FLYSHEET:

Volume 3B of 4 - Code for Electrical Installations in Buildings

THE REPUBLIC OF UGANDA

MINISTRY OF WORKS AND TRANSPORT

CODE FOR ELECTRICAL INSTALLATIONS IN BUILDINGS

B1

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FOREWORD

The mission of the Ministry of Works and Transport (MoWT) is to promote an adequate, safe and well maintained works and transport infrastructure and services so as to effectively contribute to the socio-economic development of the country.

In exercising this mission and in discharging its responsibilities, the Ministry is issuing a series of Design Manuals, Guidelines, Codes and Standards, of which the “Code for Electrical Installations in Buildings” is one part thereof.

The Code for Electrical Installations in Buildings will be a nationally recognized document which will serve as a standard reference for the regulation of design and construction of electrical installations and equipment in buildings.

The major benefits to be gained in applying this document are the harmonization of professional practice in the building construction in Uganda and curtailment of informal developments so as to ensure well-planned, well-maintained, safe, cost effective and decent building developments and human settlements throughout the country.

The Code will be periodically updated and new editions issued to cater for the dynamic technological developments in the construction industry.

Abraham Byandala
Minister of Works and Transport

December 2012

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Definitions

Alarm box control room: A facility from which the necessary firefighting measures can be initiated at all time.

Alerting facility : A facility which issues the fire alarm –e.g. by means of audible and visual signaling devices – and which is not contained in the fire alarm control and indicating panels.

Automatic fire alarm system: A system which detects the occurrence of fire in its incipient stage and immediately signals this without human intervention.

Automatic fire detector: A part of a fire alarm system which, either continually or at periodic intervals, observes a suitable physical and/or chemical identifier for detecting a fire in the monitored area.

Flame detector : A detector which responds to the radiation emitted in the air.

Fire identifier : Physical variables which are subject to measurable changes in the environment of a fire in its incipient stage; e.g. rise in temperature, smoke, flame radiation.

Fire alarm signal: A signal which alerts the fire fighting forces.

Fire alarm system : The entirety of the equipment and parts, matched for correct interaction, used in a fire alarm system.

False alarm : A fire alarm signal caused by technical malfunctions in the fire alarm system(alarm resulting from disturbance) or spurious alarms resulting from the fire detector being "mislead".

Heat detector : A detector which respond to an increase in temperature.

Non-automatic (manual) fire alarm devices: Alarm devices which can be used to initiate the fire alarm signals manually.

Smoke : Particulate product of combustion generated by fire, whether this be of smouldering or open-flame type.

Sounders: Devices in which electric signals are converted into sound signals.

Smoke detector : A detector which responds to products of combustion and/or pyrolysis (suspended matter) contained in the air.

PV cell: Basic PV device which can generate electricity when exposed to light such as solar radiation

PV module: Smallest completely environmentally protected assembly of interconnected PV cells

PV string: Circuit in which PV modules are connected in series, in order for a PV array to generate the required output voltage.

PV array: Mechanically and electrically integrated assembly of PV modules and other necessary components, to form a d.c. power supply unit.

PV array junction box:	Enclosure where all PV strings of PV array are electrically connected and where protection devices can be located if necessary.
PV generator:	Assembly of PV arrays
PV generator junction box:	Enclosure where all PV arrays are electrically connected and where protection devices can be located if necessary.
PV string cable:	Cable connecting PV modules to form a PV string.
PV array cable:	Output cable of a PV array.
PV d.c. main cable:	Cable connecting the PV generator junction box to the d.c. terminals of the PV inverter
PV inverter :	Device which converts d.c. voltage and d.c. current into a.c. voltage and a.c. current
PV supply cable :	Cable connecting the a.c. terminals of the PV inverter to a distribution circuit of the electrical installation.

SECTION 1 SCOPE AND DEFINITIONS

1.1 Scope

This Code for Electrical Installations and Equipment in Buildings establishes general principles for the wiring, selection, erection and testing of electrical installations for residential commercial and public premises. They are applicable to electrical installations that operate at a voltage up to and including 1000V a.c or d.c., supplied from the public supply or from a private generating plant.

a) residential, commercial and public premises, and
b) is applicable to electrical installations that operate at a voltage up to and including 1000V a.c. or d.c., and
c) are supplied from an external source or from a private generating plant.

1.2 Definitions

For the purpose of this Code, the following definitions shall apply:

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

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

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

Apparatus: An electrical apparatus, and includes all apparatus, machines and fittings in which conductors are used, or of which they form a part.

Authority: means Uganda Electricity Regulatory Authority.

Authorized person: a person employed or appointed, by the Authority to carry out certain duties incidental to the generation, distribution or use of electrical energy, such a person being competent for the purposes transmission in which the term is used, and holds an appropriate certificate of competency issued in accordance with the provisions of the Electricity Act of Uganda.

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

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.

Bonding conductor: A protective conductor providing equipotential bonding.

Building void, accessible: A space within the structure or the components of a building only at certain points.

Building void, non-accessible: A space within the structure or the components of a building which has no ready means of access.

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

specified distance.

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.

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 conductors and/or cables throughout their length during and after installation. A cable channel may or may not form part of the building construction.

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.

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

Cable ducting: A manufactured enclosure of metal or insulating material, other than conduit or cable trunking, intended for the protection of cables which are drawn-in after erection of the ducting.

Cable ladder: A cable support consisting of a series of supporting elements rigidly fixed to main supporting members. The supporting elements occupy les than 10% of the plan area.

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

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

Cable tunnel: An enclosure (corridor)containing supporting structures for conductors and or cables and joints and whose dimensions allow persons to pass freely throughout the entire length.

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

Ceiling rose: An accessory for connection to the fixed wiring of an installation to pass current to a lampholder or a luminaire by means of the conductors of a flexible cord.

Ceiling rose - surface type: A ceiling rose provided with a seating surface such that when mounted as intended it projects wholly outside the surface on which it is mounted.

Ceiling rose - semi-recessed or flush-type: A ceiling rose intended for mounting with its base partially or completely sunk into a box complying with BS 31, BS 4568: Part 2, BS 4607: Part 5 or BS 4662.

Circuit: An assembly of electrical equipment supplied from the same origin and protected against over current by the same protective device(s).

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 such as short-circuit currents. It is usually required to operate infrequently although some types are suitable for frequent operation.

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

Circuit protective conductor (cpc): A protective conductor connecting exposed-conductive-parts of equipment to the main earthing terminal.

Conduit: A part of a closed wiring system for cables in electrical installations, allowing them to be drawn in and/or replaced, but not inserted laterally.

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.

Consumer unit: A particular type of distribution board comprising a co-coordinated assembly for the control and distribution of electrical energy, principally in domestic premises, incorporating manual means of double pole isolation on the incoming circuits(s) and an assembly of one or more fuses, miniature circuit-breakers, residual current operated devices or signaling and other devices purposely manufactured for such use.

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.

Current-using equipment: Equipment which converts electrical energy into another form of energy, such as light, heat or motive power.

Danger: Risk of injury to persons (and livestock where expected to be present) 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.

Dead: At, or about, zero potential, and disconnected from any live system.

Direct contact: Contact of persons or livestock with live part which may result in electric shock.

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.

Distribution board: An assembly containing switching or protective devices (e.g. 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 signaling and other control devices. Means of isolation may be included in the board or may be provided separately.

Distribution circuit: A category I circuit connecting the origin of the installations to:-

a) an item of switchgear, or
b) an item of control gear, or
c) a distribution board to which one or more final circuits or items of current-using equipment are connected (see also definition 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.

Double insulation: Insulation comprising both basic insulation and supplementary insulation.

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

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.

Fault current: A current resulting from a fault.

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.

Flexible cable: A cable whose structure and materials make it suitable to be flexed while in service.

Flexible cord: A flexible cable in which the cross-sectional area of each conductor does not exceed 4 mm^2

Fuse carrier: The movable part of a fuse designed to carry a fuse link.

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

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

Fused plug: A plug having provision for a replaceable cartridge fuse link.

Fused socket-outlet: A socket-outlet having provision for a replaceable cartridge fuse link.

Indirect contact: A contact of persons or livestock with exposed-conductive-parts which have become live under fault conditions.

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

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.

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

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 purpose of this Code, a lamp holder, however supported, is deemed to be a luminaire.

Main earthing terminal: The terminal or bar provided for a connection of protective conductors, including equipotential bonding conductors, and conductors for functional

earthing, if any, to the means of earthing.

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 Code.

Non-rewirable plug: A plug so constructed that it forms a complete unit with the flexible cord after connection and assembly by the manufacturer of the plug.

Origin of an installation: The position at which electrical energy is delivered to an electrical installation.

Over-current: A current exceeding the rated value. For conductors the rated value is the current-carrying capacity.

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

Overload current: An over-current occurring in a circuit which is electrically sound.

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 Code.

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

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

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

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.

Public supply: The supply of electrical energy to the premises of any person by licensed electricity service provider.

Rewirable plug: A plug so constructed that a flexible cord can be fitted or replaced using general purpose tools.

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.

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

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.

Short-circuit current: An over-current resulting from a fault of negligible impedance between live conductors having a difference in potential under normal operating conditions.

Skilled person: A person with technical knowledge or sufficient experience to enable him/her to avoid dangers which electricity may create.

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.

Shutter: A movable device arranged to shield the current-carrying socket-outlet contacts automatically when a corresponding plug is removed.

Street furniture: Fixed equipment, located on a highway, the purpose of which is directly associated with the use of the highway.

Street located equipment: Fixed equipment, located on a highway, the purpose of which is not directly associated with the use of the highway.

Supplier: A person who supplies electrical energy, and, where electric lines and apparatus used for that purpose are owned otherwise than by that person, shall include the owner of those electric lines and apparatus.

Supplier's works: Electric lines, supports and apparatus of, or under the control of, a supplier used for the purposes of supply, and cognate expressions shall be construed accordingly.

Substation: Any premises, or that part of any premises in which electrical energy is transformed or converted to or from voltage above low voltage, except for the purpose of working instruments, relays, or similar auxiliary apparatus, if such premises or part of the premises are large enough for a person to enter after the apparatus is in position.

Switchboard passage-way: A passage-way or compartment large enough for a person to enter, and used in connection with a switchboard when live.

Switched socket-outlet: A socket-outlet with an associated switch to

disconnect the supply from the line socket contact or from both line and neutral socket contacts.

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 such as those of short-circuit. It may also be capable of making, but not breaking, short-circuit currents.

Switchboard: An assembly of switchgear with or without instruments, but the term does not apply to groups of local switches in final circuits.

Switchgear: Main switches, cut-outs or fuses, conductors and other apparatus in connection therewith, used for the purpose of controlling or protecting electrical circuits or machines or other current using appliances.

System: An electrical system consisting of a single source of electrical energy and an installation. For the purpose of this Regulation (Code), the system adapted shall be protective multiple earthing (PME), in accordance with the Uganda Electricity Distribution Company.

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

Extra-low voltage: Normally not exceeding 50 V a.c. or 120 V ripple free d.c., whether between conductors or to earth.

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

Medium voltage: Normally exceeding 1kv but not exceeding 35 kv.

High voltage: Normally exceeding 35kv but not exceeding 230 kv.

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

SECTION 2 GENERAL REQUIREMENTS

2.1 Administrative

2.1.1 In exercise of the powers conferred upon the Minister by Section 47 of the BuildingControl Act, this **Code for Electrical Installations and Equipment in Buildings** has been adapted and hereby orders and directs its observance.

2.1.2 This Code shall be cited as the **Code for Electrical Installations and Equipment in Buildings**.

2.1.3 Electrical contractors or other responsible for the carrying out the work shall obtain a permit from the Authority before commencing work with respect to installation, alteration, repair, or extension of any equipment

2.1.4 An application for inspection shall be fixed with the Authority on a form provided by the later at the time the permit is obtained.

2.1.5 A copy of the permit shall be posted in a conspicuous place on the site of the work and shall not be removed until the inspection is completed

2.1.6 The Authority shall be notified in writing by the electrical contractor that work is ready for inspection at such time or times as will permit inspection being made before any work or portion thereof is commenced.

2.1.7 Plans and specifications in duplicate or in greater number if required by the Authority, one copy to be retained by the Authority shall be submitted by the owner or his agent to, and acceptance obtained from, the Authority before work is commenced on:

a) wiring installation of residential, commercial, public buildings, and other establishments in which public safety is involved;.

b) large light and power installations and the installation or apparatus such as generators transformers switchboards, large storage batteries;

c) such other installations as may be prescribed by the Authority.

2.1.8 Where any electrical installation or part thereof to which electrical power or energy has not previously been supplied is made in or upon any land building or premises, where any electrical installation or part thereof has been disconnected or cut off from any service or other source of supply under this code, no Private Generating Plant, contractor or other person shall connect or reconnect the installation or part thereof to any service or other source of supply unless:

a) the installation and all work in respect thereof have been inspected by an authorized person;

b) a connection authorization has been issued by the Authority in respect of the installation.

2.1.9 The Authority reserves the right to re-inspect at any time electrical installation notwithstanding any previous inspection and acceptance, if and when it considers such action to be necessary.

2.1.10 The Authority may require such changes as may be necessary to be made to existing installations where, through hard usage wear and tear, or as a result of alteration or extensions, dangerous conditions have developed.

2.1.11 No one shall use any electrical equipment other than approved electrical

equipment of a kind or type and rating approved for the specific purpose for which it is to be employed.

2.1.12 In any case where deviation or postponement of the Regulation (Code) may be necessary, special permission shall be obtained before proceeding with the work, but this special permission shall apply only to the particular installation for witch it is given.

2.1.13 Even though approval has previously been granted, the Authority may reject, at any time any electrical equipment under any of the following conditions:

a) if the equipment is substandard with respect to the sample on which approval was granted;

b) if the condition of use indicate that the equipment is not suitable;

c) if the terms of the approval agreement are not being carried out.

2.1.14 Electrical equipment shall be installed as to insure that, after installation, there is ready access to nameplates and access to parts requiring maintenance.

2.1.15 No person shall interfere with any electrical installation or component thereof except when, in the course of alteration or repairs to non-electrical equipment or structures, it may be necessary to disconnect or move components of an electrical installation.

2.1.16 It shall be the responsibility of the person carrying out the alteration or repairs to issue that the electrical installation is restored to a safe operating condition as soon as the progress of the alterations or repair will permit.

2.2 Technical

2.2.1 Graphical symbols that are to be used in all drawings, wiring plans, etc. for electrical installation of buildings shall be issued by Authority having jurisdiction or reference may be made to other recognized Code of practice.

2.2.2 Proper coordination and collaboration between the architect, building engineer and the electrical engineer shall be effected from the planning stage of the installation.

