Public Comment Draft

Zambian Standard

WIRING OF PREMISES – CODE OF PRACTICE

Part 1: Fundamental Principles and Assessment of General Characteristics

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FOREWORD

The Zambia Bureau of Standards (ZABS) is the Statutory Organization established by an Act of Parliament. ZABS is responsible for the preparation of national standards through its various Technical committees composed of representation from government departments, the industry, academia, regulators, consumer associations and non-governmental organisations.

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1. **SCOPE**

The Zambian Code of Practice for Wiring of Premises gives the rules for the design, selection, erection, inspection and testing of electrical installations. The rules are intended to provide for the safety of persons, livestock and property against dangers and damage which may arise in the reasonable use of electrical installations and to provide for the proper functioning of these installations.

1.1 This standard applies to electrical installations such as those of:

a). residential premises;
b). commercial premises;
c). public premises;
d). industrial premises;
e). agricultural and horticultural premises;
f). prefabricated buildings;
g). caravans, caravan sites and similar sites;
h). construction sites, exhibitions, fairs and other installations for temporary purposes;
i). marinas;
j). external lighting and similar installations;
k). medical locations;
l). mobile or transportable units;
m). photovoltaic systems; and
n). low - voltage generating sets.
1.2 These rules include requirements for:

a). circuits supplied at nominal voltages up to and including 1000 V a.c. or 1500 V d.c.;

For a.c., the preferred frequency which is taken into account in this standard is 50 Hz. The use of other frequencies for special purposes is not excluded.

b). circuits, other than the internal wiring of equipment, operating at voltages exceeding 1000 V and derived from an installation having a voltage not exceeding 1000 V a.c., e.g. discharge lighting, electrostatic precipitators;

c). wiring systems and cables not specifically covered by the standards for appliances;

d). all consumer installations external to buildings;

e). fixed wiring for information and communication technology, signalling, control and the like (excluding internal wiring of equipment); and

f). additions and alterations to installations and also parts of the existing installation affected by an addition or alteration.

1.3 The rules are intended to be applied to electrical installations generally but, in certain cases, they may need to be supplemented by the requirements or recommendations of other Zambian and applicable International Standards or by the requirements of the person ordering the work.

Such cases include the following:

a). Electric signs and high voltage luminous discharge tube installations
b). Emergency lighting
c). Electrical apparatus for explosive gas atmospheres
d). Electrical apparatus for use in the presence of combustible dust
e). Fire detection and fire alarm systems in buildings
f). Telecommunications systems
g). Electric surface heating systems
h). Electrical installations for open-cast mines and quarries
i). Code of practice for temporary electrical systems for entertainment and related purposes -
j). Life safety and fire fighting applications

1.4 These rules do not apply to the following installations:

a). Systems for the distribution of electricity to the public
b). Railway traction equipment, rolling stock and signaling equipment
c). Equipment of motor vehicles, except those to which the requirements of the Regulations concerning caravans or mobile units are applicable
d). Equipment of mobile and fixed offshore installations
1.5 The rules apply to items of electrical equipment only so far as selection and application of the equipment in the installation are concerned. They do not deal with requirements for the construction of assemblies of electrical equipment, which are required to comply with appropriate standards.

1.6 For installations in premises over which a licensing or other authority exercises a statutory control, the requirements of that authority shall be ascertained and complied with in the design and execution of the installation.

2. NORMATIVE REFERENCES

The following documents contain provisions which, through reference in this text, constitute provisions of DZS 791-1. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on DZS 791-1 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 can be obtained from the Zambia Bureau of Standards.

The Electricity Act

ZS 588: Plugs, socket-outlets and couplers for industrial purposes.

3. DEFINITIONS

For the purposes of these Rules, the following definitions shall apply:

3.1. **8/20 Current Impulse**: A current impulse with a virtual front time of 8 µs and a time to half value of 20 µs where:

   i). the front time is defined as \(1.25(t_{90}-t_{10})\), where \(t_{90}\) and \(t_{10}\) are the 90% and 10% points on the leading edge of the waveform

   ii). the time to half value is defined as the time between the virtual origin and the 50% point on the tail. The virtual origin is the point where a straight line drawn through the 90% and 10% points on the leading edge of the waveform intersects the I=0 line.
3.2. **Accessible**: Not permanently closed in by the structure or finish of the building.

3.3. **Accessory**: Any device, other than a lighting fitting, associated with the wiring and appliances of an installation; for example a switch, a fuse, a plug, a socket-outlet, a lamp-holder or a ceiling rose.

3.4. **Agricultural and horticultural premises**: Rooms, locations or areas where:

- Livestock are kept or
- Feed, fertilisers, vegetable and animal products are produced, stored, prepared or processed or
- Plants are grown, such as greenhouses.

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

3.6. **Amusement device**: Ride, stand, textile or membrane building, side stall, show, tent, booth or grandstand intended for the entertainment of the public.

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

3.8. **Arm's Reach**: A zone of accessibility to touch, extending from any point on a surface where persons usually stand or move about, to the limits which a person can reach with his hand in any direction without assistance.

This zone of accessibility is illustrated by **Figure 3-1** in which the values refer to bare hands without any assistance, e.g. from tools or ladder.

**Figure 3-1**: Zone of accessibility
3.9. **Arrangements for livestock keeping:** Buildings and rooms (housing for animals), cages, runs or other containers used for continuous accommodation of livestock.

3.10. **Backup protection:** Protection which is intended to operate when the a system fault is not cleared, or abnormal conditions not detected, in the required time because of failure or inability of other protection to operate or failure of the appropriate circuit breaker(s) to trip.

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

3.12. **Basic Insulation:** Insulation applied to live parts to provide basic protection and which does not necessarily include insulation used exclusively for functional purposes.

3.13. **Basic Protection:** Protection against electric shock under fault-free conditions.

   **NOTE:** For low voltage installations, systems and equipment, generally corresponds to protection against direct contact, that is “contact of persons or livestock with live parts”.

3.14. **Basin of fountain:** A basin not intended to be occupied by persons and which cannot be accessed (reached by persons) without the use of ladders or similar means. For basins of fountains which maybe occupied by persons, the requirements of swimming pools apply.
3.15. **Bathroom**: A room or part of a room which contains a bath, a shower or spa or any combination of these, each installed as a fixture.

3.16. **Bonding Conductor**: A protective conductor providing equipotential bonding.

3.17. **Bonding network (BN)**: A set of interconnected conductive parts that provide a path for currents at frequencies from direct current (d.c.) to radio frequency (RF) intended to impede the passage of electromagnetic energy.

3.18. **Bonding ring conductor (BRC)**: A bus earthing conductor in the form of a closed ring.

   **NOTE**: Normally the bonding ring conductor, as part of the bonding network has multiple connections to the common bonding network that improves its performance.

3.19. **Booth**: Non-stationary unit intended to accommodate equipment generally for pleasure or demonstration purposes.

3.20. **Building Void, accessible**: A space within the structure or the components of a building accessible only at certain points. Such voids include the space within partitions, suspended floors, ceilings and certain types of window frames, door frames and architraves.

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

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

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

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

   **NOTE**: Other system components may include tap-off units

3.24. **Cable**: A length of conductor having one or more cores that are assembled together during manufacture and that may or may not have an overall mechanical covering.

3.25. **Cable: armoured**: A cable provided with a metallic covering of wires or tapes as a protection against mechanical damage.
3.26. **Cable bracket:** A cable support system spaced at intervals along the length of the cable and to which the cable is fixed or on which it rests.

3.27. **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 allows access to the conduits and/or cables throughout their length during and after installation. A cable channel may or may not form part of the building construction.

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

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

3.30. **Cable ducting:** An 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.

3.31. **Cable ladder:** A cable support consisting of a series of transverse supporting elements rigidly fixed to the main longitudinal supporting members.

3.32. **Cable tray:** A cable support consisting of a continuous base with raised edges and no covering. The tray shall be perforated and the holes shall occupy 30% or more of the base surface area (this includes wire mesh trays).

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

3.34. **Cable tunnel:** A corridor containing supporting structures for cables and joints and/or other elements of wiring systems and whose dimensions allow persons to pass freely throughout the entire length.

3.35. **Caravan:** A trailer accommodation vehicle, used for touring, designed to meet the requirements of legislation for road vehicles.

3.36. **Caravan park/camping park:** An area of land which contains two or more caravan pitches and/or tents.

3.37. **Caravan pitch:** A plot of ground intended to be occupied by a leisure accommodation vehicle.

3.38. **Cartridge fuse link:** A device comprising a fuse element or two or more fuse elements connected in parallel enclosed in a cartridge usually filled with arc extinguishing medium and connected to terminations (see fuse link)
3.39. **Central power supply system**: A system supplying the required emergency power to essential safety equipment.

3.40. **Central power supply system (low power output)**: Central power supply system with a limitation of the power output of the system at 500W for 3h or 1 500W for 1h.

   NOTE: A low power supply system comprises a maintenance-free battery and a charging and testing unit.

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

3.42. **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.

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

3.44. **Circuit protective conductor (CPC)**: A protective conductor connecting exposed conductive parts of equipment to the main earthing terminal.

