by obstacles;

(b) placing out of reach for low voltage overhead lines only constructed to the standard required by the Electricity Distribution Utility; and

(c) other means excepting placing out of reach for the maintenance of street located equipment or street furniture by skilled persons specially trained.

8.5.1.2 A door in street furniture or street located equipment used for access to electrical equipment shall not be used as a barrier or an enclosure. To satisfy the purposes of protection against direct contact the requirements of clause 6.2.2.2.3 shall be applied.

8.5.1.3 Protection against indirect contact shall be done by:

(a) Earthed equipotential bonding and automatic disconnection of supply; or

(b) Class II equipment or by equivalent insulation. (Refer clause 6.2.3).

8.5.1.4 A maximum disconnection time of 5s shall apply to all circuits feeding fixed equipment used in highway power supplies.

8.5.1.5 Protection against indirect contact provided by using earthed equipotential bonding and automatic disconnection, metallic structures which are not part of the street furniture or street located equipment or connected to it shall not be connected to the main earthing terminal as extraneous conductive parts.

8.5.2 Devices for isolation and switching

8.5.2.1 Where isolation and switching is to be carried out only by qualified persons, the means of isolation shall be provided by a suitably rated fuse-carrier.

8.5.2.2 Where the supplier's cut-out is used as the means of isolation of a highway power supply the approval of the supplier shall be obtained.

Identification of electrical installation

8.5.3 On completion of highway distribution circuit and highway power supply, detailed records in accordance with clause 7.1.4.6 shall be provided with the Electrical Installation Certificate required by clause 9.5.

8.5.4 Installation of underground cables for highway power supply shall be as follows:

(a) A buried cable in the ground shall be of insulated concentric construction or shall incorporate an earthed armour or metal sheath or both;

(b) Buried cables, conduits and ducts shall be at a sufficient depth to prevent damage by ground disturbance; and

(c) Cable tiles, ducts and marking tapes used with cables shall be suitably colour coded or marked for identification purposes and shall be distinct from other services.

8.5.5 Highway power supply installations shall be subject to programmed inspection and testing procedure.

8.6 Temporary supplies

8.6.1 Temporary supplies taken from street furniture shall not reduce the safety of the permanent installation and shall generally be in accordance with clause 5.13.

8.6.2 On every temporary supply unit there shall be a durable label externally mounted stating the maximum sustained current to be supplied from that unit.

8.7 Installations in special structures

Every installation in a special structure shall have the basic requirements for safety as indicated in this Schedule. The following shall be used as general guidelines in the wiring of the underlisted specialized structures. However, other methods that can be demon-strated to ensure equal or better standards of safety may be permitted by the Electricity Distribution Utility. Refer to Annex C (drawing on mudhouse).

8.7.1 Mud Houses

8.7.1.1 To ensure that accessories like switches, socket-outlets, plugs, receptacles are firmly secured in position in mud houses, the following types of arrangements are recom-mended:

(a) conduit wiring with all accessories flush-mounted; or

(b) surface wiring mounted on a cement mixture reinforced section of the wall to ensure that surface mounted accessories are secure.

8.7.1.2 In cases where no suitable rigid facial arrangement exists to accept service lines direct from the Electricity Distribution Utility's pole, it is recommended that a treated wooden service pole of a minimum length of 7 m shall be mounted close to the mud house to be supplied.

8.7.1.3 The mounting height of meter and main switch shall be out of the reach of children, but shall be at a height acceptable to the Electricity Distribution Utility.

8.7.2 Thatched-roof structures

8.7.2.1 There shall be no direct mounting of wires or accessories on any thatched roof. All wiring shall be kept at a minimum of 20cm from the roof because of its combustible na-ture. A wooden support may be installed across the ceiling to which outlets, lights, and the like may be fastened.

8.7.2.2 In cases where the arrangement of thatched roof houses does not provide sufficient overhang protection for external fixtures, every light fitting or enclosure for main switch shall be of the weather-proof type.

8.7.3 Wooden structures

8.7.3.1 To prevent the premature deterioration of cables every fitting shall be mounted at least 20cm from the metal roof.