2.2.3 The provisions that will be needed for the accommodation of substation, transformer, switch room, lift wells and other equipment rooms, service cable ducts, rising mains and distribution cables, sub-distribution boards, openings and chases in floor and walls for all required electrical installations etc. shall be specified in advance.

2.2.4 The ideal location of an electrical substation for a group of buildings would be at the load center and shall be located on the ground floor.

2.2.5 In multi–storeyed buildings, the substation shall preferably be installed on the lowest floor level, but direct access from the street for installation or removal of equipment shall be provided. The floor level of the substation or switch room shall be above the highest flood level of the locality. In this case, the load center would be somewhere between the geometrical center and the air-conditioning plant room.

2.2.6 The availability of power lines nearby may also be kept in view while deciding the location of the substation.

2.2.7 In allocating area of a substation it shall be noted that the flow of electric power is from supply company's line to transformer where required and finally to the

low voltage switchgear room. The layout shall be in accordance with this flow.

2.2.8 The following rooms are required in a substation:

a) switchgear room-Supply company's switchgear room and/or space for meters.
b) transformers room-The number and size of transformer rooms shall be ascertained from the total power requirement of the consumer where required.
c) stand-by generator room-A room for housing a stand-by generator in accordance with the requirement of the supplier where required.

2.2.9 In large installations other than where a substation is provided, a separate switch room shall be provided; this shall be located as closely as possible to the electrical load center and suitable ducts shall be laid with minimum number of bends from the point of entry of the supply to the position of the main switchgear.

2.2.10 The switch room shall be placed in such a position that rising ducts may readily be provided there from to the upper floors of the building in one straight vertical run.

2.2.11 In larger buildings, more than one rising duct and horizontal ducts may also be required for running cable from the switch room to the foot of each rising main.

2.2.12 Suitably segregated cable ducts shall be reserved for the electrical services which may, include low and extra-low voltage installations, such as bell call-systems; fire alarm and computer net work system and telephone installations.

2.2.13 The electrical control gear distribution boards and other apparatus, which are required on each floor, may conveniently be mounted adjacent to the rising mains, and adequate space should be provided at each floor for this purpose.

2.2.14 Information regarding provision for and location of PBX/PABX shall be obtained from the relevant authority and adequate space should be provided for the installation of the boards.

2.3 Planning and Designing

2.3.1 The design and planning of an electrical installation shall take into account all the prevailing conditions which may include some or all of the following:

a) type of supply;
b) envisaged load having regard to the requirements of the owner or occupant;
c) the probable modifications and future extensions;
d) the degree of electrical and mechanical protection necessary;
e) the probable operation and maintenance cost taking into account the electricity supply tariffs available;
f) the relative cost of various alternative methods;
g) the need for radio and telecommunication interference abatement.

2.3.2 The electrical layout should be considered after proper locations of all outlets for lamps, fans, and appliances- both fixed and transportable, motors, etc, have been selected and best methods of wiring determined.

2.3.3 All runs of wiring and exact positions of all points of switch-boxes and other

outlets shall be first marked on the plans of the building and approved by the engineer in charge or the owner before the actual commencement of the work.

2.3.4 The design of electrical installation shall insure:

a) the protection of persons livestock and property;
b) the proper functioning of electrical installation for the intended use.

2.3.5 The information required as a basis for design shall be:

a) nature of current; a.c and/or d.c
b) nature and number of conductors:
   i) fora.c
      - phase conductor(s)
      - neutral conductor;
      - protective conductor,
   ii) ford.c
      - conductors equivalent to those listed above
c) voltage and voltage tolerances;
d) frequency and frequency tolerances;
e) maximum current allowable
f) prospective sort-circuit current;
g) nature of demand;
h) emergency supply or supplies;
i) environmental conditions;

2.3.6 The design shall comply with the requirements of this Regulation (Code).

2.3.7 Each piece of electrical equipment shall bear such of the following markings as may be necessary to identify the equipment and ensure that it is suitable for the particular installation.

a) the maker's name, trademark or other recognized symbol of identification;
b) catalogue number or type;
c) voltage;
d) rated load amperes;
e) watts volt-amperes or horsepower;
f) whether for d.c ,a.c or both;
g) number of phases;
h) frequency in Hertz;
i) rated load speed in revolution per minute;
j) designation of terminals;
k) whether for continuous or intermittent duty;
l) evidence of approval;
m) such other marking as may be necessary to ensure safe and proper operation.

2.3.8 Each service box, at the time of installation, shall be marked in a conspicuous, legible and permanent manner to indicate clearly the maximum rating of the over-current device which may be used for this installation.

2.3.9 At each distribution point, circuit breakers, fuses and switches shall be marked, adjacent thereto, in a conspicuous and legible manner to indicate clearly:

a) which installation or portion of installation they protect or control;
b) the maximum rating of over-current device that is permitted.

SECTION 3 METHODS OF INSTALLATION

3.1 General

3.1.1 Requirements for approval of building plans shall include drawings, for electrical installations and equipment in accordance with Section 2, Clause 2.1 (8).

3.1.2 All works shall be finished, completed and ready for service. It shall be tested in accordance with this Code and to the satisfaction of the Building Committee, through its nominated supervising officer.

3.1.3 The Contractor shall supply all superintendence and labour, skilled and unskilled, necessary to carry out the work in the best possible manner. Trade custom in the various classes of work must be followed.

3.1.4 All of the installation and components thereof shall be in accordance with the latest edition of and current amendments to:-

(a) "Regulations for the Electrical Equipment of Buildings", issued by the Institution of Electrical Engineers (IEE), Great Britain;

(b) Uganda Government Electricity Rules currently in force.

3.2 Fundamental Requirements for Safety

3.2.1 Workmanship and Materials

3.2.1.1 All Equipment shall be constructed, installed and protected and shall be capable of being maintained, inspected and tested, so as to prevent danger so far as is reasonably practicable.

3.2.1.2 All equipment shall be suitable for the maximum power demanded by the current-using equipment when it is functioning in its intended manner.

3.2.1.3 All electrical conductors shall be of sufficient size and current carrying capacity for the purpose for which they are intended.

3.2.1.4 All conductors shall either be insulated and where necessary further effectively protected or be so placed and safeguarded as to prevent danger, so far as is reasonably practicable.

3.2.1.5 All conductors and equipment likely to be exposed to weather, corrosive and explosive atmospheres, inflammable surroundings, or other adverse conditions shall be so constructed or protected as may be necessary to prevent danger arising from such exposure.

3.2.2 Protective Devices

3.2.2.1 Every installation and every circuit thereof shall be protected against over current by devices which:

a) will operate automatically at values of current which are suitably related to the safe current rating of the circuit, and
b) are of adequate breaking capacity and where appropriate, making capacity, and
c) are suitably located and are constructed so as to prevent danger from overheating, arcing or the scattering of hot particles when they come into operation, and

d) to permit ready restoration of the supply without danger.

3.2.2.2 Every switch, circuit-breaker, and isolating link shall be:

(a) so constructed, placed or protected as to prevent danger;
(b) so constructed and adjusted as accurately to make and to maintain good contact;
(c) provided with an efficient handle or other means of working, insulated from the system and so arranged that the hand cannot inadvertently touch live metal;
(d) so constructed or arranged that it cannot accidentally fall or move into contact when left out in off position.

3.2.2.3 Every switch intended to be used for breaking a circuit and every circuit-breaker shall be so constructed that it cannot with proper care be left in partial contact. This applies to single pole, double-pole, or multi-pole switches or circuit.

3.2.2.4 Efficient means, suitably located, shall be provided for cutting off all voltage from every part of a system as may be necessary to prevent danger.

3.2.2.5 Every fuse shall have a fusible metal that shall be readily renewed without any danger.

3.2.2.6 Every electrical joint and connection shall provide durable electrical continuity, insulation and adequate mechanical strength.

3.2.2.7 Where one of the conductors of a system is connected to earth, no single-pole switch, other than a link for testing purposes or a switch for use in controlling a generator, shall be placed in such conductor or any branch thereof.

3.2.2.8 A switch or automatic or other cut-out may, however, be placed in the connection between the conductor and earth at the generating station, for use in testing and emergencies only.

3.2.3 Portable Appliances

3.2.3.1 Every flexible wire for portable apparatus shall be connected to the system either by efficient permanent joints or connections or by a properly constructed connector.

3.2.3.2 The metal-work of a portable apparatus, pendant lamps with switches and any flexible metallic covering of the conductors shall be efficiently earthed.

3.2.3.3 A lamp holder shall not be in metallic connection with the guard or other metal-work of a portable or pendant lamp.

3.2.3.4 Any portable apparatus and its flexible wire shall be controlled by efficient means suitably located and capable of cutting off the supply.

3.2.3.5 Where the voltage exceeds low voltage the metal-work shall be efficiently earthed independently of any flexible metallic cover of the conductors and any such flexible cover shall itself be independently earthed.

3.3 Switchboard and Switchgear

3.3.1 General

3.3.1.1 Switchboards for the control of equipment rated at 240V/415V shall conform with BS 5486 (IEC 60439: Part1). Panels shall be free standing of uniform height, flush mounted and totally enclosed protection class not less than IP 43 in accordance with BS 5420:1977.

3.3.1.2 Each switchboard shall be controlled by a suitable isolating switch/circuit breaker. The general arrangement of switchboards shall, so far as is practicable, be such that:

a) all parts which may have to be adjusted or handled are readily accessible;
b) the course of every conductor may where necessary be readily traced;
c) conductors not arranged for connection to the same system are kept well apart,and can, where necessary, be readily distinguished;
d) all bare conductors are so placed protected as to prevent danger from accidental short circuit.

3.3.1.3 The following equipment may be housed in the panels as required and where applicable:

a) ammeters, voltmeter and selector switches for incoming supply;
b) main incoming circuit breaker;
c) moulded-case (MCCB) and miniature (MCB) circuit breakers for power socket lighting ; etc.
d) automatic changeover contactor unit for stand-by generator;
e) auxiliary facilities like emergency power shut-off, under voltage relay release and power factor correction;
f) any other equipment necessary for proper operation of the system.

3.3.1.4 The base of the panel shall be effectively sealed against the ingress of vermin and termites, and all equipment shall be rated for continuous operation in a tropical climate. Any ventilation louvers shall be backed by brass fine mesh gauze to exclude termites.

3.3.1.5 Framework for the panels shall be of welded construction and panels shall be fabricated from mild steel sheet of 2mm minimum thickness, folded and braced where necessary to provide a rigid structure.

3.3.1.6 All bolts, nuts, screws, hinges, handles etc shall be corrosion resistant. Interiors shall be furnished white, and the exterior shall be furnished to light grey shade except the plinth which shall be black.

3.3.1.7 Cabling access shall be from the rear by means of gasketted bolt-on plates, which shall be fitted with handles to facilitate removal/replacement. Access to the cubicles or cubicles compartments for all normal routine maintenance shall be from front by hinged and lockable doors fitted with neoprene gaskets (all gaskets shall be termite resistant) and chromium plated lockable tee type handles. All doors shall be electrically bonded to the main frame, using adequate flexible conductors, protected against mechanical damage.

3.3.1.8 All locks on a given panel unit shall be operated by the same key. Each multi-compartment control panel shall comprise an assembly of individually constructed cubicles. These shall be assembled to include a metallic sheet between adjacent cubicles. In each multi-compartment panel at least one empty compartment shall be provided for future use.

3.3.1.9 Panels shall be readily capable of extension at either end, within the bus bar rating. Where panel size is excessive, easily handled sections shall be supplied for site assembly. Sections shall be fitted with eyebolts, which after positioning of the panel, shall be removed and replaced with plated bolts and washers.

3.3.1.10 All bus-bars shall be of electro tinned copper, and shall be of uniform section throughout the length of the panel. They shall be run in a separate screened compartment divided with barriers into as many compartments as there are cubicles in the panel. Access to individual compartments shall be via bolt-on cover plates each bearing the legend in white on a red background:-"DANGER" – "LIVE BUS-BARS," also the red arrow symbol denoting danger from electric shock. The neutral bus-bars shall be not less than half the cross sectional area of the base bars. Phase bus-bars shall be colour coded Red, Yellow and Blue. The neutral shall be black.

3.3.1.11 Panels shall be equipped with an electro tinned earth running the full length of the panel rated to withstand without damage, the thermal and dynamic effects of earth fault currents, minimum size shall be 25 x 3mm.

3.3.1.12 The contractor shall be responsible for ensuring that all components, sub-assemblies, gland plates, etc are solidly bonded to earth using green/ yellow PVC insulated copper conductors of appropriate cross sectional area. Reliance on metal to metal joints for electrical continuity will not be accepted.

3.3.1.13 Surge arresters shall be installed on the 240V/415V bus-bar of the LV panel. They shall be connected permanently between each phase and earth and shall be as near as possible to the incoming circuit breaker. Each unit shall be seated and encapsulated with connecting tails and be suitable for continuous operation at 400V.

It shall also comply with class 2.5KA requirements according to IEC 60099: Part1. All solid state control or electronic devices which may be located within panel, shall be individually protected by surge arresters.

3.3.1.14 Suitably sized compression type cable gland shall be provided for all cables. Glands used for armoured cable shall include provision for sealing the armour wires to protect them from corrosion and to prevent ingress of moisture into the cable. Brass lugs shall be provided for connection of the cable armouring to earth. Adequately sized blank gland plates shall be provided below each out going terminal section to accommodate the requisite glands. Gland plates shall be positioned 200mm minimum above the base of the cubicle, and shall be solidly bonded to earth.

3.3.1.15 All indicating instrument shall be moving iron type with a quadrant scale of minimum length 75 mm and conform to IEC 60051. Their accuracy shall be to class 2.5 or better. Main switchboards and control panels shall be equipped with voltmeter and ammeter

selection switches. All instruments and protective relays shall be flush mounted and effectively sealed against ingress of moisture, dust and insects.

3.3.1.16 Control and selector switches shall have their positions clearly labeled and additional shall each have a separate label to indicate the switch function. Label shall correspond with the associated schematic diagrams.

3.3.1.17 Interlocks of a substantial mechanical type shall be provided on each cubicle between door and the circuit breaker or fused switch such that the door cannot be opened unless the circuit breaker or fused switch is in the off position. ON/ OFF switches and circuit breakers shall be pad-lockable in the 'OFF' position.

3.3.1.18 Push buttons and indication lamps shall be selected from a matching range and they shall be colour coded in compliance with IEC 60073 as follows:

Indicating Lamps	**Colour**
On	White
Off	Green
Fault	Red
Alarms	Yellow
Heaters	Blue

Push Buttons	**Colour**
Start	Green
Stop	Red
Alarm accept	Black
Emergency stop	Red

3.3.1.19 Each indicating lamp shall incorporate a push-test feature. Alternatively a test push button shall be provided which activates all lamps simultaneously via a contactor. Lamp fittings shall be capable of pre-lamping from the front of the panel, and shall be positively locked against rotation.