3.45. **Class I Equipment**: Equipment in which protection against electric shock does not rely on basic insulation only, but which includes means for the connection of exposed conductive parts to a protective conductor in the fixed wiring of the installation.

3.46. **Class II Equipment**: Equipment in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions such as supplementary insulation are provided i.e. double insulation, there being no provision for the connection of exposed metal work of the equipment to a protective conductor, and no reliance upon precautions to be taken in the fixed wiring of the installation.

3.47. **Class III Equipment**: Equipment in which protection against electric shock relies on supply at separated extra-low voltage (SELV) and in which voltages higher than those of SELV are not generated.

3.48. **Cold tail**: the interface between the fixed installation and a heating unit.

3.49. **Common equipotential bonding system, common bonding network (CBN)**: Equipotential bonding system providing both protective equipotential bonding and functional equipotential bonding.

3.50. **Competent person**: A person who possesses sufficient technical knowledge, relevant practical skills and experience for the nature of the electrical work undertaken and is able at all times to prevent danger and, where appropriate injury to him/herself and others.
3.51. **Complementary floor heating:** Direct heating system integrated into the floor construction, for example, in the border zones closer to outer walls, which complements the heat dissipation of a thermal storage floor heating system.

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

3.53. **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.

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

3.55. **Consumer unit:** (may also be known as a consumer control unit or electricity control unit). A particular type of distribution board comprising a type tested co-ordinated assembly for the control and distribution of electrical energy, principally in domestic premises, incorporating manual means of double-pole isolation on the incoming circuit(s) and an assembly of one or more fuses, circuit-breakers, residual current operated devices or signalling and other devices proven during the type-test of the assembly as suitable for such use.

3.56. **Continuous operating voltage (U_c):** Maximum r.m.s voltage which may be continuously applied to an SPD’s mode of protection. This is equal to the rated voltage.

3.57. **Controlgear:** (see Switchgear)

3.58. **Conventional impulse withstand voltage:** The peak value of an impulse test voltage at which insulation does not show any disruptive discharge when subjected to a specified number of applications of impulses of this value, under specified conditions.

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

3.60. **Current using equipment:** the maximum current which can be carried by a conductor under specified conditions without its steady state temperature exceeding a specified value.

3.61. **d.c. system:** - see Appendix 1.

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

   i) fire, electric shock and burns arising from the use of electrical energy, and
ii) mechanical movement of electrically controlled equipment, in so far as such danger is intended to be prevented by electrical emergency switching or by electrical switching for mechanical maintenance of non-electrical parts of such equipment.

3.63. **Design Current (of a Circuit):** The magnitude of the current (r.m.s value for a.c.) to be carried by the circuit in normal service.

3.64. **Device for connecting a luminaire (DCL):** System comprising an outlet and a connector providing a fixed luminaire with electrical connection to and disconnection from a fixed installation but not providing mechanical support for a luminaire.

3.65. **Discrimination:** Ability of a protective device to operate in preference to another protective device in series.

3.66. **Distribution Board:** An assembly containing switching and/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, where applicable and protective circuit conductors. It may also include signalling and other control devices. Means of isolation shall be included in the board or may be provided separately.

3.67. **Distribution circuit:** A circuit supplying a distribution board or switchgear.

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

3.68. **Distributor:** A person who distributes electricity to consumers using electrical lines and equipment that he/she owns or operates.

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

3.70. **Duct, ducting:** (see Cable ducting)

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

3.72. **Earth electrode:** Conductive part which may be embedded in the soil or in a specific conductive medium, e.g. concrete or coke, in electrical contact with the Earth.

3.73. **Earth electrode network:** Part of an earthing arrangement comprising only the earth electrodes and their interconnections.

3.74. **Earth electrode resistance:** The resistance of an earth electrode to Earth.
3.75. **Earth fault current**: A current resulting from a fault of negligible impedance between a line conductor and an exposed conductive part or a protective conductor.

3.76. **Earth fault loop impedance**: The impedance of the earth fault current loop starting and ending at the point of earth fault. The impedance is denoted by the symbol $Z_s$.

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

- the circuit protective conductor;
- the consumer's earthing terminal and earthing conductor;
- for TN systems, the metallic return path;
- for TT and IT systems, the earth return path;
- the path through the earthed neutral point of the transformer;
- the transformer winding; and
- the line conductor from the transformer to the point of fault.

3.77. **Earth leakage current**: (see Protective conductor current)

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

3.79. **Earthing**: Connection of the exposed conductive parts of an installation to the main earthing terminal of that installation.

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

3.81. **Electric shock**: A dangerous physiological effect resulting from the passing of an electric current through a human body or livestock.

3.82. **Electrical circuit for safety services**: Electrical source intended to be used as part of an electrical supply system for safety services

3.83. **Electrical Equipment** (abbr. Equipment): Any item for such purposes as generation, conversion, transmission, distribution or utilization of electrical energy, such as machines, transformers, apparatus, measuring instruments, protective devices, wiring systems, accessories, appliances and luminaires.

3.84. **Electrical Installation** (abbr: Installation): An assembly of associated electrical equipment supplied from a common origin to fulfil a specific purpose and having certain co-ordinated characteristics.

3.85. **Electrical supply system for safety services**: A supply system intended to maintain the operation of essential parts of an electrical installation and equipment:

For the health and safety of persons and livestock, and
To avoid damage to the environment and to

NOTE: The supply system includes the source and the circuit(s) up to the terminals of the electrical equipment

3.86. Electrically independent earth electrodes: Earth electrodes located at such a distance from one another that the maximum current likely to flow through one of them does not significantly affect the potential of the other(s).

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

3.88. Electronic convertor (static convertor): A convertor having no moving parts and notably using semiconductor rectifiers.

3.89. Emergency stopping: An emergency switching operation intended to stop an operation.

3.90. Emergency switching: An operation intended to remove, as quickly as possible, which may have occurred unexpectedly.

3.91. Enclosure: A part providing protection of equipment against certain external influences and in any direction protection against direct contact.

3.92. Equipment: (see electrical equipment in 3.98).

3.93. Equipotential Bonding: Electrical connection maintaining various exposed conductive parts and extraneous conductive parts at substantially the same potential. (see also Protective equipotential bonding).

3.94. Escape route: Path to follow for access to a safe area in the event of an emergency.

3.95. Exhibition: Event intended for the purpose of displaying and/or selling products etc., which can take place in any suitable location, either a room, building or temporary structure.

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

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

3.98. Extra-low voltage: (see voltage, nominal)

3.99. Extraneous conductive part: A conductive part liable to introduce a potential, generally Earth potential, and not forming part of the electrical installation.
3.100. **Fairground:** Area where one or more stands, amusement devices or booths are erected for leisure.

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

3.102. **Fault current:** A current resulting from a fault.

3.103. **Fault protection:** Protection against electric shock under single fault conditions.

NOTE: For low voltage installations, systems and equipment, fault protection generally corresponds to protection against indirect contact, mainly with regard to failure of basic insulation. Indirect contact is contact of persons or livestock with exposed conductive parts which have become live under fault conditions.

3.104. **Final Circuit:** A circuit connected directly to current-using equipment, or to one or more socket outlets, or other outlet points for the connection of such equipment.

3.105. **Fixed equipment:** Equipment designed to be fastened to a support or otherwise secured in a specified location.

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

3.107. **Flexible sheet heating element:** Heating element consisting of sheets of electrical insulation laminated with electrical resistance material or a base material on which electrically insulated heating wires are fixed.

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

3.109. **Follow-current interrupting rating:** The level of prospective short-circuit current that an SPD IS able to interrupt without back-up protection.

3.110. **Functional bonding conductor:** Conductor provided for functional equipotential bonding.

3.111. **Functional earth:** Earthing of a point or points in a system or in an installation or in equipment for purposes other than electrical safety such as for proper functioning of electrical equipment.

3.112. **Functional extra-low voltage (FELV):** An extra-low voltage system in which not all of the protective measures required for SELV or PELV have been applied.
3.113. **Functional switching:** An operation intended to switch ‘on’ or ‘off’ or vary the supply of electrical energy to all or part of an installation for normal operating purposes.

3.114. **Fuse:** A device for the purpose of protecting a circuit against damage from an excessive current flowing in it, by opening the circuit on the melting of a fuse-element by such excessive current. The fuse comprises all the parts that form the complete device.

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

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

3.117. **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.

3.118. **Fused connection unit:** A device associated with the fixed wiring of an installation by which appliances may be connected and having provision for a replaceable cartridge fuse link.

3.119. **Gas installation pipe:** Any pipe not being a service pipe (other than any part of a service pipe comprised in a primary meter installation) or a pipe comprised in a gas appliance for conveying gas for a particular consumer and including any associated valve or other gas lifting.

3.120. **Harmonized Standard:** A standard which has been drawn up by common agreement between national standards bodies notified to the relevant regional/continental bodies by all member states and published under national procedures.

3.121. **Hazardous Live Part:** A live part which can give, under certain conditions of external influence, an electric shock.

3.122. **Hazardous Situation:** A situation where a serious accident may occur due to even a slight leakage of current or, where an arc being established in any switchgear, appliance or accessory or the heat naturally generated by an appliance or conductor, may cause ignition or explosion.

3.123. **Heating cable:** Cable with or without a shield or a metallic sheath intended to give off heat for heating purposes.