8.7.3.2 To ensure secure earthing, the earthing lead shall be mechanically protected by passing it through a conduit tube from the body of the structure to the point of connection to the earth electrode.

8.7.3.3 In cases where no rigid facial arrangement exists on the structure to accept service lines directly from the Electricity Distribution Utility's service pole, it is recommended that a wooden pole as described in clause 8.8.1.2 shall be used.

8.7.3.4 In cases where overhang facilities are not provided to afford protection from the weather, all external fittings shall be of the weather-proof type.

8.7.4 Metal structures

8.7.4.1 All wiring shall be of the surface conduit type; preferably PVC. Surface wiring may be permitted if wooden panels or strips are provided.

8.7.4.2 All wiring entering or leaving the metallic container must be protected by rigid conduit.

8.7.4.3 Apart from the circuit earthing, the body of the metallic container shall also be earthed with a minimum of 16 sq. mm copper conductor. In addition, the earthing lead shall be mechani-cally protected by passing it through a plastic tube from the body of the container to the point of connection to the earth electrode. Effective electrical earthing contact shall be provided by ensuring proper bonding at the metallic container and the earth electrode.

8.7.4.4 In cases where no rigid facial arrangement exists in metallic containers to accept service lines directly from the Electricity Distribution Utility's service pole, it is recommended that a wooden pole as described in clause 8.8.1.2 shall be used.

8.7.5 Play grounds

8.7.5.1 Every electrical installation work shall conform to the safety requirements of this clause. In particular, overhead conductors shall be of the insulated type and the construction work shall meet the standards approved by the Electricity Distribution Utility.

8.7.5.2 Every underground cable shall be properly buried to a minimum depth of 500 mm.

8.7.5.3 Every exposed fitting shall be of the weather-proof type and of the appropriate class of insulation. (see GS IEC 60536)

8.7.5.4 Wiring of temporary connections on fenced walls shall be avoided.

9 INSPECTION AND TESTING

Every electrical wiring shall be inspected and tested before being put into use. This shall also apply when any addition or alteration to the fixed wiring is made to any existing installation.

Precautions shall be taken to avoid danger to persons and damage to property and installed equipment during inspection and testing.

A completed and signed Electrical Installation Certificate together with the schedule of inspections and test results shall be given to the person ordering the work if the inspection and tests are satisfactory.

9.1 Inspection

The purpose of inspection is to verify that installed equipment is:

(a) appropriately selected and installed in accordance with the Standards contained in this Schedule; and

(b) not defective or visibly damaged so as to limit the risk of accident.

Inspection shall be done with that part of the installation under inspection disconnected from the supply. Inspection shall always precede testing.

9.1.1 The following checklist shall, where applicable to the installation, form the basis of inspection

(a) connection of conductors;

(b) identification of conductors;

(c) routing of cables in safe zones or protected against mechanical damage;

(d) selection of conductors for current-carrying capacity and voltage drop, in accordance with the design;

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

(f) correct connection of accessories and equipment;

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

(h) very neat and tidy connection of conductors and accessories;

(i) methods of protection against electric shock;

(j) protection against both direct and indirect contacts, as follows

(i) SELV; and

(ii) limitation of discharged energy;

(k) protection against direct contact (including measurement of distances where appropriate) as follows:

(i) protection by insulation of live parts;

(ii) protection by a barrier of an enclosure;

(iii) protection by obstacles;

(iv) protection by placing out of reach; and

(v) protection by PELV;

(l) protection against indirect contact as follows:

(i) earthed equipotential bonding and automatic disconnection of supply;

(ii) presence of earthing conductor;

(iii) presence of protective conductors;

(iv) presence of main equipotential bonding conductors;

(v) presence of supplementary equipotential bonding conductors;

(vi) use of Class II equipment or equivalent insulation; and

(vii) electrical separation;

(m) prevention of mutual detrimental influence;

(n) presence of appropriate devices for isolation and switching correctly located;

(o) presence of undervoltage protective devices where applicable;

(p) choice and setting of protective and monitoring devices for protection against indirect contact or protection against overcurrent;

(q) labelling of protective devices, switches and terminals;

(r) selection of equipment and protective measures appropriate to external influences:

(s) adequacy of access to switchgear and equipment;

(t) presence of danger notices and other warning signs;

(u) presence of diagrams, instructions and similar information;

(v) erection methods;

(w) requirements for special locations; and

(x) correct labelling of all appliance loads and circuits in space provided in switch board cover (legend).