3.3.1.20 Fault indicating lamps shall remain on until the associated trip relay is reset or the fault is corrected. Should there be an interruption to the electricity supply, all fault indicating lamps will again be illuminated on reconnection of the supply, until the fault is cleared or the trip relay is reset.

3.3.1.21 At exposed terminals on the rear of door mounted components shall be shrouded to prevent accidental contact when the panel doors are open. Component labels shall also be of laminated plastic and shall show the reference by which it is identified on the schematic diagram.

3.3.1.22 When an item of switchgear is required by the Code to disconnect all live conductors of a circuit, it shall be of a type such that the neutral conductor cannot be disconnected or reconnected before the phase conductors.

3.3.1.23 All switchgears shall be of 240 volt or 415 volt grade according to application. It shall be single pole and neutral, double pole and neutral, triple pole and neutral, and quad pole and neutral, as specified in the bill of quantities.

3.3.1.24 Consumer units shall comply with BS EN 60439. Miniature Circuit Breaker that comply with BS EN 60898 shall be used ,but Cartridge fuse links, fuse carriers, bases and associated parts that comply with BS 1361 may be used in the installation as specified and agreed by the Engineer. Residual current operated circuit breakers (RCCB) that comply with BS 4293 shall be included to give added protection against earth faults.

3.3.1.25 Three phase switchgear terminals shall be connected with phases red, yellow and blue in that order from left to right.

3.3.1.26 All main gear is to be sign-written with the place of isolation if remote from isolation.

Complete fuse charts shall be fixed in lids or mounted adjacent to all distribution boards.

3.3.1.27 Labels engraved "DANGER 415 VOLTS" shall be attached to all three phase switches and distribution gear.

3.3.2 Isolation (Protection against direct contact)

3.3.2.1 Every switchboard having bare conductors normally so exposed that it may be touched, shall, if not located in an area or areas set apart for the purpose, where necessary be suitably fenced or enclosed.

3.3.2.2 No person except an authorized person, or a person acting under his immediate supervision, shall have access to any part of an area so set apart.

3.3.2.3 All apparatus appertaining to a switchboard and requiring handling, shall so far as is practicable be so placed or arranged as to be operated from the working platform of a switchboard.

3.3.2.4 All measuring instruments and indicators connected therewith shall, so far as is practicable, be so placed as to be observed from the working platform. If such apparatus be worked or observed from any other place, adequate precautions shall be taken to prevent danger.

3.3.2.5 Where bare conductors are exposed and arranged in such a way that they shall be touched when live, a clear and unobstructed passage-way, free from danger, of ample width and height, with a firm even floor shall be provided

3.3.2.6 Where necessary to prevent danger, adequate precautions shall be taken either by earthing or by other suitable means to prevent any metal other than the conductor from become electrically charged.

3.3.2.7 Adequate precautions shall be taken to prevent any conductor or apparatus from being accidentally or inadvertently electrically charged when persons are working thereon.

3.3.2.8 Insulating stands or screens shall be provided and kept permanently in position, and shall be maintained in sound condition.

3.3.2.9 Portable insulating stands, screens, boots, gloves or other suitable means shall be provided and used when necessary to prevent danger, and shall be periodically examined by an authorized person.

3.3.2.10 Adequate working space and means of access, free from danger, shall be provided for all apparatus that has to be worked or attended to by any person.

3.3.2.11 All those parts of premises in which apparatus is placed shall be adequately lighted to prevent danger.

3.3.2.12 No person except an authorized and competent person over the apparent age of twenty or acting under his immediate supervision shall undertake any work such as repair, alteration, extension, cleaning or such work where technical knowledge or experience is required

3.3.2.13 Where a contractor is employed, and the danger to be avoided is under his control, the contractor shall appoint the authorized person, but if the danger to be avoided is under the control of the occupier, the occupier shall appoint the authorized person.

3.3.2.14 Every substation shall be substantially constructed and shall be so arranged that no person other than an authorized person can obtain access thereto otherwise than by the proper entrance, or can interfere with the apparatus or conductors therein from outside.

3.3.2.15 Every substation shall be provided with efficient means of ventilation and, in the cases of open-air substations, it shall be kept dry.

3.3.2.16 Every substation shall be under the control of an authorized person, and none but an authorized person or a person acting under his immediate supervision shall enter any part thereof where there may be danger.

3.3.2.17 Every underground substation not otherwise easily and safely accessible shall be provided with adequate means of access by a door, or trap door, with a staircase or ladder securely fixed and so placed that no live part of any switchboard or any bare conductor shall be within the reach of a person thereon

3.3.2.18 Instructions in the prescribed form as to the treatment of persons suffering from electric shock shall be affixed in all premises where electrical energy is generated, transformed, or used above low voltage; and in such premises or classes of premises in which electrical energy is generated, transformed or used at or below low voltage as the Responsible Officer may direct.

3.3.2.19 Occupiers and contractors shall ensure that authorized or competent persons employed by them are conversant with these instructions.

3.3.3 Cable Terminations to Switch Gear

3.3.3.1 Unless instructed otherwise by the Engineer cable termination boxes to switchgear shall be supplied and fixed under a separate contract. The cable contractor will however be required to make the cable terminations and supply all necessary compounds, solder, tape and bonding materials.

3.4 Wiring and Wiring Accessories

3.4.1 Cable Wiring

3.4.1.1 Wiring of the main and final sub-circuits shall be carried out in PVC insulated and PVC sheathed cables as specified on the drawings or contract documents.

3.4.1.2 All cables shall be manufactured and tested in accordance with BS 2004(US 602 and 605) with the exception that the conductors need not necessarily be tinned.

3.4.1.3 `All cables shall be of a minimum 240 volt grade unless stated otherwise and not less than 1mm^2.

3.4.1.4 The final sub-circuit wiring for all services shall be of such cross-section that the permissible voltage drop as allowed for in the IEE Wiring Regulations current Edition is not exceeded.

3.4.1.5 Calculations shall be based on final sub-circuit distribution board to the last point in the circuit. Note: mains and sub-mains have been calculated for in this arrangement.

3.4.1.6 No cables forming sub-circuits connected to different distribution boards are to be drawn in the same conduit or draw-in box.

3.4.1.7 No reduction of the number of strands forming the conductors will be allowed at switch or other terminals, and all strands shall be efficiently secured by screws or nuts and washers or some other approved method.

3.4.1.8 No cables shall be installed within 300mm of galvanized iron roofs when run on surface unless authorized by the Engineer.

3.4.1.9 Unless otherwise specified, all outdoor wiring shall be carried out in PVC cables buried underground and protected by conduit or other suitable means where rising above ground.

3.4.1.10 Unless specifically indicated on the drawing, not more than one phase of the a.c. installation shall be brought into a switch, ceiling rose or socket-outlet or other fitting in the lighting or single phase power circuits.

3.4.1.11 All flexible conductors to lighting fittings etc. shall be visible without exception.

3.4.1.12 Cable joints shall be kept to a minimum in any part of underground wiring system. However, where such joints are unavoidable and are specified on the drawings or are deemed to be necessary by the Engineer they shall be "made off" to an approved terminal block, of approved current rating for the associated cable, housed within a suitable case or box.

3.4.1.13 Connections between flexible cables and conduit wiring shall be made by means of an approved connector secured in a suitable case or box.

3.4.1.14 Lighting switches shall be connected in the phase line of all circuits.

3.4.1.15 Ceiling switches when called for shall be fixed at a distance of not less than 300mm from the point they control and shall not foul the associated fitting.

3.4.1.16 Sheathed cables without conduit protection shall only be used when they are approved by the Building Committee.

3.4.1.17 Sheathed cables shall be secured to the surface of walls and ceiling by means of saddles or clips with brass pins where fixed to wood, screws in other positions.

3.4.1.18 Where the materials of a building are unsuitable for direct cable mounting, timber battens shall be provided by the main building contractor for securing cables.

3.4.1.19 Electrical contractors shall supply and fix timber battens on contracts where building contractors are not present. The maximum spacing of saddles or clips shall comply with current IEE Wiring Regulations. Cable sheathing shall be carried well into all accessories such as junction boxes, control gear, cases, etc.

3.4.1.20 Where sheathed cables pass through ceilings, the holes shall be made good to prevent any possibility of the spread of fire.

3.4.1.21 Where cables pass through walls and floors, the holes shall be fitted with sleeves with bushed or belled ends to avoid any possibility of damage to the cables.

3.4.1.22 Where switchgear is mounted on the external surface of buildings, all cables entering the building must be enclosed in conduit.

3.4.1.23 Where a building is fed by an overhead line distribution system, the service cable shall be led to the switchgear in conduit with "swan neck" and "bell mouth" at take off, and constructed in such a fashion as to prevent the ingress of moisture.

3.4.1.24 Flexible cords shall be: -

a) not less than 0.75mm^2,
b) fire resistant
c) manufactured and tested in accordance with BS 6007 and BS 6500, and particular attention must be paid to the application of Regulations BS 36 of the current IEE regulations.

3.4.1.25 Unless otherwise stated on contract documents, cables shall be coloured as follows:-

(a) Red phase : Red /Brown
Yellow phase : Yellow/Brown
Blue phase : Blue /Brown
Neutral : Black/Blue
(b) d.c. positive: Red/Brown ,d.c. negative Black /Blue
(c) Earth wire in all circumstances: Green / Yellow

When brown is used phases shall be clearly marked or taped.

3.4.2 Cable Trunking

3.4.2.1 Trunking of all sizes shall be secured at intervals of not more than 1200mm, and joints shall overhang fixings by more than 600mm.

3.4.2.2 All tees and bends shall leave the trunking trough clear of obstructions and continuously open except when passing through walls and floors.

3.4.2.3 When trunking passes through walls, floors and ceilings, the covers shall be solidly fixed to 13mm of either sides of walls, and 150mm of either side of floors and ceilings.

3.4.2.4 No trunking shall be installed with its cover on the underside unless detailed onthe drawing or authorized by the Engineer.

3.4.2.5 Screws and bolts securing trunking covers shall be so designed that damage to cables cannot occur when fixing covers in position by such screws and/or bolts.

3.4.2.6 Adjoining sections of trunking shall be tightly secured and joined by copper bending links. The trunking shall be electrically and mechanically continuous throughout its length.

3.4.2.7 Where switchgear and fuse boards, etc., are secured to trunking, such connections shall be made by necks and not by multiple conduit couplers unless specifically authorized by the Engineer.

3.4.2.8 Where trunking is slotted to receive connecting necks, gaskets made from synthetic resins bonded fabric to BS 2966, 20mm smaller than the trunking, shall be fixed in position to prevent abrasion to cables on sharp edges.

3.4.2.9 Where cables are installed in trunking, each group of cables comprising a circuit shall be half hitched at 600mm intervals , and the circuit reference identified with "Elasso" or similar approved tape at 1800mm intervals on straight runs and 150mm back from tees and bends.

3.4.3 Conduit Wiring

3.4.3.1 All conduit and conduit fittings shall be manufactured and tested in accordance with the requirements of BSEN 60423, BS 731 and BS 31 Class B, and all conduit boxes shall be provided with covers.

3.4.3.2 All conduit and conduit fittings shall be of heavy gauge, solid drawn or welded steel, galvanized or sheradised when run externally; black enamel or "high impact" rigid grade plastic where run internally.

3.4.3.3 Where internal surface conduit is detailed in the case of bathrooms, kitchens, laundries, ducts and any damp disputations, galvanized conduits shall be used. Plastic conduit may be used on the surface upon approval of the Building Committee.

3.4.3.4 Conduit shall not be less than 20mm diameter.

3.4.3.5 Fixing screws for all conduits, switches and box covers shall be made of brass or sheradised.

3.4.3.6 "Spacer bar" type saddles shall be used for fixing of conduit on the surface of walls and ceilings.

3.4.3.7 Spacing of saddles shall be such as to give adequate support. Saddles shall be installed within 300mm either side of conduit boxes where the free length of conduit exceeds this distance.

3.4.3.8 Multiple saddles shall be used where two or more surface conduits run parallel and adjacent to each other.

3.4.3.9 Where conduit passes through a floor, wall, partition or ceiling, the fabric shall be made good with cement or the fabric medium to the thickness of floor, wall, etc.

3.4.3.10 Where conduits terminate at a main switchboard, distribution board, consumer unit, box or any metal-clad accessory, screwed sockets shall be used and so arranged as to be in good mechanical and electrical contact with the metal case, with internal brass male bushes into the sockets from the inside of the case and the two locked together.

3.4.3.11 All conduit bends are to be made on site and not more than two right angle bends will be permitted without the inter-positioning of a draw box.

3.4.3.12 Conduits that are concealed in the building fabric shall be arranged as a "looping- in" system and no elbows, tees or bends, solid or inspection type, shall be employed.

3.4.3.13 Conduits shall be kept at least 150mm clear of gas piping and colour coded where required.

3.4.3.14 Conduits shall be kept at least 150mm clear of steam and hot water systems and preferably installed beneath the gas piping and hot water systems services.

3.4.3.15 Care should be taken when installing conduit to see that the enamel is removed from threads and from the interior of the fitting to ensure good connection.

3.4.3.16 The interior of conduit ends shall be rendered free from burrs and sharp edges. Where threads are exposed on conduit after it has been screwed into equipment, all such threads shall be painted with an approved paint to prevent rusting.

3.4.3.17 Conduit runs shall be complete before wiring is started and shall not be dismantled for wiring operations.

3.4.3.18 Conduit used in flameproof installations shall be of the solid drawn type.

3.4.3.19 Where conduit crosses expansion joints, the contractor shall provide expansion couplers. He shall run an earth wire between the nearest conduit box from each side of the coupling. This earth wire shall be solidly bonded at each box.

3.4.4 MountingHeights of Wiring Accessories

3.4.4.1 The approximate positions of lighting fittings, socket outlets, main switchgear and distribution boards shall be indicated on the drawings.

3.4.4.2 The contractor shall determine the exact positions of any conduit runs, when necessary, in consultation with the Engineer and with the local power supply authority.

3.4.4.3 Switchgear, distribution boards and consumer units shall, unless detailed to the contrary, be mounted with the lower edge 2000mm from the finished floor level.

3.4.4.4 Light switches, other than ceiling switches, shall be fixed at 1400mm to centre of switch above finished floor level.

3.4.4.5 Isolators and switch fuses other than those mounted on bus bar chambers or providing local control shall be unless otherwise stated on the drawings, fixed at 1400mm from finished floor level to underside of fitting.