3.124. **Heating-free area:** Unheated floor or ceiling area which is completely covered when placing pieces of furniture or kept free fix built-in furniture.

3.125. **Heating unit:** Heating cable or flexible sheet heating element with rigidly fixed cold tails or terminal fittings which are connected to the terminals of the electrical installation.
3.126. **High-density livestock rearing:** Breeding and rearing of livestock for which the use of automatic systems for life support is necessary.

   **NOTE:** Examples of automatic life support systems are those for ventilation, feeding and air conditioning.

3.127. **High voltage:** (see Voltage, nominal).

3.128. **Highway:** A highway means any way (other than a waterway) over which there is public passage and includes the highway verge and any bridge over which or tunnel through which the highway passes.

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

3.130. **Highway distribution circuit:** A Band II circuit connecting the origin of the installation to a remote highway distribution board or items of street furniture. It may also connect a highway distribution board to street furniture.

3.131. **Highway power supply:** An electrical installation comprising an assembly of associated highway distribution circuits highway distribution boards and street furniture supplied from a common origin.

3.132. **Houseboat:** Floating decked structure which is designed or adapted for use as a place of permanent residence often kept in one place on inland water.

3.133. **Impulse current (I_{imp}):** A parameter used for the classification test for SPDs; it is defined by three elements: a current peak value, a charge Q and a specific energy W/R.

3.134. **Impulse withstand voltage:** The highest peak value of impulse voltage of prescribed form and polarity which does not cause breakdown of insulation under specified conditions.

3.135. **Inspection:** Examination of an electrical installation using all the senses as appropriate.

3.136. **Installation:** (see electrical installation)

3.137. **Instructed person:** A person adequately advised or supervised by skilled persons to enable him/her to avoid dangers which electricity may create.

3.138. **Insulation:** Suitable non-conductive material enclosing, surrounding or supporting a conductor.
3.139. **Insulation co-ordination:** The selection of the electric strength of equipment in relation to the voltages which can appear on the system for which the equipment is intended taking into account the service environment and the characteristics of the available protective devices.

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

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

3.142. **Ladder:** (see Cable ladder)

3.143. **Leakage current:** Electric current in an unwanted conductive path under normal operating conditions.

3.144. **Leisure accommodation vehicle:** Unit of living accommodation for temporary or seasonal occupation which may meet requirements for construction and use of road vehicles.

3.145. **Lightning protection zone (LPZ):** Zone where the lightning electromagnetic environment is defined.

3.146. **Line 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 Regulations.

3.147. **Live (alive):** Energized or electrically charged.

3.148. **Live conductor:** (see Live part)

3.149. **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.

3.150. **Low voltage:** (see voltage, nominal)

3.151. **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.

**NOTE:** Lamps includes devices such as light emitting diodes.
3.152. **Low voltage switchgear and control gear assembly:** A combination of one or more low voltage switching devices together with associated control, measuring, signalling, protective, regulating equipment, etc., completely assembled under the responsibility of the manufacturer with all the internal electrical and mechanical interconnection and structural parts. The components of the assembly may be electromechanical or electronic. The assembly may be either type-tested or partially type-tested.

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

3.154. **Maintenance:** Combination of all technical and administrative actions including supervision actions intended to retain an item in or restore it to a state in which it can perform a required function.

3.155. **Marina:** Facility for mooring and servicing of pleasure craft with fixed wharves, jetties, piers or pontoon arrangements capable of berthing one or more pleasure craft.

3.156. **Mechanical Maintenance:** The replacement, refurbishment, repair, adjustment or cleaning of lamps and non-electrical parts of equipment, plant and machinery.

3.157. **Medical location:** Location intended for purposes of diagnosis treatment including cosmetic treatment, monitoring and care of patients

- **Applied part** - Part of medical electrical equipment that in normal use necessarily comes into physical contact with the patient for ME equipment or an ME system to perform its function.

- **Group O** - Medical location where no applied parts are intended to be used and where discontinuity (failure) of the supply cannot cause danger to life.

- **Group 1** - Medical location where discontinuity of the electrical supply does not represent a threat to the safety of the patient and applied parts are intended to be used:
  - externally
  - invasively to any part of the body except where group:2 applies.

- **Group 2** - Medical location where applied parts are intended to be used, and where discontinuity (failure) of the supply can cause danger to life. in applications such as:
  - intra-cardiac procedures
  - vital treatments and surgical operations.

**NOTE:** An intracardiac procedure is a procedure whereby an electrical conductor is placed within the heart of a patient or is likely to come into contact with the heart, such conductor being accessible outside the patient’s body. In this context, an electrical conductor includes insulated wires such as cardiac pacing electrodes or intracardiac ECG electrodes, or insulated tubes filled with conducting fluids.
• **Medical electrical equipment (ME equipment):** Electrical equipment having an applied part or transferring energy to or from the patient or detecting such energy transfer to or from the patient and which is
  a). provided with not more than one connection to a particular supply mains and
  b). intended by the manufacturer to be used;
    - in the diagnosis, treatment or monitoring of a patient or
    - for compensation or alleviation of disease, injury or disability.

  NOTE: ME equipment includes those accessories as defined by the manufacturer that are necessary to enable the normal use of the ME equipment

• **Medical electrical system (ME system):** Combination as specified by the manufacturer of items of equipment at least one of which is medical electrical equipment to be interconnected by functional connection or by use of a multiple socket-outlet.

  NOTE: The system includes those accessories which are needed for operating the system and are specified by the manufacturer.

• **Medical IT system:** IT electrical system fulfilling specific requirements for medical applications.

  NOTE: These supplies are also known as isolated power supply systems.

• **Patient:** Living being (person or animal) undergoing a medical, surgical or dental procedure.

  NOTE: A person under treatment for cosmetic purposes may be considered a patient.

• **Patient environment:** Any volume in which intentional or unintentional contact can occur between a patient and part of the medical electrical equipment or medical electrical system or between a patient and other persons touching parts of the medical electrical equipment or medical electrical system.

  NOTE: This applies when the patient's position is predetermined; if not, all possible patient positions should be considered.

3.158. **Meshed bonding network (MESH-BN):** Bonding network in which all associated equipment frames, racks and cabinets and usually the d.c. power return conductor are bonded together as well as at multiple points to the CBN and may have the form of a mesh.

  NOTE: MESH-BN improves the performance of a common bonding network.

3.159. **Minimum illuminance:** Illuminance for emergency lighting at the end of the rated operating time.
3.160. **Minor works:** Additions and alterations to an installation that do not extend to the provision of a new circuit.

**NOTE:** Examples include the additional socket-outlet or lighting point to an existing circuit, the relocation of a light switch etc.

3.161. **Mobile and offshore installations:** Installations used for the exploration or development of liquid or gaseous hydrocarbon resources.

3.162. **Mobile equipment (portable equipment (deprecated)):** Electrical equipment which is moved while in operation or which can easily be moved from one place to another while connected to the supply.

3.163. **Mobile home:** A transportable leisure accommodation vehicle which includes means of mobility but does not meet the requirements for construction and use of road vehicles.

3.164. **Monitoring:** Observation of the operation of a system or part of a system to verify correct functioning or detect incorrect functioning by measuring system variables and comparing the measured values with specified values.

3.165. **Motor Caravan:** Self-propelled leisure accommodation vehicle used for touring that meets the requirements for the construction and use of road vehicles.

**NOTE:** It is either adapted from a series production vehicle or designed and built on an existing chassis, with or without the driving cab, the accommodation being either fixed or dismountable.

3.166. **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 and also identifies either the mi-wire of a three wire d.c. circuit or the earthed conductor of a two wire earthed d.c. circuit.

3.167. **Nominal discharge current (I_{nspd}):** A parameter used for the classification test for Class I SPDs and for preconditioning of an SPD for Class I and Class II tests: it is defined by the crest value of current through an SPD, having a current II waveform of 8/20.

3.168. **Nominal Voltage:** (see voltage, nominal).

3.169. **Obstacle:** A part preventing unintentional contact with live parts but not preventing deliberate contact.

3.170. **Open-circuit voltage under standard test conditions line U_{oc STC}:** Voltage under standard test conditions across an unloaded (open) generator or on the d.c. side of the convertor.
3.171. **Operating and maintenance gangway:** Gangway providing access to facilitate operations such as switching, controlling, setting, observation and maintenance of electrical equipment.

3.172. **Open Wiring:** The system of installing uncased insulated conductors.

3.173. **Ordinary Person:** A person who is neither a skilled person nor an instructed person.

3.174. **Origin of an Installation:** The position at which the electrical energy is delivered to an electrical installation.

3.175. **Origin of the temporary electrical installation:** Point on the permanent installation or other source of supply from which electrical energy is delivered to the temporary electrical installation.

3.176. **Overcurrent:** A current exceeding the rated value. For conductors the rated value is the current-carrying capacity.

3.177. **Overcurrent Detection:** A method of establishing that the value of current exceeds a predetermined value for a specified length of time.

3.178. **Overload Current:** An overcurrent occurring in a circuit which is electrically sound.

3.179. **PEL:** A conductor combining the functions of both a protective earthing conductor and a line conductor.