9.2 Testing

Where a test fails, the installation shall be corrected and the test and any preceding test, the result of which could have been influenced by the fault indicated, shall be repeated to ensure compliance.

The following checklist, where applicable to the installation, shall form the basis of testing:

(a) continuity of all protective conductors;

(b) continuity of ring final circuit conductors;

(c) insulation resistance between live conductors and between each live conductor and earth;

(d) polarity;

(e) earth electrode resistance;

(f) earth fault loop impedance;

(g) prospective fault current; and

(h) functional testing of RCDs and RCBOs.

9.2.1 Sequence of tests

Tests shall be carried out in accordance with clauses 9.2.1.1 and 9.2.1.2:

9.2.1.1 Before supply is connected

(a) continuity of all protective conductors;

(b) continuity of ring final circuit conductors;

(c) insulation resistance between live conductors and between each live conductor and earth;

(d) polarity, by continuity methods; and

(e) earth electrode resistance, when using an earth electrode resistance tester.

9.2.1.2 With supply connected

(a) recheck of polarity;

(b) earth electrode resistance, when using a loop impedance tester;

(c) earth fault loop impedance;

(d) prospective fault current; and

(e) functional testing of RCDs and RCBOs.

9.2.2 The permitted test voltages for various circuits are indicated in Table 37. Minimum insulation resistance values measured with the test voltages indicated in Table 37 shall be considered satisfactory.

Table 37 —Minimum values of insulation resistance

Circuit nominal voltage(V) Test voltage d.c.(V) Minimum insulation resistance in M

SELV and PELV

Up to and including 500V with the exception of the above systems 250

500 0.5

2.0

9.3 Periodic inspection and testing

9.3.1 Periodic inspection and testing of all installations shall be mandatory. The frequency of inspection and testing shall be determined by the type of installation, its use, maintenance schedule and environmental influences.

9.3.2 Generally, periodic inspection and testing of installations shall be undertaken according to the following schedule:

(a) 10 years after initial installation and use;

(b) every 3 - 5 years after 10 years of initial installation and use up to 30 years; and

(c) every 2 years after 30 years of service.

9.4 Renewal of installation

9.4.1 Every installation after 30 years of use shall be thoroughly inspected and tested for possible renewal.

9.4.2 The relevant requirements of clauses 9.1 and 9.2 shall apply to renewed installations.

9.5 Certification and Reporting

Any defects or omissions revealed in the works shall be made good before a Certificate is issued.

Original certificates shall be given to the persons ordering the works and the duplicates retained by the contractors.

9.5.1 Electrical Installation Certificate

9.5.1.1 An Electrical Installation Certificate shall be prepared and signed by a qualified electrician duly certified in respect of the design, construction, inspection and testing of a new installation or for an alteration or addition to an existing installation where new circuits have been introduced.

9.5.1.2 The Electrical Installation Certificate shall indicate the responsibility for design, construction, inspection and testing.

9.5.1.3 The schedule of inspection and the schedule of test results shall be issued with the Electrical Installation Certificate to validate the Certificate.

9.5.2 Minor Electrical Installation Works Certificate

9.5.2.1 A Minor Works Certificate shall be prepared and signed by a competent person in respect of inspection and testing of an installation for which an alteration or addition does not extend to the introduction of a new circuit.

9.5.2.2 The Minor Works Certificate shall indicate the responsibility for design, construction, inspection and testing.

9.5.3 Periodic Inspection Report

9.5.3.1 A Periodic Inspection Report shall be prepared and signed by a qualified electrician duly certified in respect of inspection and testing of an installation.