3.4.4.6 Switched-socket-outlets and socket outlets in offices and corridors shall, unless otherwise specified, be fixed 300mm above finished floor level to underside of fittings.

3.4.5 Ceiling Roses and Lamp Holders

3.4.5.1 Ceiling roses shall be of best quality white bakelite to BS 67.

3.4.5.2 Unless otherwise stated in the contract documents, all lamp holders shall be of the "bayonet cap" BS 7895 and BS EN 61184 type and best quality bakelite suitably reinforced and fitted with shade carrier rings.

3.4.5.3 Batten type lamp holders shall be suitable for mounting direct on a conduit box and shall be of best quality bakelite suitability reinforced and fitted with shade carrier rings.

3.4.5.4 Lamp holders for lamps rated 200 watts and above shall be of the Edison screw type.

3.4.6 Switches and Socket Outlets

3.4.6.1 Lighting switches shall be to BS 3676-1, 6 amp or 15 amp where necessary, insulated pattern, single pole, quick make and slow break type for a.c. circuits and quick make and quick break for d.c. circuits, unless prior approval to the contrary is obtained from the Building Committee.

3.4.6.2 Ceiling switches shall be complete with pull cords and suitable for mounting direct on a conduit box.

3.4.6.3 The successful action of switches shall not depend wholly upon spring action.

3.4.6.4 All single-phase socket outlets shall be 3 pin rectangular, shuttered to BS 2814, (1363-2)1957, with boxes to BS 3676-1 or 1363. Socket outlets shall be unstitched unless instructed to the contrary.

3.4.6.5 All three phase socket outlets and all three phase with neutral outlets shall be of the 4 pin or 5 pin scraping earth pattern.

3.4.6.6 Switched type socket outlets may be used where required.

3.4.6.7 The third pin of all single phase socket outlets shall be effectively earthed.

3.4.7 Motors

3.4.7.1 All motors shall generally be supplied and installed by others but the contractor is responsible for the wiring from each motor control to the respective motor terminals.

3.4.7.2 An earth wire, green or yellow insulated copper cable, shall be run to connect the frame of the motor to the earth termination of the controlling isolator.

3.4.7.3 When installing welding transformers and big motors (10KW and above), local power supply authority shall be consulted.

3.4.7.4 The method of starting motors unless otherwise stated shall be as follows:

a) Motors up to and including 5.5KW shall be started direct on line (D.O.N.)
b) Motors 7.5 and above star / delta or autotransformer.

3.4.8 Final Circuits

3.4.8.1 For low voltage systems 240V/415V A.C. the following shall apply:

a) All final three phase and single phase circuits to motors and fixed equipment shall be controlled locally by the appropriate three phase and neutral(T.P. & N.) double phase and neutral, or single phase and neutral (DP or SP. & N) isolating switch.

The contractor shall include for the provision of these switches. Separate switches may be omitted where combined motor starters and isolators are used.

b) Additional isolators shall be provided adjacent to equipment or a motor where normal control gear or starting is installed remote from the equipment or motor. In general, control gear more than 1800mm from equipment shall be considered remote; however, this distance may be increased at the discretion of the supervising officer (electrical) or as instructed on drawings.

c) Single pole switching and fusing shall be used on single phase circuits where one conductor is normally earthed.

d) Double pole switching and fusing shall be used on single phase systems such as 1:1 transformers, low voltage systems, etc., where neither conductor is normally earthed.

e) One conductor of low voltage supply systems shall be earthed when the utilization of the supply makes this possible.

f) Where a transformer is used to supply a secondary circuit the control switch shall be on the primary side.

g) Switching and fusing shall be single, double or triple.

3.4.8.2 Directs current systems:

a) The minimum size of cable to d.c. socket outlets shall be 2.5mm^2. Larger cables may be used on low voltage d.c. systems at the discretion of the Engineer to prevent excessive proportional voltage drop.

b) The main distributing spur maybe adopted to serve more than one point as allowed by I.E.E. regulations.

c) Double pole fusing shall be employed except when one conductor is common to several voltages in which case the common conductor shall be solid.

d) D.C supplied outside the limit of 240 volt and/or 15 amps shall be treated individually, preferably by a permanent connection to the apparatus served through an approved isolator.

e) Exposed terminal connection shall not be used on d.c. equipment rated at 50 volt or above unless specified

3.5 Underground Cables

3.5.1 Cable Specification

3.5.1.1 The cables shall be of approved manufacture in accordance with BS 6004, 6007&6346 or other appropriate BS, IEC or manufacturer's standard and specification and shall be suitable for the voltage and nature of the supply specified.

3.5.1.2 Medium voltage (up to 3.3 KV) cables and low voltage cables shall be XLPE SwA, PVC 2, 3 or 4 core with high conductivity copper shaped conductors of equal section and complying in all respects with BS 6480, 1988 for 1,100 volt cables or aluminum cables approved by the Engineer.

3.5.1.3 240 volt d.c. services shall be XLPE SwA, PVC 2, 3 or 4 core with high conductivity copper shaped conductors of equal section and complying in all respects with BS 6480; 1988 or aluminum cables approved by the Engineer.

3.5.1.4 Telephone cables shall have high conductivity copper conductors of 3kg or 9kg per mile weight as specified and shall be polythene insulated PVC sheathed overall. The number of conductor pairs will be specified on the drawings.

3.5.1.5 Multi-core Cables shall have 2.5mm^2 high conductivity copper conductors and be PVC insulated and PVC sheathed galvanized steel wire armoured and PVC sheathed overall.

3.5.2 Cable Laying

3.5.2.1 All cables shall be buried in open ground or drawn into earthenware or other ducts as specified where crossing roadways, paths exceeding 1508cm in width, and on entry into buildings.

3.5.2.2 Cables shall be laid in such manner that no electrical or mechanical damage is sustained during the laying process.

3.5.2.3 Where more than one cable is laid in a trench cables should be spaced apart in accordance with the following table (or as given on drawings):

CABLE	EHV	EHV	MV or LV	TELEPHONE	CO-AXIAL
EHV	50mm	50mm	-	-	-
HV	50mm	50mm	-	-	-
MV	300mm	300mm	25mm	25mm	-
Telephone	300mm	300mm	300mm	25mm	-
Co-Axial	300mm	300mm	300mm	25mm	25mm

3.5.2.4 All cables shall be separated by at least 230mm from gas and water mains.

3.5.2.5 In straight run trenches cable crossing will not be permitted except when cables have to branch from main run.

3.5.2.6 At every draw-in point or junction box, and at the foot of any pole, the cable shall be laid snaked, to the satisfaction of the supervising Officer.

3.5.2.7 Cables to termination points in substations or buildings shall enter via glazed earthenware piped, supplied and fixed by others which shall be sealed in an approved manner after the cables have been laid.

3.5.2.8 Appropriate sealing compound mixture shall be provided at both outlets ends of the pipe.

3.5.2.9 Before cables are laid, the bottom of the trench shall be evenly graded and cleared of loose stones and shall then be covered with 50mm layer of sand or sieved earth which shall have been pressed through sieve with a maximum mesh of 13mm.

3.5.2.10 The cables shall be carefully laid in the bed without dragging and they shall then be covered with fine sand or sieved earth in such quantity as to ensure a cover of 75mm after tamping.

3.5.2.11 Where cover tiles are required before the sand or sieved earth is filled in, the cable run shall be marked with temporary wood pegs, in order to ensure that when the warning covers are laid over they overlap the cable each side by 50mm.

3.5.2.12 Sand provided by the contractor may be used where the Engineer agrees that the ground is unsuitable for sieving.

3.5.2.13 Cables shall not be laid in ashes, organic refuse or other materials likely to damage them. When such conditions are encountered the method of laying the cables shall be agreed with the Engineer.

3.5.2.14 Cables having a run of more than 1800mm inside a building shall be cleated or saddled to walls or ceilings with cleats or saddles at spacing recommended by IEE Wiring Regulations current Edition.

3.5.3 Warning Covers

1. Unless otherwise stated by the Supervising Officer warning covers shall be provided over all cables except as detailed in Clause 2 below.
2. Warning covers shall not be provided over; XLPE SwA, PVC cables except when the Engineer considers the cables are liable to damage.
3. All covers shall be earthenware apex type in accordance with drawings and laid to provide a margin of 50mm of cover on both sides of cable, (s).
4. The warning tape shall be coloured yellow/black stripes and bear the following legend in block black capitals, at regular intervals: “CAUTION-ELECTRIC CABLE BELOW” It shall be laid at a depth 200mm below final grade.

3.5.4 Earthenware Ducts and Fiber Conduits

1. Where cables cross under roads or paved areas the following ducts or conduits shall be provided under a separate contract, unless otherwise determined:-

   a)Earthenware duct

i) 1 cable	2 x 100mm or 150mm ducts
ii) 2 cables	3 x 100mm or 150mm ducts
ii) 3 cables	4 x 100mm or 150mm ducts
vi) 4 or 5 cables	6 x 100mm or 150mm ducts
v) 6, 7 or 8 cables	9 x 100mm or 150mm ducts

2. Five or more plastic sheathed cables shall normally be laid together, depending on the size of cable, shall be drawn into 100mm or 150mm duct where the need arises
3. Should the contractor be required to supply and lay ducts the following conditions shall apply:-

   a) Trenches for stoneware ducts shall be scooped out at all points where the sockets rest, so that the body of the duct lies solid on the ground.
   b) Rocky soils and a layer of soft earth shall be spread over the bottom of the trench and rammed to afford bedding for the ducts.
   c) Where the soil is unstable or water logged, a foundation for the ducting

should be provided by laying 75mm of suitable concrete. The Contractor shall carry out all necessary cutting of ducts.

d) Ducts and conduits shall be clear of gas or water pipes, drains and sewers.

3.5.5 Concrete Cable Markers

1. Reinforced concrete cable markers shall be installed at all positions necessary to indicate the run of cables.
2. Concrete marker posts shall be erected at intervals of 25m and at changes of directions of cable trenches. A plate shall be fixed to the post stating “BURIED CABLES” and their position marked on the final “AS INSTALLED” drawings.
3. Adequate number of ducts shall be provided at points of entry into buildings. These shall be in form of easy sweep ends, having a bending radius appropriate to the size of the largest cable but in any case not less than 10 times a cable diameter.
4. After installation and the final tests, all cable ducts will be sealed using fine resistant materials to the satisfaction of the Engineer, to prevent ingress into buildings of water, vermin termites etc.

3.5.6 Cables Jointing

1. Cable jointing shall be carried out in accordance with the relevant British Standard Code of Practice, and the respective cable maker's instructions.
2. Underground joints in all cables shall be kept to a minimum, and may be allowed by permission of the Engineer, and in a manner approved by him.

3.5.7 Identification of Cables and Cable Joints

1. At all cable terminations cables shall be identified by labels securely attached to the cables.
2. Labels shall be made of heavy gauge brass or gunmetal of such a size as to render their reading clear and be punch lettered with the name of the service and size of cable, number of cores and location of termination of the other end of the cable.
3. All underground joints in cables shall be indicated by concrete cable markers as indicated in Clause 3.5.5, suitably lettered with details of the cable joint and placed above the joint.

3.5.8 Position of Cable Routes

1. The positioning of all cable routes, street lighting columns and feeder pillars shall be agreed with the Engineer before any work is put in hand.

3.5.9 Bonding and Earthing of Cables

1. Cables entering any piece of apparatus shall enter via an approved type armour clamp and gland effecting a satisfactory mechanical connection to the casing of the apparatus, and making an efficient earth connection with all metal parts of the apparatus to be bonded. A wire binder shall be provided on the armouring of the cable entering the apparatus.

2. On jointing cables buried in the ground two wire binders shall be provided on the armouring on each cable at the joint in addition to the armour clamps. The armour clamp shall grip the armouring firmly to the joint box gland or casting so that no undue stress is caused by ground movement.
3. The armouring of all cables shall be efficiently bonded to the cable sealing boxes and joint boxes by the use of copper tapes. The size of the copper tape used shall be agreed by the Engineer.

3.6 Excavation and Reinstatement

1. The contractor shall obtain a work permit prior to excavation.
2. Works related to excavation, planking and strutting, supply of and laying of ducts, back fillings, reinstatement, removal of surplus soil and any other work of this nature shall be as indicated in the preliminaries and/or particular specification.
3. Where extensive trenching is involved this may be carried out under a separate contract and in which case the cabling contractor shall mark out in advance the positions of all cuttings. The contractor shall be held responsible for accurate and satisfactory installation of the work in open ground.
4. Where necessary excavations shall be kept free from water at all times by pumping, bailing or other means.
5. Where pumping is necessary the material in and around the excavations shall not be disturbed thereby and temporary sumps shall be constructed if necessary and back filled on completion.
6. The Contractor shall provide all the necessary equipment to keep the work clear of water, together with pipes, chutes, dams, screening chambers, diversions and the like.
7. Where necessary the Contractor shall properly timber or shore the sides of trenches, and the sides, and roofs of tunnels in such a manner as to ensure their withstanding against falls, slips, and all loose materials and to ensure the safety of men and protection of the work and adjoining property from damage.
8. All excavations shall be taken out sufficiently full to allow for adequate timbering and the efficient carrying out of the works.
9. All damage arising from the falling in of the sides of any excavations through insufficient or careless timbering or other causes must be made good at the Contractor's expense and the Contractor shall forthwith remove all the material which has fallen in.
10. On completion of the laying and testing of the cables as specified, the Contractor shall complete the filling in of trenches in layers of not more than 150mm thickness each layer being well rammed until solid before the next is added. If instructed, watering of the backfill shall be adopted to secure proper consolidation.
11. The final reinstatement of excavations shall be left sufficiently mounded to allow for future settlement. If such settlement is of a major nature the Contractor will be required to make good such subsidence free of cost.
12. All hollows formed outside the limits of the excavations or trenches due to collapse or any other cause shall be filled in with excavated material, properly backfilled, rammed and consolidated.
13. The surplus material arising from the excavations shall be removed to a distance not exceeding 400m deposited, spread and leveled as directed by the Supervising Officer.

14. The length of trench opened at any time shall be kept to a minimum. The top soil shall be carefully removed and shall be replaced to its original position as soon as possible after closing in of the work. All turf shall be carefully preserved and replaced.

15. During excavation the contractor shall take particular care to avoid damaging any other services which may cross or run adjacent to the cable route. Any services uncovered shall be adequately supported by slings or other suitable means.

16. The approximate position of existing services will be indicated on the drawings.

17. The Contractor shall exercise great care in carrying out excavations in the vicinity of existing services and in the event of damage he shall be charged for remedial work that may be necessary.

18. Trenches shall be excavated to enable the cables to be laid at minimum depth below finished ground level, as detailed on drawings. Cables will normally be laid at a depth of 600mm unless otherwise specified.