3.180. **PELV** (protective extra-low voltage): An extra-low voltage system which is not electrically separated from Earth but which otherwise satisfies all the requirements for SELV.

3.181. **PEM** A conductor combining the functions of both a protective earthing conductor and a midpoint conductor.

3.182. **PEN Conductor:** A conductor combining the functions of both protective conductor and neutral conductor.

3.183. **Phase Conductor:** (see Line conductor)

3.184. **Pleasure craft:** Any boat vessel, yacht, motor launch, houseboat or other floating craft used exclusively for sport or leisure.

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

3.186. **Point (in Wiring):** A termination of the fixed wiring intended for the connection of current-using equipment.
3.187. **Portable Equipment**: (see Mobile equipment).

3.188. **Powertrack**: A system component, which is generally a linear assembly of spaced and supported busbars, providing electrical connection of accessories.

3.189. **Powertrack system (PT system)**: An assembly of system components including a powertrack b) which accessories may be connected to an electrical supply at one or more points (predetermined or otherwise) along the powertrack.

NOTE: The maximum current rating of a powertrack system is 63A.

3.190. **Prefabricated wiring system**: Wiring system consisting of wiring sections incorporating the means of interconnection designed to allow sections to be connected together to form a given system and incorporating installation couplers conforming to IEC 61535.

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

3.192. **Protective bonding conductor**: Protective conductor provided for protective equipotential bonding

3.193. **Protective Extra-low Voltage (PELV)**: An extra low voltage system which is not electrically separated from earth.

3.194. **Protective conductor**: A conductor used for some measure of protection against electric shock and intended for connecting together any of the following parts:

- i). exposed conductive parts;
- ii). extraneous conductive parts;
- iii). the main earthing terminal;
- iv). earth electrodes; and
- v). the earthed point of the source.

3.195. **Protective conductor current**: Electric current appearing in a protective conductor such as leakage current or electric current resulting from an insulation fault.

3.196. **Protective equipotential bonding**: Equipotential bonding for the purposes of safety.

3.197. **Protective multiple earthing (PME)**: An earthing arrangement found in TN-C-S systems. in which the supply neutral conductor is used to connect the earthing conductor of an installation with Earth.

3.198. **Protective separation**: Separation or one electric circuit from another by means of:
i). double insulation, or
ii). basic insulation and electrically protective screening (shielding). or
iii). reinforced insulation.

3.199. PV: Solar photovoltaic

- **PV a.c. module**: Integrated module convertor assembly where the electrical interface terminals are a.c. only, no access is provided to the d.c. side.
- **PV array**: Mechanically and electrically integrated assembly or PV modules, and other necessary components to form a d.c. power supply unit.
- **PV array cable**: Output cable of a PV array.
- **PV array junction box**: Enclosure where J>V strings or any PV array are electrically connected and where devices can be located.
- **PV cell**: Basic PV device which can generate electricity when exposed to light such as solar radiation.
- **PV convertor**: Device which converts d.c. voltage and d.c. current into a.c. voltage and a.c. current.
- **PV d.c. main cable**: Cable connecting the I'V generator junction box to the d.c. terminals or the PV convertor.
- **PV generator**: Assembly or PV arrays.
- **PV generator junction box**: Enclosure where PV arrays are electrically connected and where devices can be located.
- **PV installation**: Erected equipment or a PV power supply system.
- **PV module**: Smallest completely environmentally protected assembly or 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 string cable**: Cable connecting PV modules to form a PV string.
- **PV supply cable**: Cable connecting the a.c. terminals or the PV convertor to a distribution circuit or the electrical installation.

3.200. **Rated current**: Value of current used for specification purposes established for a specified set of operating conditions of a component, device, equipment or system.
3.201. **Rated impulse withstand voltage level (Uw):** The level or impulse withstand voltage assigned by the manufacturer to the equipment, or to part or it characterizing the specified withstand capability or its insulation against overvoltages.

3.202. **Reduced low voltage system:** A system in which the nominal line-to-line voltage does not exceed 110 volts and the nominal line to Earth voltage does not exceed 63.5 volts.

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

3.204. **Reporting:** Communicating the results of periodic inspection and testing or an electrical installation to the person ordering the work.

3.205. **Residences and other locations belonging to agricultural and horticultural premises:** Residences and other locations which have a conductive connection to the agricultural and horticultural premises by either protective conductors or the same installation or by extraneous-conductive-pans.

**NOTE:** Examples of other locations include offices, social rooms, machine halls, workrooms, garages and shops.

3.206. **Residential park home:** A factory produced relocatable dwelling designed for permanent residence which may be used for leisure purposes

3.207. **Residual current:** Algebraic sum of the currents in the live conductors or a circuit at a point in the electrical

3.208. **Residual Current:** The vector sum of the instantaneous values of current flowing through all live conductors of a circuit at a point in the electrical installation

3.209. **Residual Current Device (RCD):** A switching device or association of devices intended to cause the opening of the contacts when the residual current attains a given value under specified conditions.

3.210. **Residual current operated circuit-breaker with integral overcurrent protection (RCBO):** A residual current operated switching device designed to perform the functions of protection against overload and/or short-circuit.

3.211. **Residual current operated circuit-breaker without integral overcurrent protection (RCCB):** A residual current operated switching device not designed to perform the functions of protection against overload and/or short-circuit.

3.212. **Residual operating current:** Residual current which causes the RCD to operate under specified conditions.
3.213. **Resistance area (for an earth electrode only):** The surface area of ground (around an earth electrode) on which a significant voltage gradient may exist.

3.214. **Response time:** The time that elapses between the failure of the normal power supply and the ability of the auxiliary power supply to energize the equipment.

3.215. **Restrictive conductive location:** (see Conductive location with restricted movement)

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

3.217. **Safety service:** An electrical system for electrical equipment provided to protect or warn persons in the event of a hazard or essential to their evacuation from a location.

3.218. **Sauna:** A room or location in which air is heated, in service to high temperatures where the relative humidity is normally low rising only for a short period of time when water is poured over the heater.

3.219. **Separated Extra-low Voltage (SELV):** 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.

3.220. **Selectivity:** (see Discrimination).

3.221. **Shock:** (see Electric shock).

3.222. **Shock current:** A current passing through the body of a person or livestock such as to cause electric shock and having characteristics likely to cause dangerous effects.

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

3.224. **Short-circuit current under standard test conditions (I_{sc,T})**: Short-circuit current of a PV module, PV string, PV array or PV generator under standard test conditions.

3.225. **Show:** Display or presentation in any suitable location either a room, building or temporary structure.

3.226. **Simple separation:** Separation between circuits or between a circuit and Earth by means of basic insulation.

3.227. **Simultaneously Accessible Parts:** Conductors or conductive parts which can be touched simultaneously by a person or, in locations specifically intended for them, by livestock.
3.228. **Skilled Person:** A person with technical knowledge or sufficient experience to enable him/her to avoid dangers which electricity may create.

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

3.230. **Spur:** A branch from a ring final circuit.

3.231. **Stand:** Area or temporary structure used for display, marketing or sales.

3.232. **Standard test conditions (STC):** Test conditions specified in IEC 60904-3 for PV cells and PV modules.

3.233. **Standby electrical source:** Electrical source intended to maintain for reasons other than safety the supply to an electrical installation or a part or parts thereof, in case of interruption of the normal supply.

3.234. **Standby electrical supply system:** Supply system intended to maintain, for reasons other than safety the functioning of an electrical installation or a part or parts thereof, in case of interruption of the normal supply.

3.235. **Static convertor:** A convertor having no moving parts and notably using semiconductor rectifiers.

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

3.237. **Street Furniture:** Fixed equipment, located on a highway.

**NOTE:** Street furniture includes street located equipment.

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

3.239. **Supplementary Insulation:** Independent insulation applied in addition to basic insulation for fault protection.

3.240. **Surge current:** A transient wave appearing as an overcurrent caused by a lightning electromagnetic impulse.

3.241. **Surge protective device (SPD):** A device that is intended to limit transient overvoltages and divert surge currents. It contains non-linear components.
3.242. **Switch**: A mechanical device capable of making, carrying and breaking current under normal circuit conditions.

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

3.244. **Switch-disconnector**: A switch which, in the open position satisfies the isolating requirement specified for a location.

**NOTE**: A switch disconnector is otherwise known as an isolating switch

3.245. **Switchboard**: An assembly of switchgear with or without instruments. The term does not apply to groups of local switches in final circuits.

3.246. **Switchgear**: An assembly of main and auxiliary switching apparatus for operation, regulation, protection or other control of an electrical machine or system.

3.247. **System**: An electrical system consisting of a single source of electrical energy and an installation. For purposes of these Rules, types of systems are identified as follows, depending upon the relationship of the source and of exposed conductive parts of the installation to the earth:

a). **TN system**: A system having one or more points of the source of energy directly earthed, the exposed conductive parts of the installation being connected to that point by protective conductors.

b). **TN-C system**: A system in which neutral and protective functions are combined in a single conductor throughout the system.

c). **TN-S system**: A system having separate neutral and protective conductors throughout the system (see Figure 6-9).

d). **TN-C-S system**: A system in which neutral and protective functions are combined in a single conductor in part of the system (see Figure 6-10).

e). **TT system**: A system having one point of the source of energy directly earthed, the exposed-conductive-parts of the installation being connected to earth electrodes which are electrically independent of the earth electrodes of the source (see Figure 6-11).

f). **IT system**: A system having no direct connection between live parts and Earth, the exposed-conductive parts of the electrical installation being earthed.

g). Multiple source and d.c. systems – see Appendix 1

3.248. **Temporary electrical installation**: Electrical installation erected for a particular purpose and dismantled when no longer required for that purpose.