9.5.3.2 The Periodic Inspection Report shall indicate the results and extent of a periodic inspection and test of an installation or any part thereof.

9.5.3.3 The Schedule Inspector and the Schedule of Test Results are issued by a person authorised by the electricity distribution utility who undertakes the inspection and testing with the Periodic Inspection Report to validate the Report.

ANNEX A

ELECTRICAL INSTALLATION CERTIFICATE (FORM A)

DETAILS OF THE CLIENT.....

.....

INSTALLATION ADDRESS .....

.....

.....

DESCRIPTION AND EXTENT OF THE INSTALLATION

(Tick boxes as appropriate)

Description of Installation:

Extent of installation covered by the Certificate:

(Use continuation sheet if necessary) see continuation sheet No..... New installation

Addition to an

existing installation

Alteration to an

Existing installation

FOR DESIGN

I/We being the person(s) responsible for the design of the electrical installation (as indicated by my/our signature below), particulars of which are described above, have exercised reasonable skill and care when carrying out the design hereby CERTIFY that the design work for which I/we have been responsible is to the best of my/our knowledge and belief in accordance with the Electrical Wiring Regulations.

The extent of liability of the signatory or the signatories is limited to the work described above as the subject of this Certificate.

For the DESIGN of the installation: **(Where there is mutual responsibility for the design)

Signature:.....Date:..... Name (IN BLOCK LETTERS):.....Designer No. 1

Signature:.....Date .....Name (IN BLOCK LETTERS):..... DesignerNo. 2**

FOR CONSTRUCTION I/We being the person(s) responsible for the construction of the electrical installation (as indicated by my/our signature below), particulars of which are described above, have exercised reasonable skill and care when carrying out the construction hereby CERTIFY that the construction work for which I/we have been responsible is to the best of my/our knowledge and belief in accordance with the Electrical Wiring Regulations.

This extent of liability of the signatory or the signatories is limited to the work described above as the subject of this Certificate.

For CONSTRUCTION of the installation:

Signature:.....Date:.....Name (IN BLOCK LETTERS):

.....Constructor

FOR INSPECTION AND TESTING

I/We being the person(s) responsible for the inspection and testing of the electrical installation (as indicated by my/our signature below), particulars of which are described above, have exercised reasonable skill and care when carrying out the inspection and testing hereby CERTIFY that the work for which I/we have been responsible is to the best of my/our knowledge and belief in accordance with the Electrical Wiring Regulations.

The extent of liability of the signatory or the signatories is limited to the work described above as the subject of this Certificate.

For INSPECTION AND TESTING of the installation:

Signature:.....Date: ..... Name (IN BLOCK LETTERS):..... Inspector

NEXT INSPECTION/We the designer(s), recommend that this installation is further inspected and tested after the interval of not more than .....years/months.

PARTICULARS OF SIGNATORIES TO THE ELECTRICAL INSTALLATION CERTIFICATE

Designer (No. 1)

Name:..... Company:.....

Location:.....

Postal address:.....Tel No:.....

Designer (No. 2)

(if applicable)

Name:..... Company:.....

Location:.....

Postal address:.....Tel No:.....

Constructor

Name:..... Company:.....

Location:.....

Postal address:.....Tel No:.....

Inspector

Name:..... Company:.....

Location:.....

Postal address:.....Tel No:.....

SUPPLY CHARACTERISTICS AND EARTHING ARRANGEMENTS Tick boxes and enter details as appropriate

Earthing Arrangements

T N-C

T N-S

TN-C-S

TT

Alternative source of supply (to be detailed on attached schedules) Number and type of Live Conductors

a.c. d.c.

1-phase, 2 wire 2-pole

2-phase, 3wire 3-pole

3-phase, 3 wire other

3-phase, 4 wire Nature of Supply Parameter

Nominal voltage, U/Uo (1).... V Nominal frequency, f(1) ..... Hz Prospective fault current, Io(2) ..kA External loop impedance Zo (2) ...

(Note (1) by enquiry, (2) by enquiry or by measurement) Supply Protective Device Characteristics

Type:

.....