3.7 Consumer Mains

3.7.1 Feeder Pillars

1. Feeder pillars shall be weatherproof and of robust construction with hinged lockable doors. The back shall have removable plates, bolted or screwed to the shell.

2. When installed the feeder pillar shall be mounted on a firm base or as shown on the drawings and arranged to prevent the ingress of rainwater within the enclosure.

3. The capacity and number of links and/or fuse ways shall be as specified on the drawings and shall have phase, colour and circuit identification. Unless otherwise specified feeder pillars shall be "dwarf type", tailless units.

3.7.2 Earthing

1. In every installation a consumer's earthing shall be provided adjacent to the consumer's supply terminals

2. Particular attention should be given to conduit and trunking installations to ensure that the earth continuity is reliable and permanent.

3. All apparatus or parts thereof not solidly connected to the earthing systems shall be connected thereto in an approved manner by a solid copper conductor secured by means of substantial bonding clamps.

4. All services entering the installation at earth potential shall be efficiently bonded to the main earth points.

5. All joints in the earth system shall be made with solder-less connectors or by an approved brazing method.

6. The resistance of the earth continuity system when measured between the main earth point and any other point in the installation, including all metalwork which may provide a path to earth such as gas, water, waste pipes, etc., shall not exceed 1 ohm.

7. All flexible metallic tubing shall have a green / yellow insulated earth conductor run with the tubing and the ends shall be securely bonded at positions accessible for inspection.

8. The size of the earth conductor shall be as indicated in the current edition of the I.E.E. Regulations and shall not be less than 4 Sqmm.
9. Care shall be taken that the neutral conductor does not become accidentally earthed.
10. The neutral of the supply shall be bonded to the earth tape, in accordance with the licensed electricity service provider's procedure of multiple neutral earthing. The actual bonding will be performed by a representative of the licensed electricity service provider.
11. The earthing terminal of every socket-outlet shall be connected to the earth-continuity conductor of the final sub-circuit.
12. Earthing shall confirm to the IEE Wiring Regulations Sixteenth Edition.

3.8 "AS INSTALLED" Drawings

1. On completion of the contract the contractor shall produce "AS INSTALLED" drawing to the satisfaction of the Engineer
2. The Contractor shall prepare "as fitted record negatives" during and upon completion of the work. The Contractor shall include for them in the tender.

3.9 Inspection and Testing

1. The complete installations or completed sections of the installations shall be subjected to acceptance tests as ordered by the Engineer before being connected to the supply.
2. The Contractor shall give 48 hours written notice to the Engineer of his intention to carry out any or all of the "acceptance tests" in Clause 3 below.
3. On completion of the installation, the Contractor shall carry out the following tests in accordance with the IEE Regulations and in the presence of the Engineer as applicable:
   a) tests as prescribed in the Ugandan Electricity Supply Regulations currently in force;
   b) tests in accordance with BS 6480:1988;
   c) megger insulation resistance (sections of, and the complete installation);
   d) circuit and earth continuity tests;
   e) loop impedance and polarity tests;
   f) continuity resistance of conductors and sheathing sections and the complete installation;
   g) phasing out;
   h) full load when specifically ordered.
4. Tests shall be carried out on each and every circuit in addition to the complete installation.
5. The contractor shall enter the results on paper, letter form, duly signed by the contractor and countersigned by the Engineer present during the said tests.
6. The contractor shall supply all necessary equipment, labour and instructions to carry out these tests and shall demonstrate the accuracy of his test instruments, to the Building Committee.
7. Periodical tests shall be conducted on electrical installations in building every 5 years.
8. The Contractor shall complete test result forms recorded in triplicate and return them signed to the Supervising Officer within 7 days of the date of the tests.

SECTION 4 MISCELLANEOUS

4.1 Street Lighting

1. Street lighting columns shall be constructed and installed in accordance with BS 5649 and shall be of the type as indicated, columns set in ground shall be fitted with a base plate unless otherwise indicated.

2. Each street lighting columns shall be fitted with a fuse unit providing terminations adequate for the cabling to be looped in and out and shall be fitted with fuses to BS 88, rating as indicated. Control equipment shall be incorporated as indicated.

3. Unless otherwise specified the lighting columns shall be of steel construction to give a fitting height of 4600mm or 7600mm or as specified on the drawings and shall be supplied to the contractor complete with lamp brackets.

4. The Contractor shall provide and install the necessary cut-out terminals and loop in facilities in the base of the column as specified and shall terminate the incoming cable or cables.

5. Wiring of the lighting columns and lighting fittings shall form part of the specification.

6. Switching:

   a) Photocells may be used for individually switching street lights or may be connected to contactors for group switching.

   b) Time switches shall incorporate a 24 hour spring reserve to operate the timing mechanism in the event of a power failure to activate contactors for switching.

7. Lanterns (luminaries):

   a) The sealing of luminaries, and their resistance to ingress of water and dirt should be as described by their international protection code IP number and shall be not less than IP34 (International Protection Code).

   b) Where night time public use is likely to be moderate and the crime risk is low, low pressure sodium lamp which emits a monochromatic light rendering yellow colour is the preferred light source.

   c) Where pedestrian activities predominate and where there is a high crime risk high pressure sodium lamp which renders colours throughout the spectrum shall be utilized.

   d) For urban and residential roads the light source used should have a colour rendering index of (Ra) ≥20.

   e) In civic centers, shopping streets, boulevards, promenades and other places that are the hub of social activity, the light source used should have a colour rendering index of (Ra) ≥60.

4.2 Lightning Protection and Earthing

1. All public buildings such as schools, churches, mosques, halls, hospitals, theatres etc shall be provided with lightning protection system.

2. Lightning protection installations shall, in general consist of copper or aluminum tapes 20mm x 3mm section with similar clips, test clamps and copper bond earth rods which shall be mounted in the position as indicated on drawings

3. Each roof tape shall be provided with a similar copper or aluminum down tape to the earth test position, and from the earth test position to the earth electrode in copper only. Suitable approved arrangements must be made for the junction of aluminum and copper tapes.

4. The electrode shall consist of a copper bond rod buried in the ground as close as possible to the installation to be protected.

5. The earth resistance of the completed system shall in no circumstances exceed 10 ohms and shall be as low as possible.

6. Where earth resistance cannot be obtained by means of a single earth electrode, extra rods shall be added in parallel at a distance not less the length of the earth electrode.

7. After completion of the installation the contractor shall be required to provide the necessary instruments and carry out earth resistance tests to the satisfaction of the Engineer.

4.3 Lifts

1. All apparatus and materials supplied and work carried out shall comply with the following provisions:

   a) Institution of Electrical Engineer (IEE) of United Kingdom
   b) The Uganda Electricity Board byelaws
   c) **"Code for Electrical Installations and Equipment in Buildings."**
   d) Any other regulations governing lift installations in Uganda.

2. Every hoist or lift shall be of good mechanical construction, sound material and adequate strength, with safe electrical controls and periodically be properly maintained.

3. A fireman's control switch shall be provided on the ground floor and main entrance lobby. The fireman's switch shall be of the type approved by the Engineer.
4. The fireman's switch shall stop all the lift cars on the next landing and without opening the doors, and all the cars shall return to the ground floor.
5. An emergency alarm system in the form of an intercom shall be installed between the car, the motor room and the reception desk on the ground floor.

6. The lift motor room shall be mechanically ventilated.

4.4 Air Conditioning and Refrigeration Systems

1. Refrigerants in air conditioning and refrigeration systems shall comply with National Environment Management Authority (NEMA) Regulations.

4.5 Radiation Emissions

1. Any person wishing to use radioactive material or other sources of dangerous ionizing radiation shall apply to the relevant authorities for an appropriate license.
2. An application for a license to use radioactive material or other source of dangerous ionizing radiation shall be in the prescribed form and shall be submitted to the Chief Radiation Safety Officer who shall prepare the appropriate license.
3. The holder of a license shall be responsible to ensure that any operation, condition of storage, transport or disposal shall not result directly or indirectly in exposure of ionizing radiation in such amounts as are likely to cause harmful

effects to the public, his employees, other workers or other users or to property owned either privately or by the Government.

4. Any person who uses radioactive material or source of dangerous ionizing radiation without authorization shall be held responsible for its effects.
5. The radiation safety requirements prescribed under the Decree on radiations do not extend to patients undergoing medical treatment by exposure to radiation by or under the supervision of a medical practitioner; but do apply to the safety of medical and technical staff working with the radioactive material or a source of ionizing radiation and to the protection of all other persons other than the patient undergoing treatment.
6. Domestic radiation equipment such as televisions shall be positioned at an appropriate distance to protect the users from the radiation emissions.
7. Living rooms shall be designed such that enough cross-ventilation is available to check on the radioactive gases.
8. Building materials such as rocks, steel rods which are rich in radioactive elements shall be avoided in construction of Buildings.

4.6 Special Services

4.6.1 Data Network

1. Asynchronous Transfer Mode (ATM) which supports speed up-to 155Mbps integrating voice, data, image and multimedia shall be used where increased band width application is required.
2. The fast Ethernet standard (100Mbps) over Unshielded Twisted Pair (UTP) cable shall be used for connection of desktops from hubs.
3. Unshielded Twisted Pair (UTP) floor cabling which supports multiple applications – Voice, Data and multimedia is recommended for local area net working.
4. For riser backbone system connecting different levels of floors with the server optical fiber cables shall be utilized.
5. Server is a powerful computer that provides services to other computers and devices on the network and is usually located on ground floor or basement.
6. Modular patch panels shall be used for the termination and interconnecting of data circuit in structured cabling system.
7. Data outlet points are those points in the network where all the computers and other devices are interconnected. The data outlet points shall be RJ-45 fed through Cat 6 Unshielded Twisted Pair (UTP) cable.
8. The wiring for each data outlet shall be carried out by the supplier and /or manufacturer. The Contactor shall liaise with the supplier and /or manufacturer to verify that adequate trunking system and concealed conduits have been included.

4.6.2 Other

Conduit installations for telephones, public address, radio and television, etc. shall be carried out to the same standards as for power and lighting services. Where detailed in specification, plastic conduits may be used and when necessary an earth wire drawn in. Cables or draw wire shall be installed as specified.

SECTION 5 SOLAR PHOTOVOLTAIC (PV) POWER SUPPLY SYSTEM MODULES AND BATTERIES

5.1 Scope

1. This section of the regulation gives guidance on safe installation and utilization of photovoltaic power supply system as an alternative source of energy.

5.2 Photovoltaic (PV) Modules

5.2.1 PV Modules (Panels) Specifications

1. The output current and voltage of the modules or panels shall be appropriate for the application, and shall be clearly established by the contractor from the manufacturer's documentation and stated in the contract. The pertinent conditions are solar radiations of 1 KW per sqm or less and cell temperature of 35ºC or higher.

2. The Uganda National Bureau of Standards is able to provide advice on quality and finish of panels, and can test new panels under local conditions where necessary.

3. The module shall have a quality mark form PV GAP or any other Accredited Testing Laboratory on the module. This mark provides assurance that the module has been tested to IEC 61215 or IEC 61646 and that the manufacturing has ISO 9000 certification and periodic auditing.

5.2.2 PV Modules Position

1. No object (trees, buildings, etc.) should shade any part of the PV-panel at any time of the year between 90 minutes after sunrise and 90 minutes before sunset.

2. Should shading be unavoidable, this shall be compensated for by reducing the daily energy output in the system design. Note that reduction in output due to partial shading will typically be much greater than the portion of the array that is shaded.

3. Where possible, the PV-panel shall be installed on the roof of a building near the controller and battery bank.

5.2.3 PV Modules Orientation

1. The panel must be installed facing due north/south, at an angle of between 10 and 20 degrees to horizontal plane.

5.2.4 PV Modules Lighting Protection

1. PV-panels shall be installed lower than the highest point of the building.

2. The support frame shall be provided with a short lightning rod if this becomes the highest point of the building.

3. The UNBS or other specialized contractors will provide expert advice in case of doubt.

4. The contractor should make the client aware of the risks that can arise due to unsafely earthed structures. Where grounding of structures for

lighting protection is needed a minimum of 16mm2 cable shall be connected to a 1.5m earth rod.

5.2.5 PV Modules Support Structure

1. The support structure for panels shall be made of permanent materials, be strong enough to withstand all climatic conditions (wind, heat, water) without deflection or vibrations and be securely braced and fixed to the roof or the wall of a building or the ground.

2. Frames, support structure and other metal parts shall be made of non-corroding materials, or protected against corrosion by galvanization, painting, etc. as appropriate for the material used. It is good practice to keep dissimilar metals separate, unless they are well sealed against water by paint or sealing compound.

3. Calculations and supporting documentation to demonstrate adequate design may be required.

5.2.6 PV Modules Roof Mounting

1. Fixing to roofs shall be done so that leakages are prevented and no corrosion of roofing materials will occur.

2. Bolts to be fixed through top of corrugations on corrugated metal roofs, to be secured to purlins, or special supports to be fixed to the roof structure if the purlins are of poor quality.

3. All holes in the roofing shall be thoroughly sealed and made waterproof with UV- resistant silicone sealant or suitable sealing compound.

5.2.7 PV Modules Ground Mounting

1. Solid foundations shall be provided at each corner of the array with additional support as required by the design of the supporting structure.

2. Panels shall not be mounted closer than 0.8m from the ground to avoid shading by grass and other vegetation.

3. Small arrays may alternatively be fixed to a single pole, securely buried into the ground and if necessary secured with stays.

4. The location shall be chosen such that no damage can be caused by animals (and the site shall be fenced).

5. This method of mounting should be avoided whenever possible.

5.3 Batteries

5.3.1 Type

1. Batteries shall be of a design suitable for PV applications. Deep discharge and long cycle life batteries are recommended.

2. Conventional car/truck starter batteries are not generally acceptable. For specifications of batteries, refer to US 149-1: 2000 Specification of batteries for photovoltaic systems.

3. The technical implications of the choice of battery and the costs and benefits of different types should be explained to the client in general terms.

5.3.2 Installation

1. Batteries shall be installed in boxes, racks, or cupboards to protect the connections (terminals) against accidental short-circuiting while still being checked.

2. At least 20mm free space shall be left between the batteries, the wall, and the top of the box.

3. Ventilation of the enclosure shall be ensured to avoid build up of explosive gases during charging.

4. The box shall be made of suitable durable materials and if made of wood, it shall be well preserved against insects (termites), rot and acid.

5. The box shall be securely fixed in position and each battery shall be marked with the date of manufacture and year and month of installation by the installer.

6. Maintenance requirements shall be clearly laid out in the owner's manual.

5.3.3 Controllers and Circuit

1. Controllers shall be designed and installed to protect the batteries against overcharging, as well as over-discharging.