3.249. **Temporary overvoltage (U_{TOV})**: A fundamental frequency overvoltage occurring on the network at a given location of relatively long duration.
NOTE 1: TOVs may be caused by faults inside the LV system ($U_{\text{TOV,LV}}$) or inside the HV system($U_{\text{TOV,HV}}$)

NOTE 2: Temporary overvoltages, typically lasting up to several seconds usually originate from switching operations or faults (for example, sudden load rejection, single phase faults etc.) and/or from non-linearity (ferroresonance effects, harmonics etc.).

3.250. Temporary structure: A unit or part of a unit, including mobile portable units situated indoors or outdoors designed and intended to be assembled and dismantled

3.251. Temporary supply unit: An enclosure containing equipment for the purpose of taking a temporary electrical supply safely from an item of street furniture.

3.252. Testing: Implementation of measures to assess an electrical installation by means of which its effectiveness is proved. This includes ascertaining values by means of appropriate measuring instruments. Where measured values are not detectable by inspection

3.253. Thermal storage floor heating system: Heating system in which due to a limited charging period, a restricted availability of electrical energy is converted into heat and dissipated mainly through the surface of the floor to the room to be heated with an intended time delay.

3.254. Triplen harmonics: The odd multiples of the 3rd harmonic of the fundamental frequency (e.g. 3rd, 9th, 15th, 21st)

3.255. Trunking: (see Cable trunking).

3.256. Verification: All measures by means of which compliance of the electrical installation with the relevant requirements of this standard are checked comprising inspection, testing and certification.

3.257. 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 (ELV) - Normally not exceeding 50 V a.c. or 120 V ripple free d.c., whether between conductors or to earth.
- Low (LV) - Normally exceeding extra-low voltage but not exceeding 1 000 V a.c. or 1 500 V d.c. between conductors, or 600 V a.c. or 900 V d.c. between conductors and earth.
- High (HV) - Normally exceeding low voltage.

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

3.258. Voltage, reduced: (see Reduced low voltage system)

3.259. Voltage band
Band I
Band I covers:
- installations where protection against electric shock is provided under certain conditions by the value of voltage:
- installations where the voltage is limited for operational reasons (e.g. telecommunications, signalling bell, control and alarm installations).
Extra-low voltage (ELV) will normally fall within voltage Band I.

Band II
Band II contains the voltages for supplies to household and most commercial and industrial installations, Low voltage (LV) will normally fall within voltage Band II.

NOTE: Band II voltages do not exceed 1000V a.c. r.m.s or 1500V d.c.

3.260. Voltage protection level \((U_p)\): A parameter that characterises the performance of an SPD in limiting the voltage across its terminals which is selected from a list of preferred values; this value is greater than the highest value of the measured limiting voltages.

3.261. Wiring System: An assembly made up of cables or busbars and parts which secure and, if necessary, enclose the cables or busbars.
4. OBJECTIVE

This standard contains the rules for the design and erection of electrical installations so as to provide for safety and proper functioning for the intended use. Section 5 states the fundamental principles. It does not include detailed technical requirements, which may be subject to modification because of technical developments.

This Standard sets out technical requirements intended to ensure that electrical installations conform to the fundamental principles of Section 5, as follows:

- Part 2: Protection for safety
- Part 3: Design, selection and erection of equipment
- Part 4: Inspection and testing
- Part 5: Special installations or locations

Any intended departure from these Parts requires special consideration by the designer of the installation and shall be noted on the Electrical Installation Certificate specified in DZS 791 Part 4. The resulting degree of safety of the installation shall be not less than that obtained by compliance with the Rules.

5. FUNDAMENTAL PRINCIPLES

5.1 Protection for Safety

The requirements of DZS 791 Part 2 are intended to provide for the safety of persons, livestock and property against dangers and damage which may arise in the reasonable use of electrical installations. The requirements to provide for the safety of livestock are applicable in locations intended for them.

In electrical installations, risk of injury may result from:

i). shock currents
ii). excessive temperatures likely to cause burns, fires and other injurious effects
iii). ignition of a potentially explosive atmosphere
iv). under voltages, over voltages and electromagnetic disturbances likely to cause or result in injury or damage
v). mechanical movement of electrically actuated equipment, in so far as such injury is intended to be prevented by electrical emergency switching or by electrical switching for mechanical maintenance of non-electrical parts of such equipment
vi). power supply interruptions and/or interruption of safety services
vii). arcing or burning, likely to cause blinding effects, excessive pressure and/or toxic gases.

5.1.1 Protection against electric shock

5.1.1.1 Basic protection (protection against direct contact)

NOTE: For low voltage installations, systems and equipment, 'basic protection' generally corresponds to protection against 'direct contact'.
Persons and livestock shall be protected against dangers that may arise from contact with live parts of the installation. This protection can be achieved by one of the following methods:

i). Preventing a current from passing through the body of any person or any livestock
ii). Limiting the current which can pass through a body to a non-hazardous value.

5.1.1.2 Fault protection (protection against indirect contact)

NOTE: For low voltage installations, systems and equipment, 'fault protection' generally corresponds to protection against 'indirect contact', mainly with regard to failure of basic insulation.

Persons and livestock shall be protected against dangers that may arise from contact with exposed-conductive-parts during a fault.

This protection can be achieved by one of the following methods:

i). Preventing a current resulting from a fault from passing through the body of any person or any livestock

i). Limiting the magnitude of a current resulting from a fault, which can pass through a body, to a non-hazardous value

ii). Limiting the duration of a current resulting from a fault, which can pass through a body, to a non-hazardous time period.

In connection with fault protection, the application of the method of protective equipotential bonding is one of the important principles for safety.

5.1.2 Protection against thermal effects

5.1.2.1 The electrical installation shall be so arranged that the risk of ignition of flammable materials due to high temperature or electric arc is minimized. In addition, during normal operation of the electrical equipment, there shall be minimal risk of burns to persons or livestock.

5.1.2.2 Persons, livestock, fixed equipment and fixed materials adjacent to electrical equipment shall be protected against harmful effects of heat or thermal radiation emitted by electrical equipment, and in particular the following:

i). Combustion, ignition, or degradation of materials

ii). Risk of burns

iii). Impairment of the safe function of installed equipment.

Electrical equipment shall not present a fire hazard to adjacent materials.

5.1.3 Protection against overcurrent

Persons and livestock shall be protected against injury, and property shall be protected against damage, due to excessive temperatures or electromechanical stresses caused by any over currents likely to arise in live conductors.
NOTE: Protection can be achieved by limiting the overcurrent to a safe value and/or duration.

5.1.4 Protection against fault current

Conductors other than live conductors, and any other parts intended to carry a fault current, shall be capable of carrying that current without attaining an excessive temperature. Electrical equipment, including conductors, shall be provided with mechanical protection against electromechanical stresses of fault currents as necessary to prevent injury or damage to persons, livestock or property.

5.1.5 Protection against voltage disturbances and measures against electromagnetic disturbances

5.1.5.1 Persons and livestock shall be protected against injury, and property shall be protected against any harmful effects, as a consequence of a fault between live parts of circuits supplied at different voltages, in accordance with Section 6.3 of DZS 791 Part 2.

5.1.5.2 Persons and livestock shall be protected against injury, and property shall be protected against damage, as a consequence of over voltages such as those originating from atmospheric events or from switching, in accordance with Section 6.4 of DZS 791 Part 2.

NOTE: For protection against lightning strikes, refer to the IEC 62305 series.

5.1.5.3 Persons and livestock shall be protected against injury, and property shall be protected against damage, as a consequence of under voltage and any subsequent voltage recovery, in accordance with Section 6.5 of DZS 791 Part 2.

5.1.5.4 The installation shall have an adequate level of immunity against electromagnetic disturbances so as to function correctly in the specified environment, in accordance Section 6.5 of DZS 791 Part 2. The installation design shall take into consideration the anticipated electromagnetic emissions, generated by the installation or the installed equipment, which shall be suitable for the current-using equipment used with, or connected to, the installation.

5.1.6 Protection against power supply interruption

Where danger or damage is expected to arise due to an interruption of supply, suitable provisions shall be made in the installation or installed equipment.

5.2 Design, Selection and Erection of Equipment

5.2.1 Design of Installations

The electrical installation shall be designed to provide for:

i). the protection of persons, livestock and property in accordance with Section 5.1
ii). the proper functioning of the electrical installation for the intended use.
The information required as a basis for design is stated in 5.2.1.1 to 4. The requirements with which the design shall comply are stated in 5.2.1.5 to 14.