Normal current rating

.....A

PARTICULARS OF INSTALLATION REFERRED TO IN THE CERTIFICATE

Tick boxes and enter details as appropriate

Means of Earthing

Supplier's facility

Installation earth Electrode Maximum Demand

Maximum demand (load) .....Amps

Details of Installation Earth Electrode (where applicable)

Type Location Electrode resistance to earth (e.g rod(s), tape, etc)

....

Main Protective Conductors

Earthing conductor: material ..... csa ..... connection verified

Main equipotential bonding

conductors material ..... csa ..... connection verified

To incoming water and/or gas service To other elements: .....

Main Switch or Circuit-breaker

GS, Type and No. of poles .....Current rating .....A Voltage rating .....V.

Location ..... Fuse rating or setting .....A

Rated residual operating current ..... mA, and operating time of ..... ms (at) (applicable only where an RCD is suitable and is used as a main circuit breaker)

COMMENTS ON EXISTING INSTALLATION (in the case of an alteration or addition see Regulation 743-01-04):.

.....

.....

.....

SCHEDULES

The attached Inspection and Test Result Schedules are part of this document and this Certificate is only valid when Test Result Schedules are attached to it.....Inspection Schedules and ..... Test Result Schedules are attached. (Enter quantities of schedules attached)

MINOR ELECTRICAL INSTALLATION WORKS CERTIFICATE

(REQUIREMENTS FOR ELECTRICAL WIRING REGULATIONS)

To be used only for minor electrical work which does not include the provision of a new circuit

PART 1: Description of minor works

1.Description of the minor works

2. Location/Address

3 Date of minor works completed

PART 2: Installation details

1. System earthing arrangement (where known) TN-C-S TN-S TT

2. Method of protection against indirect contact

3. Protective device for the modified circuit Type.....Rating .....A

PART 3: Essential Tests

Earth continuity satisfactory

Insulation resistance:

Phase/neutral .....M

Phase/earth .....M

Neutral/earth .....M

Earth fault loop impedance .....

Polarity satisfactory

RCD operation (if applicable). Rated residual operating currents .....mA

and operating time of ..... ms (at)

PART 4: Declaration

I/We CERTIFY that the said works do not impair the safety of the existing installation, that the said works have been designed, constructed, inspected and tested in accordance with the Electrical Wiring Regulations and that the said works, to the best of my/our knowledge and belief, at the time of my/our inspection complied with the Electrical Wiring Regulations except as detailed in Part 2.

Name:.....

For and on behalf of .....

Address: .....

.....

.....

Signature:.....

Position:.....

Date:.....

PERIODIC INSPECTION REPORT FOR AN ELECTRICAL INSTALLATION

(REQUIREMENTS FOR ELECTRICAL WIRING REGULATIONS)

DETAILS OF THE CLIENT

Client:.....
.....

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

Purpose for which this report is required:

.....
.....

DETAILS OF THE INSTALLATION (Tick boxes as appropriate)

Occupier:.....
.....

Installation:.....
.....

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

Description of Premises: Domestic Commercial Industrial Other

Estimated age of the Electrical Installation:..... years

Evidence of alterations or additions: Yes No Not apparent

If "Yes", estimate age: .....years

Date of last inspection:.....Records available Yes No

EXTENT AND LIMITATION OF THE INSPECTION

Extent of electrical installation covered by this report:

Limitations:

This inspection has been carried out in accordance with the Electrical Wiring Regulations. Cables concealed within trunking and conduits, or cables and conduits concealed under floors, in roof spaces and generally within the fabric of the building or underground have not been inspected.

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

DECLARATION

INSPECTED AND TESTED BY

Name.....
Signature:.....

For and on behalf of.....
Position:.....

Address: .....

Date:.....

SUPPLY CHARACTERISTICS AND EARTHING ARRANGEMENTS Tick boxes and enter details as appropriate

Earthing Arrangements

.....

T N-C

T N-S

TN-C-S

TT

Alternative source

of supply (to be detailed on attached schedules) Number and type of Live Conductors

.....

a.c. d.c.