2. Voltage disconnect/reconnect settings shall depend on the type of battery.

3. The rated capacity of the controller shall be selected to handle the maximum short circuit current from the PV-array and the maximum load.

4. The charge controllers and circuit breakers / fuses shall bear manufacturers PV quality mark, PV GAP or any other Accredited Testing Laboratory PV Quality Mark.

5. This quality mark provides the assurance that the module has been tested by an Accredited Testing Laboratory to IEC 61215 or IEC 61646, and that the manufacturing has ISO 9000 certification and periodic auditing.

6. A warning system consisting of a light and or an audible alarm providing at least three minutes advanced warning of disconnection should be installed.

7. Where the controller is installed in a room which is not regularly used, a remote alarm shall be installed at a place where it can be easily noticed.

8. Essential Service (ES) circuits may be provided with a switch to facilitate bypass of the over- discharge protection or to bypass the regulator completely.

9. Warning for low battery shall however be included as for Non-Essential Services (NES).

10. The owners manual and markings on the bypass device shall clearly indicate the implications and potentially irreversible damage that may be caused by bypassing this protection.

11. The system shall be protected against damage due to accidental short-circuits by use of fuses or circuit breakers.

12. Any consumer circuits shall have circuit breakers.

13. Individual circuits from the battery shall have a maximum rated capacity of 25 amperes where not otherwise specified

14. Each circuit shall be so designed that the peak demand does not exceed 80% of the rated capacity of the fuse or circuit breaker.

15. Required fuses and circuit breakers may be integrated in the controller box or installed separately in a fuse or distribution box positioned near the controller and battery.

16. Each fuse or circuit-breaker shall be clearly marked with rated capacity and for which circuit it is used.

5.4 Samples

1. Where new components or of innovative techniques, are used by the contractor samples of materials and equipment shall be submitted for approval before installation commences. It is recommended, where possible, to show the client an existing installation so that any ambiguities may be explained.

5.5 System Design - Essential and Non- Essential Service (ES and NES)

5.5.1 Design data

1. The client may provide data for dimensioning of each system where the design is not prepared in detail by the contractor.

2. It shall be the responsibility of the contractor to ensure that such system details are consistent with the:-

   a) Type of lights and appliances
   b) Essential Services (ES)and Non-Essential Services (NES)
   c) Daily Load (DL)

3. The contractor shall specify the manufacturer, types of equipment with relevant rated capacities to be installed and enclose calculations and other documentation to prove that all requirements are met.

5.5.2 Calculations

1. Calculations of requirements for a functional system shall depend on whether it is considered NES or ES.

2. The system sizing rules are based on mathematical modeling with daily solar radiation records from Uganda over the period of at least 5 years, taking into account panel degradation as well as battery ageing.

3. Essential Service (ES) and Non- Essential Service (NES) systems should in general be installed as totally separate systems.

4. Where a combination of ES and NES are connected to the same system, it shall be sized as if all services are ES, unless particular calculations are provided to prove that the design of all combined system will satisfy the requirements to both types of services

5.5.3 System Autonomy

1. The period of autonomy of a Photovoltaic system may be defined as the total period for which the system shall provide power to its regular load without solar energy input. In other words, this is the period for which the system will operate normally without sunlight.

2. The autonomy of a system depends mostly on the depth of discharge of the batteries under normal daily loads and the number of batteries included in the system.

3. If a battery is only discharged by a small fraction of its total capacity each day, it will clearly provide more days of operation than a battery that is discharged by a large fraction each day.

4. The overall life of a battery is affected by the depth of its regular daily discharge; the life being inversely proportional to the depth of discharge (i.e. the shallower the discharge the longer the battery life).

5. The contractor shall give careful consideration to the sizing of the batteries in relation to the system load requirements. The cost implications of this should be presented clearly to the client

5.5.4 Essential Services (ES)

1. The battery capacity shall be at least 5 times the maximum daily load in Ah. This provides a normal cycle depth of 20% or less, assuming ample battery service life, and will provide 5 days autonomy in case of total array failure.

2. The array output current / in amperes under conditions as specified above shall be at least DL (Ah)/4(h).

5.5.5 Non-Essential Services (NES)

1. The total nominal capacity of the batteries in Ah shall be at least 4 times the daily load in Ah.

2. The array output current; in amperes under conditions as specified above shall be DL (Ah)/4(h).

5.6 Labels

1. Supply and fixing of labels shall be carried out by the contractor.

2. Labels shall be made of; permanent inerasable material with clearly legible letters and shall be displayed in a prominent position(s), providing the following information.

   a) Battery enclosure:

      "Danger!""Explosive gas". “Do not smoke”. “Do not use open flames”. “Do not short circuit battery terminals!"

   b) At Controller
      i) Name and address of electrical contractor responsible for installation
      ii) Date of installation
      iii) How to read performance (display or coloured lights)
      iv) Operation of circuit breakers or fuses (replacement of fuses)

vi) Identification of circuits from the controller
vii) Instructions on maintenance/cleaning of photovoltaic panels.

c) Distribution Board (if using wiring for 240V a.c.) the following phase shall be clearly indicated- "Use 12 Volt appliances only".

d) Remote Warning if is installed, shall have an explanation of the warning signals.

e) At main entrance to building or home, the following text in English and/or Swahili, or any other appropriate local dialect shall be clearly marked "Please save energy. Switch off lights and appliances when leaving room".

5.7 Inspection and Testing

1. On completion of installation the system shall be inspected to ensure expected operation.

2. In addition to checking that all parts are correctly installed and operating satisfactorily, the electrician will certify in writing that:

a) Voltage drop (loss) in cables does not exceed specifications
b) Output from PV modules is within 5% of manufacturer's specified value
c) All wiring has been installed in an appropriate manner
d) No safety hazards exist
e) All signs and labels have been sensibly placed

5.8 Maintenance, Spare Parts and Warranties

1. The contractor shall be liable for all repair or replacement as per the installation warranty that he will provide.

2. Spare parts and expertise for maintenance and repair shall be made available by the contractor for the equipment after expiry of the warranty period.

3. Cost shall be separately detailed in the original quotation

4. Notwithstanding any third party warranties that may be passed on by the contractor, the minimum warranty period of some important system components shall be as follows:

Components	**Minimum warranty period**
Light bulbs	1 year
Batteries	1 year
PV modules and Wiring to PV modules	5 years
Controller / Inverter	3 years
Complete system	1 year

5.9 Registration, Approval and Acceptance for Photovoltaic Installations

1. Registration of Contractors for photovoltaic installation shall be carried out by the

Uganda National Bureau of Standards (UNBS).

2. The UNBS shall issue certificate of registration to the registered Contractors who will then be entitled to use the title and logo of "UNBS Approved Contractor" in their Company and promotional literature.

3. The certificate shall be issued subject to a nominal certification fee, and shall be uniquely numbered with the contractor's number.

4. The certificate shall remain the property of the UNBS, as the agent for the Code of Practice control body.

5. The Code of Practice Control Body will reserve the right to publicize all newly approved contractors in the public media in Uganda.

6. All contractors shall be required to maintain numbered records of all Photovoltaic installations they perform. Such records shall include the date, system type, unit installed, serial number, etc.

7. All contractors shall be required to inform the UNBS the date, type and system details of all new installations, but need only refer to their own internal reference number. Such detail may not include commercial or financial information.

8. The Control Body shall at random select installations from each contractor by these reference numbers for follow up inspections. It is planned to inspect one installation per year for each approved installation.

5.10 Field of Application

1. This code shall be read in conjunction with the relevant parts of the current IEE Regulations for Electrical installations, and shall apply to installation of direct current (d.c.) Photovoltaic (PV) energy systems.

2. This code has been drafted for 12V and 24V systems for residential applications, the so-called Solar Home Systems and is not intended to be used for other PV systems such as PV- pumping systems and grid -connected systems.

3. The application of this Code of Practice shall include everything necessary to provide lights and outlets for power as part of a photovoltaic power system.

4. Where drawings or instructions are not specified, then they shall be specified by the client, or as shown on the contractors drawings, including PV-panels, batteries, controllers, fuses and/or circuit breakers, switches, socket outlets, wiring, appliances, etc., The work shall also include repair of all damages to buildings and grounds caused by the installation where not otherwise specified by the client.

5.11 Installation Design

1. Where the layout of the installation is shown in drawings or detailed specifications are given, these shall be accurately followed.

2. Where no detailed drawings are provided, the installation shall be designed as efficiently as possible to minimize the loss of energy through cables and junctions.

3. A system design specified for a client by a contractor should be in a form that may be readily explained to a non-technical client.

4. This design information should be kept on file by the contractor, and may prove useful after completion of the installation in case of any subsequent dispute.

5. In the case of a client-specified installation, it is the responsibility of the contractor to inform the client of any areas that do not conform to this Code of Practice.

6. The contractor is entirely responsible for any deviations from the established code of practice and wiring standards.

7. Under no circumstances, even by client dispensation, shall any unsafe practice be acceptable. Written dispensation from the client should be obtained where necessary to protect the interests of the contractor.

5.12 Wiring Methods and Cables

5.12.1 Conduit Wiring

1. Surface mounted conduit with single wire conductors shall be installed using saddles or supports at suitable interval.

2. Conduits must be supported using saddles or supports. Drooping or unsupported runs shall be avoided.

3. PVC conduit may be used under floors but steel conduit should be used in all places where heavy or unpredictable loads may occur.

4. Under floor conduit should not be less than 19mm to allow for subsequent maintenance.

5.12.2 Cable Wiring

1. Surface mounted cables shall be installed using appropriate fasteners at suitable intervals to prevent sagging as shown on drawings.

5.12.3 Conductor Cross-section and Voltage Drop

1. The cross-sections of the conductors shall be according to Building Code "Code for Electrical Installations and Equipment in Buildings", APPENDIX 3 and the relevant tables in the IEE Wiring Regulations 16th edition.

2. The rated current carrying capacity at 35°C for any given wire cross-section shall not be exceeded. Wires of cross section area less than 2.5mm^2 are not recommended for use with photovoltaic systems.

3. The voltage across any appliance shall not be less than 5% volts of the battery terminal voltage. Under no conditions is a voltage of less than 10.5V permissible across an appliance. The voltage shall be measured with all appliances in the circuit, including those connected to socket outlets.

4. Voltage drop between the PV-panels and batteries shall not exceed 1.0V or 5% measured at maximum charging current. This voltage drop measurements will include any series or protection diodes.

5. To avoid using long cable runs with large numbers of T and star junctions, the load may be split into several circuits from the controller.

5.12.4 Use of Existing 240V AC Wiring

1. The existing wiring of 240V a.c. shall be used, provided it complies with other conditions in Clause 5.13.3 above.

2. If new wiring is installed in 240V a.c. conduits, it shall also be in accordance with IEE Wiring Regulations 16th edition for 240Va.c.

5.12.5 Cable Connections

1. Cables can be connected by the use of junction boxes, block connectors or soldering joints (with insulating sleeves).

2. All cable joints must be contained within a suitable junction box where they will be visible.

3. The rated capacity through the joints shall not be less than for the circuit they form a part of.

4. Lights, switches and sockets may be used as junction boxes where this is practicable.

5.12.6 Power Intake - Underground and Overhead

1. Underground cables shall be at least 0.6m below the surface and be indicated with markers (coloured plastic tape, minimum 50mm wide or lining with bricks or slates, 0.2m above the cable).
2. Underground cables shall be used across all areas with vehicular traffic and they may also be used for aesthetic reasons or to achieve a short cable run as instructed by the client.

3. The cables must be designed for this type of application and conduit must be able to withstand vertical loads if heavy vehicles are expected to cross the area.

4. Suspended cables shall be mounted so that the lowest point is at least 2.7m above ground level.

5. The cables shall be held in position by suitable brackets and strain relief to prevent mechanical wear and stress of the electrical connections.

6. Cables for outdoor exposed usage, shall be fully UV-resistant

7. Attachment of cables or conduit to concrete, bricks or mortar, walls etc. shall be made with appropriate fasteners and attachment of cables to metal or asbestos sheeting or similar material shall be made by use of suitable toggles.

8. Holes through roofing should be avoided where possible. Cables through roofing shall be contained in roof-entry boxes, which also shall form a waterproof seal to avoid leakage.

9. All holes for cables shall be drilled at top of corrugations. All holes in the roofing shall be thoroughly sealed and made waterproof with UV-resistant silicone sealant or equivalent.

10. Where wires or cables are fixed to or passing through particularly flammable materials (thatch, etc.) they should be shielded in non-flammable conduits.

11. Fittings must be fastened to suitable supports, which may need to be provided if not already present. No conduit or fitting should be attached directly to thatch, or any other non-supportive surface.

12. Holes for cables through walls shall be sealed with mortar or putty and the surfaces touched up with paint. Holes that penetrate external walls must slope downwards slightly towards the inside to prevent the ingress of water.

5.13 Workmanship and Finishing

1. Where no detailed specifications are provided by the client for choice of materials or workmanship, standard practice for the trade shall be followed.

2. Regarding the approval of quality, assessing capacity of PV-panels, batteries, controllers and other components, the client or contractor may seek assistance from the Uganda National Bureau of Standards (UNBS), or from the Energy Unit of the Ministry of Energy and Mineral Development.

3. The installation shall include the completion and tidying up of any work that is a direct result of the installation. Any damage to surface walls or fittings caused by or as a result of the installation should be repaired by the contractor.

5.14 Light Fixtures

1. For general purpose and task indoor lighting, fluorescent lamps that comply with BS 1853 shall be recommended.

2. Ballasts for tubular fluorescent lamps shall comply with BS EN 60920 and 60921. Power factor correction shall be provided and this shall be not less than 0.85 lagging unless otherwise indicated.

3. Tungsten incandescent lamps that comply with BS 161 shall be used for particular tasks as required.

4. Halogen lamps in approved adjustable or portable fixtures shall be used for task light or spot light.

5. Where lamps are fitted next to thatched or flammable ceiling materials a metal lamp fitting or a metal shield shall be used to minimize the risk of fire.

6. For outdoor lighting such as security and street lighting, sodium vapour or other monochrome high intensity lamp shall be used.
7. Where there are insect's lamps with enclosures or defractors must be capable of being opened for cleaning by the client.

8. Where tools are necessary to open lamps for cleaning, such tools should be provided by the contractor as part of the installation.

5.15 Sockets

1. Socket outlets to be connected to solar PV system shall be designed for 12V d.c. and 2-pin plugs and shall not be possible to reverse the polarity.

2. Domestic appliances such as radios, fans spotlights, rechargeable torches, refrigerators and special instruments shall be connected to the solar PV system through socket outlets designed for such voltage or provided with suitable and efficient adaptors or inventers.