5.2.1.1 Characteristics of available supply or supplies

Information on the characteristics of the available supply or supplies shall be determined by calculation, measurement, enquiry or inspection. The following characteristics shall be included in the documentation referred to in Clause 5.2.1.12 to show conformity with the Rules:

i). Nature of current: a.c. and/or d.c.

ii). Purpose and number of conductors:
- for a.c.: line conductor(s)
  neutral conductor
  protective conductor
- for d.c.: line conductors
  midpoint conductor
  protective conductor

**NOTE:** The function of some conductors may be combined in a single conductor

iii). Values and tolerances:
- nominal voltage and voltage tolerances
- nominal frequency and frequency tolerances
- maximum current allowable
- prospective short-circuit current
- external earth fault loop impedance

iv). Protective measures inherent in the supply, e.g. earthed neutral or mid-wire

v). Particular requirements of the distributor.

**NOTE:** If the distributor changes the characteristics of the power supply this may affect the safety of the installation.

5.2.1.2 Nature of demand

The number and type of circuits required for lighting, heating, power, control, signalling, communication and information technology, etc shall be determined from knowledge of:

i). location of points of power demand

ii). loads to be expected on the various circuits

iii). daily and yearly variation of demand

iv). any special conditions, such as harmonics

v). requirements for control, signalling, communication and information technology, etc.

vi). anticipated future demand if specified.
5.2.1.3 Electrical supply systems for safety services or standby electrical supply systems

Where a supply for safety services or standby electrical supply systems is specified the following shall be determined:

i). Characteristics of the supply
ii). Circuits to be supplied by the safety source.

5.2.1.4 Environmental conditions

5.2.1.4.1 The design of the electrical installation shall take into account the environmental conditions to which it will be subjected.

5.2.1.4.2 Equipment in surroundings susceptible to risk of fire or explosion shall be so constructed or protected, and such other special precautions shall be taken, as to prevent danger

5.2.1.5 Cross-sectional area of conductors

The cross-sectional area of conductors shall be determined for both normal operating conditions and, where appropriate, for fault conditions according to:

i). the admissible maximum temperature
ii). the admissible voltage drop
iii). the electromechanical stresses likely to occur due to short-circuit and earth fault currents
iv). other mechanical stresses to which the conductors are likely to be exposed
v). the maximum impedance for correct operation of short-circuit and earth fault protection
vi). the method of installation
vii). harmonics
viii). thermal insulation.

5.2.1.6 Type of wiring and method of installation

The choice of the type of wiring system and the method of installation shall include consideration of the following:

i). The nature of the location
ii). The nature of the structure supporting the wiring
iii). Accessibility of wiring to persons and livestock
iv). Voltage
v). The electromechanical stresses likely to occur due to short-circuit and earth fault currents
vi). Electromagnetic interference
vii). Other external influences (e.g. mechanical, thermal and those associated with fire) to which the wiring is likely to be exposed during the erection of the electrical installation or in service.
5.2.1.7 Protective equipment

The characteristics of protective equipment shall be determined with respect to their function, including protection against the effects of:

i). overcurrent (overload and/or short-circuit)
ii). earth fault current
iii). overvoltage
iv). under voltage and no-voltage.

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

5.2.1.8 Emergency control

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

5.2.1.9 Disconnecting devices

Disconnecting devices shall be provided so as to permit switching and/or isolation of the electrical installation, circuits or individual items of equipment as required for operation, inspection, testing, fault detection, maintenance and repair.

5.2.1.10 Prevention of mutual detrimental influence

The electrical installation shall be arranged in such a way that no mutual detrimental influence will occur between electrical installations and non-electrical installations. Electromagnetic interference shall be taken into account.

5.2.1.11 Accessibility of electrical equipment

Electrical equipment shall be arranged so as to afford as may be necessary:

i). sufficient space for the initial installation and later replacement of individual items of electrical equipment
ii). accessibility for operation, inspection, testing, fault detection, maintenance and repair.

5.2.1.12 Documentation for the electrical installation

Every electrical installation shall be provided with appropriate documentation, including that required by section 2.5.7 of DZS 791 Part 3 and where applicable Part 5.

5.2.1.13 Protective devices and switches

5.2.1.13.1 A single-pole fuse, switch or circuit-breaker shall be inserted in the line conductor only
5.2.13.2 No switch or circuit-breaker, except where linked, or fuse, shall be inserted in an earthed neutral conductor. Any linked switch or linked circuit-breaker inserted in an earthed neutral conductor shall be arranged to break all the related line conductors.

5.2.14 Isolation and switching

5.2.14.1 Effective means, suitably placed for ready operation, shall be provided so that all voltage may be cut off from every installation, from every circuit thereof and from all equipment, as may be necessary to prevent or remove danger.

5.2.14.2 Every fixed electric motor shall be provided with an efficient means of switching off, readily accessible, easily operated and so placed as to prevent danger.

5.2.15 Additions and alterations to an installation

No addition or alteration, temporary or permanent, shall be made to an existing installation, unless it has been ascertained that the rating and the condition of any existing equipment, including that of the distributor, will be adequate for the altered circumstances. Furthermore, the earthing and bonding arrangements, if necessary for the protective measure applied for the safety of the addition or alteration, shall be adequate.

5.2.2 Selection of Electrical Equipment

5.2.2.1 General

5.2.2.1.1 Every item of equipment shall comply with the appropriate Zambian or International Standard.

5.2.2.1.2 Where there are no applicable standards, the item of equipment concerned shall be selected by special agreement between the person specifying the installation and the installer.

Where equipment to be used is not in accordance with Clause 5.2.2.1 or is used outside the scope of its standard, the designer or other person responsible for specifying the installation shall confirm that the equipment provides at least the same degree of safety as that afforded by compliance with the Rules.

5.2.2.2 Characteristics

Every item of electrical equipment selected shall have suitable characteristics appropriate to the values and conditions on which the design of the electrical installation (see Section 5.2.1) is based and shall in particular fulfil the requirements of 5.2.2.1 to 4

5.2.2.2.1 Voltage

Electrical equipment shall be suitable with respect to the maximum steady-state voltage (r.m.s value for a.c.) likely to be applied as well as overvoltages likely to occur.
NOTE: For certain equipment, it may also be necessary to take into account the lowest voltage likely to occur.

5.2.2.2 Current

Electrical equipment shall be selected with respect to the maximum steady current (r.m.s value for a.c.) which it has to carry in normal service and with respect to the current likely to be carried in abnormal conditions and the period (e.g. operating time of protective devices, if any) during which it may be expected to flow.

5.2.2.3 Frequency

Equipment shall be suitable for the frequencies likely to occur in the circuit.

5.2.2.4 Power

Electrical equipment which is selected on the basis or its power characteristics shall be suitable for the duty demanded of the equipment taking into account the load factor and the normal service conditions.

5.2.2.5 Conditions of installation

Electrical equipment shall be selected so as to withstand safely the stresses, the environmental conditions (see clause 5.2.1.4) and the characteristics of its location. An item of equipment which does not by design have the properties corresponding to its location may be used where adequate further protection is provided as part of the completed electrical installation.

5.2.2.6 Prevention of harmful effects

All electrical equipment shall be selected so that it will not cause harmful effects on other equipment or impair the supply during normal service. Including switching operations.

NOTE: Examples of characteristic which are likely to have harmful effects are given in section 6.3

5.2.2.7 New materials and inventions

Where the use of a new material or invention leads to departures from these requirements, the resulting degree or safety of the installation shall be not less than that obtained by compliance with the requirements. Such use is to be noted on the Electrical Installation Certificate specified in DZS 791 Part 4.

5.2.3 Erection and Initial Verification of Electrical Installations

5.2.3.1 Erection

5.2.3.1.1 Good workmanship by competent persons or persons under their supervision and proper materials shall be used in the erection of the electrical installation. Electrical equipment
shall be installed in accordance with the instructions provided by the manufacturer of the equipment.

5.2.3.1.2 The characteristics of the electrical equipment as determined in accordance with Section 5.2.2 shall not be impaired by the process of erection.

5.2.3.1.3 Conductors shall be identified in accordance with Section 2.5 of DZS 791 Part 3. Where identification of terminals is necessary they shall be identified in accordance with Section 2.5 of DZS 791 Part 3

5.2.3.1.4 Every electrical Joint and connection shall be of proper construction as regards conductance, insulation, mechanical strength and protection.

5.2.3.1.5 Electrical equipment shall be installed in such a manner that the design requirements are not exceeded

5.2.3.1.6 Electrical equipment likely to cause high temperatures or electric arcs shall be laced or guarded so as to minimize the risk of ignition of flammable materials.

Where the temperature of an exposed part of electrical equipment is likely to cause injury to persons or livestock, that part shall be so located or guarded as to prevent accidental contact therewith.

5.2.3.1.7 Where necessary for safety purposes, suitable warning signs and/or notices shall be provided.

5.3 Inspection and Testing

5.3.1 Initial verification

5.3.1.1 During erection and on completion of an installation or an addition or alteration to an installation, and before it is put into service, appropriate inspection and testing shall be carried out by competent persons to verify that the requirements of this Standard have been met. Appropriate certification shall be issued in accordance with Sections 4.1 and 4.2 of DZS 791 Part 4.

5.3.1.2 The designer of the installation shall make a recommendation for the interval to the first periodic inspection and test as detailed in DZS 791 Part 4.

Note: The requirements of Chapter 34 (maintainability) should be taken into consideration.

