

# NON-DOMESTIC **ELECTRICAL** **INSTALLATION** SAFETY CODE





---

© All rights reserved. Reproduction of all or any part of this publication via electronic, mechanical, recording or other medium is strictly prohibited without written consent from the Energy Commission.

PUBLISHED BY:  
SURUHANJAYA TENAGA (ENERGY COMMISSION)

No. 12, Jalan Tun Hussein, Precinct 2, 62100 Putrajaya, Malaysia.  
Tel: (03) 8870 8500 Fax: (03) 8888 8637  
Toll Free: 1-800-2222-78 (ST)  
[www.st.gov.my](http://www.st.gov.my)

ISBN : 978-967-2085-02-7  
ST PUBLICATION NUMBER : ST(P)13/06/2017  
PRINTED IN MALAYSIA

# ELECTRICITY SUPPLY ACT 1990

[Act 447]

## NON-DOMESTIC ELECTRICAL INSTALLATION SAFETY CODE

KOD/ST/No.4/2016

IN exercise of the power conferred by Section 50A of the Electricity Supply Act 1990 [Act 447], the Energy Commission, with the approval of the Minister makes the following Code:

### Citation and Commencement

1. This Code may be cited as the "Non-Domestic Electrical Installation Safety Code".
2. The Non-Domestic Electrical Installation Safety Code will be issued by the Commission, based on the approval by the Commission on 20<sup>th</sup> October 2016 and the Minister on 24<sup>th</sup> December 2016 and shall be enforced and effect from the date of registration.

### Application of the Code

3. This Code shall be applicable to all non-domestic installations of consumers and installation of licensees for retail and licensees of private installation where electricity is supplied to, except installations as stated in part 1.2.4 of the Code.

### Interpretation

4. The term and expression used shall, unless defined in the Code or the context otherwise requires, have the same meaning as in the Act or Regulations made under it.

## Notice by the Commission

6. The Energy Commission may issue written notices from time to time in relation to the Code.

## Amendment and Variation

7. The Energy Commission under Section 50D of Electricity Supply (Amendment) Act 2015, may at any time review, amend, modify, vary or revoke this Code or any part thereof, under the following circumstances:

- i) to effect changes in the electricity supply industry;
- ii) where it is expedient to address safety aspect of electrical installation in respect to design, construction, inspection and testing, operation and maintenance;
- iii) as recommended by the Non-Domestic Electrical Installation Safety Code Committee and approved by the Energy Commission; or
- iv) any other justifiable reasons as the Energy Commission deems necessary.

Dated : 17 MAY 2017



**DATUK IR. AHMAD FAUZI BIN HASAN**  
Chief Executive Officer  
for Energy Commission

# CONTENTS

<b>1.0</b>	<b>INTRODUCTION</b>	<b>7</b>
1.1	Custodian	7
1.2	Scope	7
1.3	Objectives	8
1.4	Definitions	9
<b>2.0</b>	<b>INSTALLATION</b>	<b>13</b>
2.1	Legal Requirements	13
2.2	Design	13
2.3	Selection of Material and Equipment	14
2.4	Earthing of Installation	15
2.5	Means of Isolation	19
2.6	Safety Considerations	19
2.7	Determination of Maximum Demand	19
2.8	Determination of Short-Circuit Currents	20
2.9	Protection	20
2.10	Selection and Erection of Electrical Equipment	23
2.11	Wiring Systems	24
2.12	Isolation, Switching and Control Equipment	25
2.13	Discrimination	26
2.14	Earthing Arrangements and Protective Conductors	26
2.15	Minimum Cross-sectional Area of a Protective Conductor or Earthing Conductor	26
2.16	Integrity of Protective Conductors and Earthing Conductors	26
2.17	Earthing Conductor	27
2.18	Other Equipment	27
2.19	Metering and Monitoring Equipment	27
2.20	Harmonics Management	28
2.21	Size of Neutral Conductor due to Third Harmonic Contents	28
2.22	Energy Management	28
2.23	Competent Control	28
2.24	Precautions for Work on Equipment Made Dead	28
2.25	Work on or Within the Safety Clearance to Live Conductors	29
2.26	Working Space, Access and Lighting	29
2.27	Permit to Work	29
2.28	Supervision and Testing of Installations	29
2.29	Initial Inspection, Testing and Commissioning	30
2.30	Safety Clearance	30

<b>3.0</b>	<b>OPERATIONS</b>	<b>31</b>
3.1	General	31
3.2	Safety Management Programme	31
3.3	Competency Requirements	31
3.4	Reporting of Accidents and Fires	32
<b>4.0</b>	<b>MAINTENANCE</b>	<b>33</b>
4.1	General	33
4.2	Maintenance Schedules	34
4.3	Precautions when Working on Installation	34
4.4	Use of Personal Protective Equipment	35
4.5	Maintenance of Records	35
<b>5.0</b>	<b>MISCELLANEOUS</b>	<b>36</b>
<b>ANNEX 1</b>	<b>SAFETY MANAGEMENT PROGRAMME</b>	<b>39</b>
<b>ANNEX 2</b>	<b>RELEVANT STANDARDS</b>	<b>43</b>
<b>ANNEX 3</b>	<b>TABLES AND FIGURES</b>	<b>50</b>
<b>ANNEX 4</b>	<b>FORMULAS</b>	<b>57</b>

# NON-DOMESTIC ELECTRICAL INSTALLATION SAFETY CODE



## 1.0 INTRODUCTION

### 1.1 Custodian

1.1.1 This Code has been developed and issued by the Energy Commission, hereinafter referred to as (the Commission).

1.1.2 This code is developed in line with the requirement under section 33B of the Electricity Supply (Amendment) Act 2015 [Act A1501] which states that a non-domestic electrical installation owner or operator registered under this Act, licensee for retail and licensee for a private installation shall comply with the non-domestic electrical installation safety code and the safety management programme, or in the absence of such code or programme, with standards and prudent industry practices as may be determined by the Commission.