1-phase, 2 wire 2-pole

2-phase, 3 wire 3-pole

3-phase, 3 wire other

3-phase, 4 wire Nature of Supply Parameter

.....

Nominal voltage, U/Uo(1)....V Nominal frequency, f(1) .....Hz Prospective fault current, Ipf (2) ..kA Eternal loop impedance Zo (2) ...

(Note (1) by enquiry, (2) by enquiry or by measurement) Supply Protective Device Characteristics

Type:.....

Normal current rating

.....A

PARTICULARS OF INSTALLATION REFERRED TO IN THE REPORT Tick boxes and enter details, as appropriate

Means of Earthing Suppliers facility Installation earth electrode Details of Installation Earth Electrode (where applicable)

Type Location Electrode resistance

(e.g. rod(s), tape, etc) to earth

....

Main Protective Conductors

Earthing conductor: material ..... csa .....

Main equipotential bonding material ..... csa .....

conductors

To incoming water service To incoming gas service To incoming oil service To structural steel

To lightning protection To other incoming service(s) (state details.....)

Main Switch or Circuit-breaker Main Switch or Circuit-breaker

GS, Type and No. of poles ..... Current rating ..... A Voltage rating..... V

Location ..... Fuse rating or setting .....A

Rated residual operating current = ...mA, and operating time of .....ms (at)

(applicable only where an RCD is suitable and is used as a main circuit breaker)

OBSERVATIONS AND COMMENDATIONS Tick boxes as appropriate

Recommendations as detailed below

Referring to the attached Schedule(s) of Inspection and Test Results and subject to the limitations specified at the Extent and Limitations of the Inspection section

No remedial work is required The following observations are made

.....
.....

.....
.....

.....
.....

.....
.....

One of the following numbers, as appropriate, is to be allocated to each of the observations made above to indicate to the person(s) responsible for the installation the action recommended

requires urgent attention requires improvement requires further investigation

does not comply with the Regulations. This does not imply that the electrical installation inspected is unsafe.

SUMMARY OF THE INSPECTION

Date(s) of the inspection:

.....
.....

General condition of the installation:

.....
.....

.....
.....

Overall assessment: Satisfactory /unsatisfactory

SCHEDULE(S)

The attached Inspection and Test Result Schedules are part of this document and this Report is only valid when Test Result Schedules are attached to it.

.....Inspection Schedules and ..... Test Result Schedules are attached

(Enter quantities of schedules attached)

ANNEX B

Schedule of Installation Methods of Cables (including Reference Method) (Form B)

FDGS 1009

Installation method

Examples Number	Description	Appropriate Reference Method for determining current-carrying capacity
1	2	3 4
Open and clipped direct:		
1	Sheathed cables clipped direct to or lying on a non-metallic surface	Method 1
In Conduit		
2	Single-core non-Sheathed cables in metallic or non-metallic conduit on a wall or ceiling	Method 3
3	Multicore cables having non-metallic sheath, in metallic or non-metallic conduit on a wall or ceiling	Method 3

The wall is assumed to consist of an outer waterproof skin, thermal insulation and an inner skin of plasterboard or wood-like material having a coefficient of heat transfer not less than 10

W/m3k. The conduit is flexed so as to be close to, but not necessarily touching, the inner skin. Heat from the cables is assumed to escape through the inner skin only.

Schedule of Installation Methods of Cables (including Reference Method) (Continued)

FDGS 1009

Installation method

Examples Appropriate Reference Method for determining current-carrying capacity

Number Description

1 2 3 4

4 Cables in conduit embedded in masonry, brickwork, concrete, plaster or the like (other than thermally insulating materials) Method 3

In trunking

5 Cables in trunking on a wall or suspended in the air Method 3

6 Cables in flush floor trunking Method 3

7 Single-core cables in skirting trunking Method 3

On trays:

8 Sheathed cables on a perforated cable tray, bunched and unenclosed. A perforated cable tray is a ventilated tray in which the holes occupy 30% or more of the surface area
Method 11

FDGS 1009

Schedule of Installation Methods of Cables (including Reference Method) (Continued)