5.3.2 Periodic Inspection and Testing

It is recommended that every electrical installation is subjected to periodic inspection and testing, in accordance with Chapter 3 of DZS 791 Part 4.
6. **ASSESSMENT OF GENERAL CHARACTERISTICS**

An assessment shall be made of the following characteristics of the installation:

i). The purpose for which the installation is intended to be used, its general structure and its supplies

ii). The external influences to which it is to be exposed

iii). The compatibility of its equipment

iv). Its maintainability

v). Recognized safety services

vi). Assessment for continuity of service

These characteristics shall be taken into account in the choice of methods of protection for safety (DZS 791 Part 2) and the selection and erection of equipment (DZS 791 Part 3).

6.1 **Purpose, Supplies and Structure**

6.1.1 **Maximum Demand and Diversity**

For economic and reliable design of an installation within thermal limits and admissible voltage drop, the maximum demand shall be determined. In determining the maximum demand of an installation or part thereof, diversity may be taken into account.

6.1.2 **Conductor Arrangement and System Earthing**

The following characteristics shall be assessed:

i). Arrangement of current-carrying conductors under normal operating conditions

ii). Type of system earthing.

6.1.2.1 **General**

The following arrangements of current-carrying conductors under normal operating conditions are taken into account in this standard:

6.1.2.1.1 **Current-carrying conductors in a.c. circuits**

![Figure 6-1: Single phase 2-wire](image)
Figure 6-2: Single phase 3-wire

Phase angle 0°
* Numbering of conductors optional

Figure 6-3: Two phase 3-wire

Phase angle 180°  Phase angle 90°  Phase angle 120°
* Numbering of conductors optional

Figure 6-4: Three-phase 3-wire

Star connection  Delta connection

Figure 6-5: Three-phase 4-wire

Three-phase, 4-wire with neutral conductor or PEN conductor. By definition the PEN conductor is not a live conductor but a conductor carrying an operating current.
NOTE 1: In the case of a single phase 2 wire arrangement which is derived from a three phase 4-wire arrangement, the two conductors are either two line conductors or a line conductor and a neutral conductor or a line conductor and a PEN conductor.

NOTE 2: In installations with loads connected between phases, the installation of the neutral conductor may not be necessary.

6.1.2.1.2 Current carrying conductors in dc circuits

Figure 6-6: 2-wire

![2-wire diagram]

Figure 6-7: 3-wire

![3-wire diagram]

NOTE: PEL and PEM conductors are not live conductors although they carry operating current. Therefore, the designation 2-wire arrangement or 3-wire arrangement applies.

6.1.2.2 Types of system earthing

The following types of system earthing are taken into account in this standard:

TN-C, TN-S, TN-C-S, TT and IT

NOTE 1: Figures 6-9 to 11 show examples of commonly used three-phase systems. For IT, multiple source, d.c. and other systems see Appendix 1.

NOTE 2: For private systems, the source and/or the distribution system may be considered as part of the installation within the meaning of this standard.

NOTE 3: The codes used have the following meanings:

First letter - Relationship of the power system to Earth:
T = direct connection of one point to Earth;
I = all live parts isolated from Earth, or one point connected to Earth through a high impedance.

Second letter - Relationship of the exposed-conductive-parts of the installation to Earth:
T = direct electrical connection of exposed-conductive-parts to Earth, independently of the earthing of any point of the power system;
N = direct electrical connection of the exposed-conductive-parts to the earthed point of the power system (in a.c. systems, the earthed point of the power system is normally the neutral point or, if a neutral point is not available, a line conductor).

Subsequent letter(s) (if any) - Arrangement of neutral and protective conductors:
S = protective function provided by a conductor separate from the neutral conductor or from the earthed line (or, in a.c. systems, earthed phase) conductor.
C = neutral and protective functions combined in a single conductor (PEN conductor).

6.1.2.2.1 TN systems

6.1.2.2.1.1 Single-source systems

TN systems have one point directly earthed at the source, the exposed-conductive parts of the installation(s) being connected to that point by protective conductors. Two types of TN system are considered according to the arrangement of neutral and protective conductors, i.e. the TN-S and TN-C-S.

Figure 6-8: TN-S system

Separate neutral and protective conductors throughout the system.

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

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

6.1.2.2.1 Single-source system

A TT system has only one point directly earthed at the source, the exposed-conductive-parts of the installation(s) being connected to earth electrodes electrically independent of the earth electrode of the supply system (the source earth). [See figure 6-11]
6.1.2.3 IT, multiple source, d.c. and other systems

See Appendix 1.

6.1.3 Supplies

6.1.3.1 General

The following characteristics of the supply or supplies, from whatever source, and the normal range of those characteristics where appropriate, shall be determined by calculation, measurement, enquiry or inspection:

i). The nominal voltage(s) and its characteristics including harmonic distortion

ii). The nature of the current and frequency

iii). The prospective short-circuit current at the origin of the installation

iv). The earth fault loop impedance of that part of the system external to the installation, $Z_e$

v). The suitability for the requirements of the installation, including the maximum demand

vi). The type and rating of the overcurrent protective device(s) acting at the origin of the installation.

These characteristics shall be ascertained for an external supply and shall be determined for a private source. These requirements are equally applicable to main supplies and to safety services and standby supplies.

NOTE: The above information should be provided by distributors on request.
6.1.3.2 Supplies for safety services and standby systems

Where the provision of safety services is required, for example, by the authorities concerned with fire precautions and other conditions for emergency evacuation of the premises, and/or where the provision of standby supplies is required by the person specifying the installation, the characteristics of the source or sources of supply for safety services and/or standby systems shall be separately assessed. Such supplies shall have adequate capacity, reliability and rating and appropriate changeover time for the operation specified.

NOTE 1: For further requirements for supplies for safety services, see section 6.5 of this standard and hereafter Chapter 7 of DZS 791 Part 3.

NOTE 2: For standby systems, there are no particular requirements in this standard.

6.1.4 Division of Installation

6.1.4.1 Every installation shall be divided into circuits, as necessary, to:

i). avoid danger and minimize inconvenience in the event of a fault;
ii). facilitate safe inspection, testing and maintenance
iii). take account of hazards that may arise from the failure of a single circuit such as a lighting circuit
iv). reduce the possibility of unwanted tripping of RCDs due to excessive protective conductor (PE) currents not due to a fault
v). mitigate the effects of electromagnetic disturbances
vi). prevent the indirect energizing of a circuit intended to be isolated.

6.1.4.2 Separate circuits shall be provided for parts of the installation which need to be separately controlled, in such a way that those circuits are not affected by the failure of other circuits, and due account shall be taken of the consequences of the operation of any single protective device.

6.1.4.3 The number of final circuits required, and the number of points supplied by any final circuit, shall be such as to facilitate compliance with the requirements of Chapter 5 of DZS 791 Part 2 for overcurrent protection, Section 4.8 of DZS 791 Part 3 for isolation and switching and Chapter 3 of DZS 791 Part 3 as regards current-carrying capacities of conductors.

6.1.4.4 Where an installation comprises more than one final circuit, each final circuit shall be connected to a separate way in a distribution board. The wiring of each final circuit shall be electrically separate from that of every other final circuit, so as to prevent the indirect energizing of a final circuit intended to be isolated.

6.2 Classification of External Influences

Refer to Chapter 2 of DZS 791 Part 3 and Appendix 2 of this standard.
6.3 Compatibility

6.3.1 Compatibility of Characteristics

6.3.1.1 An assessment shall be made of any characteristics of equipment likely to have harmful effects upon other electrical equipment or other services or likely to impair the supply, for example, for co-ordination with concerned parties e.g. petrol stations, kiosks and shops within shops. Those characteristics include, for example:

i). transient overvoltages  
ii). undervoltage  
iii). unbalanced loads  
iv). rapidly fluctuating loads  
v). starting currents  
vi). harmonic currents  
vii). earth leakage current  
viii). excessive PE conductor current not due to a fault  
ix). d.c. feedback  
x). high-frequency oscillations  
xii). necessity for additional connections to Earth

For an external source of energy the distributor shall be consulted regarding any equipment of the installation having a characteristic likely to have significant influence on the supply.

6.3.2 Electromagnetic Compatibility

6.3.2.1 All electrical installations and equipment shall be in accordance with the EMC regulations and with the relevant EMC standard.

6.3.2.2 Consideration shall be given by the designer of the electrical installation to measures reducing the effect of induced voltage disturbances and electromagnetic interferences (EMI). Measures are given in Chapter 6 of DZS 791 Part 2.

6.4 Maintainability

6.4.1 General

6.4.1.1 An assessment shall be made of the frequency and quality of maintenance the installation can reasonably be expected to receive during its intended life. The person or body responsible for the operation and/or maintenance of the installation shall be consulted. Those characteristics are to be taken into account in applying the requirements of DZS 791 Parts 2 to 5 so that, having regard to the frequency and quality of maintenance expected:

i). any periodic inspection and testing, maintenance and repairs likely to be necessary during the intended life can be readily and safely carried out, and

ii). the effectiveness of the protective measures for safety during the intended life shall not diminish, and
iii). the reliability of equipment for proper functioning of the installation is appropriate to the intended life.

NOTE: There may be particular statutory requirements relating to maintenance.