3. Any 12 V appliance shall not have a 240V a.c. mains type plug attached to it.

4. Where 240V outlets from a d.c.-a.c. inverter are provided, mains type socket shall be used and a label on each socket shall be added to show the maximum power available from that socket.

5. All wiring in these circuits shall conform to IEE wiring regulations for 240V a.c. mains wiring

6. Circuit breakers and proper earth safety system shall be provided to prevent damage to the inverter in case of an overload.

7. All installations that have d.c. sockets shall be wired so that the large diameter pin in the plug is always positive.

8. All positive connections shall be made with red insulated wire and all negative connections with black insulated wires.

5.16 Switches

1. Standard switches for 240Va.c. shall not be used as an alternative to special switches for 12 V d.c. unless written approval from the manufacturer is obtained which shall include acceptable d.c. voltage and current limits.

2. All switches shall be rated at twice their expected current carrying load.

3. Where particularly required, special time switches, photosensitive switches, remote and relay switches shall be specified and these shall be of good quality and performance, as specified for each purpose.

4. All switches shall include a clear visual indication of their state.

5.17 Installation

1. The whole of the installation and components shall be in accordance with:-

   a) The current edition of "Regulations for the Electrical Equipment of Buildings" issued by the Institution of Electrical Engineers.

   b) Relevant British Standard specifications.

   c) Relevant Uganda Government Legislation.

SECTION 6 FIRE ALARM SYSTEM

6.1 Scope

This section provides recommendations for planning, design and installation of a local fire alarm system

6.2 General Design Considerations

1. Fire alarm system shall be designed so that:

   a) the earliest possible definite warning of fire (i.e., avoiding false alarm) is given to all personnel immediately concerned;

   b) it is capable of indicating the locality of the origin of the fire alarm as to facilitate the safe evacuation of the premises and to direct the fire fighters; and

   c) it performs its function with great reliability.

2. The equipment, wiring and use of fire alarm system shall be exclusive to that system and its power supply shall be provided independently from those for any other equipment.

3. The audible and visual alarm signals shall be used solely for the fire alarm purpose, and these signals shall not rest automatically.

4. The fire alarm and associated indicating panel shall be sited where they can be under constant observation when the premises are occupied and shall be accommodated in a room:

   a) in the direct vicinity of the main entrance;

   b) that provides adequate protection against ambient influences which could impair operations; e.g. vibration, smoke, dust, gasses, vapour, etc. produced by machinery, etc.; and

   c) that has room climate suitable for proper operation of the fire alarm control and indicating panel.

5. The design of a fire alarm circuit shall provide facilities for rapid and reliable transmission of initiated signals when manual call points or detectors are operated and when specified faults occur to control and indicating equipment.

6. Any resultant signal shall be transmitted by the simplest possible circuitry to sounders and other indicating equipment and to any equipment which is to be operated by the fire alarm system; e.g. fire extinguishers, fire protection traps, local plant facilities, etc.

7. Where chances of malfunction are high in fire alarm system, discriminatory circuit shall be incorporated in the system so that false alarms are identified.

8. Except in buildings where fire can be located without delay, the fire alarm system shall include an identification panel designed to show clearly the location of the origin of the alarm

6.3 Manual Call Points Location, Construction and Requirements

1. A manual call point shall be operated by a spring-loaded switch, which is held in “non- alarm” position and protected from accidental operation by a cover usually of glass. Breaking this glass cover releases the switch to an “alarm” position and the system starts to operate

2. Manual call points shall:

   a) be constructed of pressed metal, cast metal or plastic materials so that will not be adversely affected by the ambient temperature;

   b) be rigid enough in construction to withstand the abuse to which they are likely to be subjected, without deterioration or reduction in their ability to operate effectively when required to do so.;

   c) have contacts that are capable of operating satisfactorily during the design life of the installation;

   d) be coloured “signal red” over at least 50% of their visible area;

   e) have replaceable glass cover ; breaking the glass shall automatically operate the call point, and shall include description of the method of operation by a concise inscription including the word “FIRE” on case, or suitably inscribed plate behind the glass cover and;

   f) incorporate means whereby satisfactory operation may be readily and individually tested; e.g. by opening the front by means of special keys.

3. A striker shall be provided adjacent to the call point to facilitate breaking the glass.

4. Manual call points shall be:

   a) so located that no person need travel more than 30.0m from any position within the premises in order to give fire alarm;

   b) located on the exit routes and, in particular, on the floor landing of staircases and on exits to the street; and

   c) fixed at a height of 1.4m above the floor at easily accessible, well illuminated and conspicuous positions free from obstruction.

5. Where manual call points are incorporated in an automatic fire alarm system, they shall be included in such a way that the operation of any one of them produces the same effects as though fire had been detected by fire detector in the same zone.

6.4 Selection of Fire Detectors

1. When selecting the type of detectors, the probable development of fire in the incipient stage, the room height, the ambient conditions and all sources of spurious alarms in the area to be monitored shall be taken into consideration.

2. If development of a smoldering fire is anticipated in the incipient stage of fire (intense smoke generation, very little or no flame radiation), smoke detectors shall be used.

3. If a rapid development of the fire is anticipated as early as in the incipient stage of a fire (intense heat generation, intense flame radiation, and generation of smoke), smoke detectors, heat detectors, flame detectors, or combinations of the various types of fire detectors shall be used.

4. If smoke damage is anticipated as early as the incipient stage of a fire owing to room occupancy (risk to human life, materials and goods sensitive to smoke), smoke detectors shall be used.

5. If a very rapid development of the fire is anticipated with a high degree of probability, an automatic extinguisher system shall be considered.

6. Where high and/or suddenly rising temperature owing to natural conditions or conditions resulting from normal operations are likely, fixed-temperature detectors shall be used.

6.5 Sitting of Detectors

1. Building and installation complexes shall be monitored or covered completely and each effectively enclosed space shall be considered separately for this purpose in accordance with the limits of spacing for the types of detectors concerned.

2. Rooms divided into sections by walls, partitions or storage racks reaching 300.0mm of the ceiling or where goods might be stacked in defined areas to a corresponding height, shall have detectors for each section or passageway.

3. Hoists, elevators and similar flue-like openings shall be monitored by detectors at the top.

4. Staircases shall be monitored by detectors on each floor.

5. Generally, the inter-relationship between the suitability of the various types of fire detectors and room height shall be considered

6. Heat sensitive point detectors shall be mounted so that their heat sensitive elements are positioned not less than 25.0mm and not more than 150.0mm below the ceiling or the underside of the roof.

7. Where ceiling are crossed by beams, girders or other structural features having a depth of 500.0mm or more, at least one detector shall be installed in each “pocket” formed between each features, and these detectors shall not be less than 500.0mm from any beam, girder or wall.

8. Smoke detectors shall normally be sitting at the highest part of the enclosed areas, and shall be mounted so that their sensing area is not less than 25.0mm or more than 600.0mm below roof ceiling, except as may be indicated by site tests.

6.6 Audible and Visual Alarms

1. Inside a building at least two sounders shall be installed.

2. In case of an automatic system, an additional sounder outside the building (preferably near fire brigades access) shall be installed.

3. Alarm sounders shall satisfy the following requirements:

   a) Their type, number and location shall be such that the alarm is distinct from the background noise in every part of the premises.

b) Their noise shall be quite distinct from any other sounders likely to be heard.

c) Alarm sounders of the same kind on a particular installation shall produce a similar sound.

4. Where a general alarm is undesirable (e.g. department stores, entertainment places, hospitals), the alarm system shall be restricted to the provision of sounders out of the hearing of the public or patients.

5. The sounders shall be supplemented by an adequate number of visual signals throughout the premises for staff recognition only and/or by discrete special alerting facilities.

6. Silencing switches shall only be installed for transferring an alarm or fault warning to a supervisory sounders, and shall be so arranged as to put out of service the smallest practicable number of manual call points and detectors.

7. The operation of a silencing switch shall neither cancel the indications of the alarm or fault on any indicator concerned while an alarm or fault condition exists not prevent the proper receipt of alarms or fault warnings on any circuit other than those with which the silencing switch is associated.

8. Where it is desired to distinguish between an alert and an evacuate signal, a two-stage alarm shall be used in which the first type of signal indicates an alert and the second type indicates a need to evacuate the locality.

9. In general, visual signals shall be used to supplement audible alarms.

10. The operation of a sounder shall not be prevented by a defect in a visual signal or vice versa.

11. In situations where a normal type of alarm sounder may be ineffective, e.g. where the background noise is excessive or where the occupants are deaf, visual signals such as rotating beacon lamps shall be used in addition.

12. Where public-address equipment is used instead of conventional sounders, it shall be ensured that:

a) alarm of fire is automatically transmitted over the public address system, taking priority and over-riding every other facility and circuit conditions of the public address system;

b) other signals such meal-break, start and stop work, are not at any time broadcast by the public address equipment in a manner which can not be confused with a fire alarm signals:;

c) during alarm conditions, all microphones are automatically disconnected, except one designated a “fire microphone” which is retained in circuit so that it can be used for announcements and instructions relating to the fire;

6.7 Cables and Wiring

1. Cables shall have copper conductors and the cross-sectional area of the. conductors shall be selected on the basis of the current consumption of the equipment used and the line length

2. All conductors of a fire alarm system shall be:

a) installed in a metal raceway of the totally enclosed type;

b) incorporated in cable, having metal armour or sheath;

c) installed in rigid non-metallic conduit where embedded in at least 50.0mm of masonry or poured concrete, or installed underground.

3. The conductors shall be installed so as to be entirely exclusive to a fire alarm installation and the wiring of the alarm system shall be segregated from the wring of any other circuits and shall not enter a fixture, raceway, box or enclosure occupied by other wiring, except as may be necessary for connection to:

   a) the source of supply,

   b) a signal,

   c) an ancillary device,

   d) a communication circuit.

4. Fire-alarm wiring shall be spaced at least 50.0mm away from the circuits of any other service.

5. Where crossings are unavoidable, a bridge of suitable non-combustible insulating material, at least 6.0mm thick, shall be securely fitted to maintain path in air of 50.0mm between circuits.

6. All conductors contained in the same raceway or cable shall be insulated for the highest voltage in the raceway or cable.

7. In order to reduce the likelihood of damage to fire-alarm cables by fire, main fire alarm wiring shall avoid lift wells, staircases, and other flue-like opening.

8. If necessary, special measures shall be taken to protect the fire-alarm networks against disruptive electrical influences (electrical interferences) resulting from lightning strike, switching on high-power loads, electrical sparks of all types and electromagnetic waves.

6.8 Power Supply System

1. For powering a fire alarm system two mutually independent power sources shall be provided. The sources shall be:

   a) a general mains or an equivalent network, operated continually; and

   b) a rechargeable lead acid or nickel cadmium with sealed cells trickle-charging battery which is able to power in the event of main's failure.

2. The battery and charger shall be contained in a ventilated metal enclosure.

APPENDICES

Appendix 1

MEASUREMENT OF EARTH ELECTRODE RESISTANCE (E.E.R) USING A FOUR-TERMINAL EARTH TESTER MEGGER

PROCEDURE

a) Set the pointer at zero

b) Auxiliary electrodes “B” and “C” must be driven to a reasonably good depth into the ground.

c) The resistance areas of the earth electrodes must not overlap.

d) The two auxiliary electrodes must be in a straight line with the main electrode “A” under test.

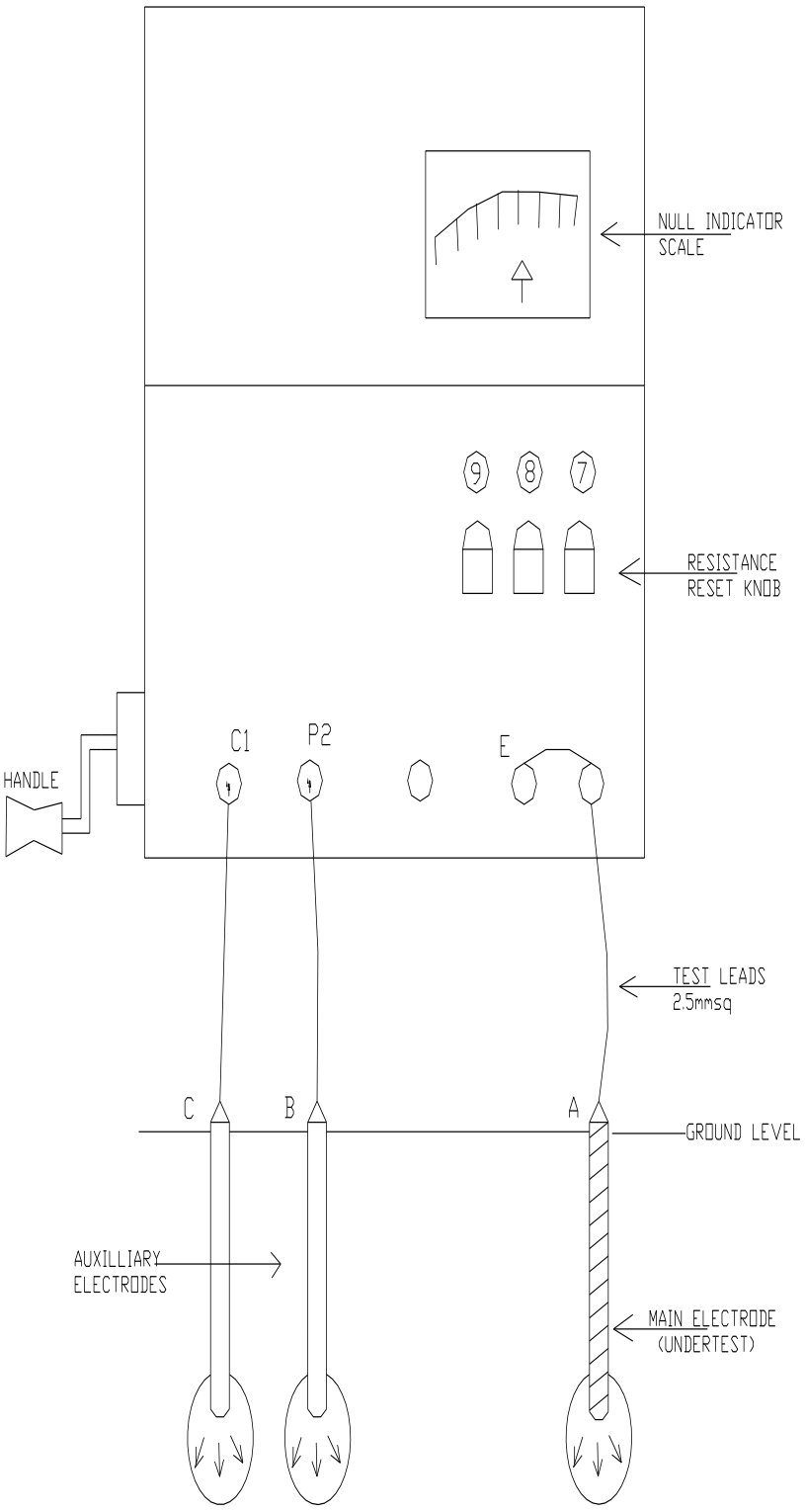
e) The test leads must not cross each other.