Installation method

Examples Appropriate Reference Method for determining current-carrying capacity

Number Description

1 2 3 4

In free air, on cleats, brackets or a ladder:

9 Sheathed single-core cables in free air (any supporting metalwork under the cables occupying less than 10% of the plan area):

Two or three cables vertically one above the other, minimum distance between cable surfaces equal to the overall cable diameter (Da); distance from the wall not less than 0.5 Dc

Two or three cables horizontally, with spacings as above

Three cables in trefoil, distance between wall and surface of nearest cable 0.5 De or nearest cables 0.75 De

Method 12

FDGS 1009

Schedule of Installation Methods of Cables (including Reference Method) (Continued)

Installation method

Examples Appropriate Reference Method for determining current-carrying capacity

Number Description

1 2 3 4

Cables in building voids:

10 Sheathed cables in ducts or voids formed by the building structure, other than thermally insulating materials

Method 4

Where the cable has a diameter De and the duct has a diameter no greater than 5 De or perimeter not greater than 20 De

Method 3

Where the duct has either a diameter greater than 5 De or perimeter greater than 20 De

NOTE 1 — Where the perimeter is greater than 60 De, installation Methods 18 to 20, as appropriate, should be used.

NOTE 2 — De is the overall cable diameter. For groups of cables De is the sum of the cable diameters.

Cables in trenches:

11 Cables supported on the wall of an open or ventilated trench, with spacings as indicated for Reference Method 12 or 13 as appropriate Method 12 or 13 as appropriate

FDGS 1009

Schedule of Installation Methods of Cables (including Reference Method) (Continued)

Installation method

Examples Appropriate Reference Method for determining current-carrying capacity

Number Description

1 2 3 4

12 Cables in enclosed trench 450 mm wide by 300 mm deep (minimum dimensions) including 100 mm cover Two to six single core cables with surface separated by a minimum of one cable diameter.

One or two groups of three single-core cables in trefoil formation.

One to four 2-core cables or one to three 3 or 4 core cables with all cables separated by a minimum of 50 mm.

Method 18 Use rating factors in Table 6

FDGS 1009

Schedule of Installation Methods of Cables (including Reference Method) (Continued)

Installation method

Examples Appropriate Reference Method for determining current-carrying capacity

Number Description

1 2 3 4

13 Cables in enclosed trench 450 mm wide by 600mm deep (minimum dimensions) including 100 mm cover Six to twelve single-core cables arranged in flat of two or three on the vertical trench wall with cables separated by one cable diameter and a minimum of 50 mm between groups.

or

two to four groups of three single-core cables in trefoil formation with a minimum of 50 mm between trefoil formations

or

four to eight cables of 2-core or three to six cables of 3 or 4 cores with cables separated by a minimum of 75 mm

All cables spaced at least 25 mm from the trench wall.

Method 19 Use rating factor in Table 6

FDGS 1009

Schedule of Installation Methods of Cables (including Reference Method) (Continued)

Installation method

Examples Appropriate Reference Method for determining current-carrying capacity

Number Description

1 2 3 4

14 Cables in enclosed trench 600 mm wide by 760 mm deep (minimum dimensions) including 100 mm cover Twelve to twenty four single-core cables arranged in either

flat formation of two or three cables in a group with cables separated by one cable diameter and each cable group separated by a minimum of 50 mm either horizontally or vertically.

or

single core cables in trefoil Formation with each group or trefoil formation separated by a minimum of 50 mm either horizontally or vertically.

or

eight to sixteen 2-core cables or six to twelve cables of 3 or 4 with cables separated by a minimum of 75 mm either horizontally or vertically.

All cables spaced at least 25 mm from the trench wall

Method 19 Use rating factor in Table 6

Figure 2 — An Illustration of the Layout of Information for Company Registration Number (REG NO) And Ghana Standard Number (STD No.) on Mark of Conformity

THE GHANA STANDARDS CERTIFICATION MARK

HON, DR. JOE OTENG ADJEI

Minister responsible for energy

Date of Gazette Notification: 20th December, 2011.

Entry into force: 24th February, 2012.