6.5 Safety Services

6.5.1 General

NOTE 1: The need for safety services and their nature are frequently regulated by statutory authorities whose requirements have to be observed.

NOTE 2: Examples of safety services are: emergency escape lighting, fire detection and fire alarm systems, installations for fire pumps, fire rescue service lifts, smoke and heat extraction equipment.

6.5.1.1 The following electrical sources for safety services are recognized:

i). Storage batteries

ii). Primary cells

iii). Generator sets independent of the normal supply

iv). A separate feeder of the supply network that is effectively independent of the normal feeder (see Clause 7.3.5 of DZS 791 Part 3).

6.5.2 Classification

Refer to Section 7.2 of DZS 791 Part 3.

6.6 Continuity of Service

6.6.1 An assessment shall be made for each circuit of any need for continuity of service considered necessary during the intended life of the installation e.g. life-support systems. The following characteristics shall be considered:

i). Selection of the system earthing

ii). Selection of the protective device in order to achieve discrimination

iii). Number of circuits

iv). Multiple power supplies

Appendix 1  Definitions - Multiple Source, DC and Other Sources
(informative)

Fig A1  Explanation of symbols used in Appendix 1

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Neutral conductor (N), midpoint conductor (M)</td>
</tr>
<tr>
<td>PE</td>
<td>Protective conductor (PE)</td>
</tr>
<tr>
<td>PEN</td>
<td>Combined protective and neutral conductor (PEN)</td>
</tr>
</tbody>
</table>

NOTE 1: The dotted lines indicate the parts of the system that are not covered by the scope of this standard, whereas the solid lines indicate the part covered.

NOTE 2: For private systems, the source and/or the distribution system may be considered as part of the installation within the meaning of this standard. For this case, the figures may be completely shown in solid lines.

Fig A1A – TN-C-S Multiple source system with separate protective conductor and neutral conductor to current using equipment
Figure A1B – TN Multiple source system with protective conductor and no neutral conductor throughout the system for 2 or 3 phase load

NOTES to Figures A1A and A1B

a). No direct connection from either the transformer neutral point or the generator star point to Earth permitted.
b). The interconnection conductor between either the neutral points of the transformers or the generator star points is to be insulated. The function of this conductor is similar to a PEN; however, it must not be connected to current using equipment.
c). Only one connection between the interconnected neutral points of the sources and the PE is to be provided. This connection is to be located inside the main switchgear assembly
d). Additional earthing of the PE in the installation may be provided.
Figure A1C – IT system with exposed conductive parts earthed in groups or individually

NOTES
Additional earthing of the PE in the installation may be provided
1. The system may be connected to Earth via a sufficiently high impedance
2. The neutral conductor may or may not be distributed

Figure A1D – TN-S d.c system earthed line conductor L – separated from the protective conductor throughout the installation
Figure A1E – TN-S d.c. system earthed midpoint conductor M separated from the protective conductor throughout the installation

NOTE to Figures A1D and A1E
Additional earthing of the PE in the installation may be provided.

Figure A1F - TN-C d.c. system earthed line conductor L – and protective conductor combined in one single conductor throughout the installation
Figure A1G – TN-C d.c. system earthed midpoint conductor M and protective conductor combined in one single PEM throughout the installation

NOTE to Figures A1F and A1G
Additional earthing of the PEL or PEM in the installation may be provided

Figure A1H – TN-C d.c. system earthed line conductor L- and protective conductor combined in one single PEL in a part of the installation
Figure A1I – TN-C d.c. system earthed midpoint conductor M and protective conductor combined in one single PEM in a part of the installation

NOTES to Figures A1H and A1I
Additional earthing of the PE in the installation may be provided
The neutral and protective functions shall not be combined in a single conductor in a consumer’s installation

Figure A1J – TT d.c. system
Figure A1K – TT d.c. system

NOTE to Figures A1J and A1K
Additional earthing of the PE in the installation may be provided

Figure A1L – IT d.c. system earthed line conductor L- and protective conductor
Figure A1M – IT d.c. system earthed midpoint conductor M and protective conductor

NOTES to Figures A1L and A1M
Additional earthing of the PE in the installation may be provided
The system may be connected to Earth via a sufficiently high impedance
Appendix 2  Classification of External Sources  
(informative)

This appendix gives the classification and codification of external influences.

NOTE: The appendix is an extract from HD 60364-5-51.

Each condition of external influence is designated by a cock comprising a group or two capital letters and number, as follows:

The first letter relates to the general category of external influence:

A    Environment
B    Utilisation
C    Construction of buildings

The second letter relates to the nature of the external influence:

... A
... B
... C

The number relates to the class within each external influence:

... . . . 1
... . . . 2
... . . . 3

For example, the code AA4 signifies:

A    - Environment
AA   - Environment - Ambient temperature
AA4  - Environment - Ambient temperature in the range -5°C to +40°C.

NOTE: The codification given in this appendix is not intended to be used for marking equipment
**CONCISE LIST OF EXTERNAL SOURCES**

<table>
<thead>
<tr>
<th>Environment</th>
<th>AA</th>
<th>Ambient (°C)</th>
<th>AF</th>
<th>Corrosion</th>
<th>AM8</th>
<th>Radiated magnetic fields</th>
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<tbody>
<tr>
<td>AA1</td>
<td>-60°C</td>
<td>+5°C</td>
<td>AF1</td>
<td>Negligible</td>
<td>AM9</td>
<td>Electric fields</td>
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<tr>
<td>AA2</td>
<td>-40°C</td>
<td>+5°C</td>
<td>AF2</td>
<td>Atmospheric</td>
<td>AM21</td>
<td>High frequency</td>
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<tr>
<td>AA3</td>
<td>-25°C</td>
<td>+5°C</td>
<td>AF3</td>
<td>Intermittent</td>
<td>AM22</td>
<td>Conducted ... nano</td>
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<tr>
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<td>-5°C</td>
<td>+40°C</td>
<td>AF4</td>
<td>Continuous</td>
<td>AM23</td>
<td>Conducted .. micro</td>
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<tr>
<td>AA5</td>
<td>+5°C</td>
<td>+40°C</td>
<td>AF5</td>
<td></td>
<td>AM24</td>
<td>Conducted ... oscillatory</td>
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<td>+60°C</td>
<td>AM8</td>
<td></td>
<td>AM25</td>
<td>Radiated HF</td>
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<tr>
<td>AA7</td>
<td>-25°C</td>
<td>+55°C</td>
<td>AG1</td>
<td>Low</td>
<td>AM31</td>
<td>Electrostatic discharges</td>
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<tr>
<td>AA8</td>
<td>-50°C</td>
<td>+40°C</td>
<td>AG2</td>
<td>Medium</td>
<td>AM41</td>
<td>Ionisation</td>
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<table>
<thead>
<tr>
<th>AB</th>
<th>Temperature and Humidity</th>
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<td>AC</td>
<td>Altitude</td>
</tr>
<tr>
<td>AC1</td>
<td>≤ 2000 metres</td>
</tr>
<tr>
<td>AC2</td>
<td>&gt; 2000 metres</td>
</tr>
</tbody>
</table>

| AD | Water                     |
| AD1| Negligible               |
| AD2| Drops                    |
| AD3| Sprays                   |
| AD4| Splashes                 |
| AD5| Jets                     |
| AD6| Waves                    |
| AD7| Immersion                |
| AD8| Submersion               |

| AE | Foreign bodies            |
| AE1| Negligible               |
| AE2| Small                    |
| AE3| Very small               |
| AE4| Light dust               |
| AE5| Moderate dust            |
| AE6| Heavy dust               |

| AM | Electromagnetic ...       |
| AM1| Level                    |
| AM2| Signalling voltages      |
| AM3| Voltage amplitude variations |
| AM4| Voltage unbalance        |
| AM5| Power frequency variations |
| AM6| Induced low frequency voltage |
| AM7| DC current in AC network |

| AP | Seismic                  |
| AP1| Negligible               |
| AP2| Low                      |
| AP3| Medium                   |
| AP4| High                     |

| AQ | Lightning                |
| AQ1| Negligible               |
| AQ2| Indirect                 |
| AQ3| Direct                   |

| AS | Wind                     |
| AS1| Low                      |
| AS2| Medium                   |
| AS3| High                     |

| AR | Movement of air          |
| AR1| Low                      |
| AR2| Medium                   |
| AR3| High                     |

| BC | Contact with Earth       |
| BC1| None                     |
| BC2| Low                      |
| BC3| Frequent                 |
| BC4| Continuous               |

| BD | Evacuation               |
| BD1| Normal                   |
| BD2| Difficult                |
| BD3| Crowded                  |
| BD4| Difficult and crowded    |

| BE | Materials                |
| BE1| No risk                  |
| BE2| Fire risk                |
| BE3| Explosion risk           |
| BE4| Contamination risk       |

| BA | Capability               |
| BA1| Ordinary                 |
| BA2| Children                 |
| BA3| Handicapped              |
| BA4| Instructed               |
| BA5| Skilled                  |

| BB | Resistance               |

| CA | Materials                |
| CA1| Non-combustible          |
| CA2| Combustible              |

| CB | Structure                |
| CB1| Negligible               |
| CB2| Fire propagation         |
| CB3| Structural movement      |
| CB4| Flexible                 |