Recommended results must be less than 8 ohms.

FOUR-TERMINAL EARTH TESTING MEGGER

A - MAIN ELECTRODE (UNDERTEST)

B & C AUXILLIARY ELECTRODES



APPENDIX 2

OVERHEAD LINE CLEARANCES

1. CLEARANCE IN CROSSINGS

Crossing of Main Roads

The vertical clearances of a current-carrying conductor from the surface of a main road shall be at least:

- 0.4kV bare conductor lines	7.5m
- 0.4kV aerial bundled conductors	7.5m
- 0.4kV bare conductor lines	8.0m
- 33kV bare conductors lines	8.0m

Crossing of Public Streets

The vertical clearance of a current-carrying conductor from the surface of a public street shall be at least:

-0.4kV bare conductor lines	5.5m
-0.4kV aerial bundled conductors	5.5m
- 11kV bare conductor lines	6.0m
- 33kV bare conductor lines	6.0m

Crossing of Private Driveways

The vertical clearances of a current-carrying conductor from the surface of a private driveway shall be at least:

-0.4kV bare conductor lines	5.0m
-0.4kV aerial bundled conductors	5.0m
- 11kV bare conductor lines	6.0m
- 33kV bare conductor lines	6.0m

Crossing of Pedestrian Walkways

The vertical clearance of a current-carrying conductor from the surface of a pedestrian walkway shall be at least:

- 0.4kV bare conductor lines	4.5.m
- 0.4kV aerial bundled conductors	4.0m
- 11kV bare conductor lines	6.0m
- 33kV bare conductor lines	6.0.m

Crossing of Railway Tracks

The vertical clearance of a current-carrying conductor from a railway track shall be at least:

-0.4kV bare conductor lines	7.0m
-0.4kV aerial bundled conductors	7.0m
-11kV bare conductor lines	7.5m
-33kV bare conductor lines	7.5m

Crossing of Water Ways

When crossing canals or other navigable waterways, the height of the conductors from the highest shall be at the highest water level at least 20m high.

2. HORIZONTAL CLEARANCE FROM ROADS

If possible the line supports (with stays) shall be located at a distance of at least 2 meters from the edge of a road.

3. CLEARANCE FROM BUILDING

3.1 Line above or adjacent to building

1. If the horizontal clearance of a current-carrying conductor of a low voltage overhead line from any part of the building is less than 2meters its height above the referred part should be at least 3meters.

2. If the horizontal clearance of a current-carrying conductor of aerial bundled conductors (ABCs) from any part of the building is less than 0.5meters, its height from the referred part shall be at least 2.0meters.

3. The horizontal clearance of 11kV and 33kV bare conductor line from buildings shall be at least 3meters.

4. The horizontal clearances of 132kV and 220kV bare conductor line from buildings shall be at least 15meters.

4. CLEARANCE FROM TELECOMMUNICATION LINES

1. The clearance of the conductor of a 33kV bare conductor line from a telecommunication line shall be at least:

    a) 2.3 meters from parallel line
    b) 1.8 meters from a crossing line

2. The clearance of the conductor of an 11kV bare conductor line from a telecommunication line shall be at least:

    a) 2.0 meters from parallel line
    b) 1.5 meters from a crossing line

3. Due to interference effects, it is not recommended to construct MV lines and telecommunication lines parallel with each other for long distances.

4. The clearance of conductor of a 0.4kV bare conductor line from a telecommunication line shall be at least:

    a) 2.0 meters from a parallel line
    b) 1.5 meters from crossing line

5. The clearance of a 0.4kV of aerial bundled conductors (ABCs) line from a telecommunication line shall be at least 0.3meters.

APPENDIX 3

1) SINGLE-CORE PVC-INSULATED CABLES, NON-ARMOURED, WITH OR WITHOUT SHEATH (COPPER CONDUCTORS)

BS 6004, BS 6231, BS 6346 **Ambient temperature: 30ºC**

CURRENT-CARRYING CAPACITY (Amperes): **Conductor operating temperature: 70ºC**

Conductor cross-sectional area	Installation method (enclosed in conduit in thermally insulated wall etc.)		Installation method (enclosed in conduit on a wall or in trunking etc.)		Installation method (clipped direct)		Installation method (on a perforated cable tray horizontal or vertical)		Installation Method (free air)		
									Horizontal flat spaced	Vertical flat spaced	Trefoil
	2 cables, single-phase a.c. or d.c.	3 or 4 cables three-phase a.c.	2 cables single-phase a.c. or d.c.	3 or 4 cables three-phase a.c	2 cables, single-phase a.c. or d.c. flat and touching	3 or 4 cables three-phase a.c flat and touching or trefoil	2 cables, single-phase a.c. or d.c. flat and touching	3 or 4 cables three-phase a.c flat and touching or trefoil	2 cables, single-phase a.c. or d.c. or 3 cables three-phase a.c.	2 cables, single-phase a.c. or d.c. or 3 cables three-phase a.c	3 cables trefoil three-phase a.c.
1	2	3	4	5	6	7	8	9	10	11	12
mm^2	A	A	A	A	A	A	A	A	A	A	A
1	11	10.5	13.5	12	15.5	14	-	-	-	-	-
1.5	14.5	13.5	17.5	15.5	20	18	-	-	-	-	-
2.5	19.5	18	24	21	27	25	-	-	-	-	-
4	26	24	32	28	37	33	-	-	-	-	-
6	34	31	41	36	47	43	-	-	-	-	-
10	46	42	57	50	65	59	-	-	-	-	-
16	61	56	76	68	87	79	-	-	-	-	-
25	80	73	101	89	114	104	126	112	146	130	110
35	99	89	125	110	141	129	156	141	181	162	137
50	119	108	151	134	182	167	191	172	219	197	167
70	151	136	192	171	234	214	246	223	281	254	216
95	182	164	232	207	284	261	300	273	341	311	264
120	210	188	269	239	330	303	349	318	396	362	308
150	240	216	300	262	381	349	404	369	456	419	356
185	273	245	341	296	436	400	463	424	521	480	409
240	320	286	400	346	515	472	549	504	615	569	485
300	367	328	458	394	594	545	635	584	709	659	561
400	-	-	546	467	694	634	732	679	852	795	656
500	-	-	626	533	792	723	835	778	982	920	749
630	-	-	720	611	904	826	953	892	1138	1070	855
800	-	-	-	-	1030	943	1086	1020	1265	1188	971
1000	-	-	-	-	1154	1058	1216	1149	1420	1337	1079

2) MULTI-CORE PVC-INSULATED CABLES, NON-ARMOURED (COPPER CONDUCTORS)

BS 6004, BS 6346 **Ambient temperature: 30ºC**

CURRENT-CARRYING CAPACITY (Amperes): **Conductor operating temperature: 70ºC**

Conductor cross-sectional area	Installation method (enclosed in an insulated wall etc.)		Installation method (enclosed in conduit on a wall or ceiling etc.)		Installation method (clipped direct)		Installation method (on a perforated cable tray or free air)	
	2 cables, single-phase a.c. or d.c.	3 or 4 cables three-phase a.c.	2 cables single-phase a.c. or d.c.	3 or 4 cables three-phase a.c	2 cables, single-phase a.c. or d.c. flat and touching	3 or 4 cables three-phase a.c flat and touching or trefoil	2 cables, single-phase a.c. or d.c. flat and touching	3 or 4 cables three-phase a.c flat and touching or trefoil
1	2	3	4	5	6	7	8	9
mm^2	A	A	A	A	A	A	A	A
1	11	10	13	11.5	15	13.5	17	14.5
1.5	14	13	16.5	15	19.5	17.5	22	18.5
2.5	18.5	17.5	23	20	27	24	30	25
4	25	23	30	27	36	32	40	34
6	32	29	38	34	46	41	51	43
10	43	39	52	46	63	57	70	60
16	57	52	69	62	85	76	94	80
25	75	68	90	80	112	96	119	101
35	92	83	111	99	138	119	148	126
50	110	99	133	118	168	144	180	153
70	139	125	168	149	213	284	232	196
95	167	150	201	179	258	223	282	238
120	192	172	232	206	299	259	328	276
150	219	196	258	225	344	299	379	319
185	248	223	294	255	392	341	434	364
240	291	261	344	297	461	403	514	430
300	334	298	394	339	530	464	593	497
400	-	-	470	402	634	557	715	597

3) SINGLE-CORE ARMOURED (NON-MAGNETIC ARMOUR) PVC INSULATED CABLES (COPPER CONDUCTORS)

BS 6346 **Ambient temperature: 30ºC**

CURRENT-CARRYING CAPACITY (Amperes): **Conductor operating temperature: 70ºC**

Conductor cross-sectional area	Installation method (clipped direct)		Installation method (on a perforated cable tray horizontal or vertical)		Installation Method (free air)						
	2 cables, single-phase a.c. or d.c. flat and touching	3 or 4 cables three-phase a.c flat and touching	2 cables, single-phase a.c. flat and touching	3 or 4 cables three-phase a.c flat and touching	2 cables single-phase a.c.		2 cables d.c.		3 or 4 cables, three-phase a.c.		
					Horizontal flat spaced	Vertical flat spaced	Horizontal spaced	Vertical spaced	Horizontal flat spaced	Vertical flat spaced	3 cables trefoil
1	2	3	4	5	6	7	8	9	10	11	12
mm^2	A	A	A	A	A	A	A	A	A	A	A
50	193	179	205	189	229	217	229	216	230	212	181
70	245	225	259	238	287	272	294	279	286	263	231
95	296	269	313	285	349	332	357	340	338	313	280
120	342	309	360	327	401	383	315	396	385	357	324
185	447	399	469	422	511	489	548	525	490	456	425
240	525	465	550	492	593	568	648	622	566	528	501
300	594	515	624	547	668	640	748	719	616	578	567
400	687	575	723	618	737	707	885	851	674	632	657
500	763	622	805	673	810	777	1035	997	721	676	731
630	843	669	891	728	893	856	1218	1174	771	723	809
800	919	710	976	777	943	905	1441	1390	824	772	886
1000	975	737	1041	808	1008	967	1685	1627	872	816	945

4) MULTI-CORE ARMOURED PVC-INSULATED CABLES (COPPER CONDUCTORS)

BS 6346 **Ambient temperature: 30ºC**

CURRENT-CARRYING CAPACITY (Amperes): **Conductor operating temperature: 70ºC**

Conductor cross-sectional area	Installation method (clipped direct)		Installation method (on a perforated horizontal or vertical cable tray or free air)	
	1 two-core cable, single phase a.c. or d.c.	1 three- or four- core cable three-phase a.c.	1 two-core cable, single-phase a.c. or d.c.	1 three- or four-core cable, three-phase a.c.
1	2	3	4	5
mm^2	A	A	A	A
1.5	21	18	22	19
2.5	28	25	31	26
4	38	33	41	35
6	49	42	53	45
10	67	58	72	62
16	89	77	97	83
25	118	102	128	110
35	145	125	157	135
50	175	151	190	163
70	222	192	241	207
95	269	231	291	251
120	310	267	336	290
150	356	306	386	332
185	405	348	439	378
240	476	409	516	445
300	547	469	592	510
400	621	540	683	590

APPENDIX 4

CAPACITIES OF CONDUITS FOR SINGLE-CORE PVC CABLES

Nominal cable cross-section (mm^2)	Size of Conduits (mm diameter)				
	20	25	32	40	50
	Maximum number of cables that may be used in conduit				
1	11	16	-	-	-
1.5	9	13	-	-	-
2.5	6	9	17	-	-
4	5	7	14	-	-
6	4	6	10	18	-
10	3	4	8	13	-
16	-	3	5	9	-
25	-	2	3	6	9
35	-	-	2	4	7
50	-	-	-	3	5
70	-	-	-	2	4

APPENDIX 5

REFERENCED DOCUMENTS

I- STANDARDS

The following standards contain provisions, which through reference in this text constitute provisions of this regulation. At the time of publication of this regulation the editions indicated were valid. All standards are subject to revision and, since any reference to a regulation is deemed to be a reference to the latest edition of that standard, parties to agreements based on this regulation are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid national and international standards may be obtained from the Uganda National Bureau of Standards (UNBS) Documentation and Information Centre.

BS 7 Rubber-insulated cables and flexible cords for electric power and lighting (for working voltages up to and including 11kv)

BS 31 Specification. Steel conduit and fittings for electrical wiring

BS 67 Specification for ceiling roses

BS 88-4 1988 Cartridge fuses for voltages up to and including 1000V a.c. and 1500V d.c.

BS 731:2:1958 Specification. Flexible steel conduit for cable protection and flexible steel tubing to enclose flexible drives

BS 3676-1:1989 Switches for household and similar fixed electrical installations

BS 1363 13A plugs, socket-outlets, adaptors and connection units

Part 1- Specifications for rewirable and non-rewirable13A fused plugs
Part 2- Specification for 13 A switched and un-switched socket-outlets

BS 2004 PVC insulated cables and flexible cords for electric power and lighting

BS 7671:1992,

AMD 8536:1994 Requirements for Electrical Installations IEE Wiring Regulations Sixteenth Edition

IEC 60364-7-712 Electrical installation of buildings Solar photovoltaic (PV) power supply system

IEC 61215 Crystalline silicone terrestrial photovoltaic (PV) module -Design qualification and type approval

IEC 61646 Thin film terrestrial photovoltaic (PV) module -Design qualification and type approval

BS EN 60423 Conduits for electrical purposes

BS EN 61184 Bayonet lamp holders

BS 7895 Specification for Bayonet lamp holders with enhanced safety

BS 6007 Specification for rubber insulated cables for electric power and lighting

BS 6480	Specification for rubber insulated cables for electric power and lighting
US 602	Standard specification for PVC- insulated cables (non-armoured) for electric power and lighting
US 605	Standard specification for conductors in insulated cables and cords

II BIBLIOGRAPHY

1. IEE Regulations for Electrical Installations – 16th Edition (1992)
2. Code of Practice for Installation of Photovoltaic system US 152:2000
3. The Atomic Energy Decree, 1972
4. National Building Code of India
5. South African Standard-Code of Practice (The wiring of premises)
6. Ethiopian Building Code Standard-Electrical Installation of Buildings