### 1.2 Scope

1.2.1 This Code shall be applicable to all non-domestic installations of consumers and installation of licensees for retail and licensees of private installation where electricity is supplied to, except installations as stated in part 1.2.4.

1.2.2 The Code elaborates on the policy and standards for the design, construction, inspection and testing, operation and maintenance of the relevant installations.

1.2.3 The Code shall apply to owners, tenants and operators of the relevant installations and any of their personnel or personnel of their contractors or sub-contractors working on the installations.

1.2.4 The Code shall not apply for: -

- i. any electricity supply infrastructure owned or operated by a generation or distribution licensee, up to and including meters on consumer premises;
- ii. any wires, fittings, equipment or accessories connected to and beyond any electrical outlet at which fixed wiring terminates, other than any such outlets used to connect sections of fixed wiring;
- iii. installation of a domestic consumer, that is, a consumer occupying a private dwelling, which is not used as a hotel, boarding house or used for the purpose of carrying out any form of business, trade, professional activities or services;



- iv. installations with an incoming electricity supply of less than 100 Amperes (single phase);
- v. installations at communications systems including radio, cable television, telecommunications, and similar systems;
- vi. installations of a specialised nature such as underground mines, oil and gas refineries and transportation systems;
- vii. automotive wiring;
- viii. temporary wiring on construction or similar projects; or
- ix. electrical appliances.

### 1.3 Objectives

1.3.1 The objectives of this Code are to: –

- i. promote suitable practices in the design, construction, inspection, testing, operation and maintenance of electrical installation which are generally found to be appropriate in terms of safety;
- ii. provide the safety requirements in relation to the design, construction, operation, inspection, testing and maintenance of the relevant installations, in accordance with applicable technical standards and good practices;
- iii. address the type of safety tools and equipment to be used in carrying out electrical works in the relevant installations; and
- iv. provide the framework for individual owners or operators of the relevant installations shall produce their own safety management programme, as stipulated in part 3.2 of this Code.

## 1.4 Definitions

**“authorized person”** means a person appointed by the management or the owner of an installation, or by a contractor, acting as an agent for and/or on behalf of the management or owner, to carry out certain duties incidental to the generation, transmission, distribution and utilization of electricity:

Provided that the said person possesses the qualifications prescribed for persons performing those duties, or if no qualifications are prescribed, is competent for the purpose for which, he is employed, the burden of proof of competency being on the employer;

**“Commission”** means the Energy Commission established under the Energy Commission Act 2001;

**“competent person”** means a person who holds a certificate of competency issued by the Commission to perform work in accordance with the restrictions, if any, stated in the certificate;

**“conductor”** means an electrical conductor arranged to be electrically connected to a system;

**“confined space”** means a limited, narrow, restricted working area, ventilation, illumination, access of an enclosed or partially enclosed space that is at atmospheric pressure during occupancy and is not intended primarily as a place of work whereby during working in a confined space, it shall be temporarily provided with illuminated, ventilated, accessed, working space suitable for work execution and is liable at any time to have an atmosphere which contains potentially harmful levels of contaminants, an oxygen deficiency or excess or cause engulfment and could have means for entry and exit;

**“dead”** or **“de-energised”** means not connected to any source of electrical supply but not necessarily isolated;

**“earthed”** means connected to the general mass of the earth;

**“earth air clearance”** means the distance between any high voltage overhead line conductor to earth under specified conditions;

**“electrical work”** means any work performed or carried out on an electrical installation and includes the installing, constructing, erecting or repairing, the altering of the structure, the replacing of any of its parts, the adding of any part to it or the carrying out of any work for the purposes of its maintenance, but does not include work in relation to: —

- (a) the manufacturing of an electrical installation or the assembling in the course of, or in connection with, its manufacture for the purpose of producing a new article; or
- (b) the oiling, greasing, cleaning or painting of an electrical installation;

**“electricity regulations”** means Electricity Regulations 1994 made under the powers conferred under section 53 of the Electricity Supply Act 1990 (Act 447);

**“extra low voltage”** (ELV) means a voltage normally not exceeding 50 volts alternating current or 120 volts direct current, whether between conductors or between conductor and earth;

**“energised”** means made alive or connected to a source of electrical supply;

**“equipment”** includes any item for such purposes as generation, conversion, transmission, distribution or utilisation of electrical energy or communications such as machines, transformers, apparatus, measuring instruments, protective devices, wiring materials, accessories, electrical products, consumer electrical equipment and appliances;

**“exposed live parts”** means bare or not covered with or protected by insulating material, or an electrical conductor, approach to which is not prevented by a barrier of rigid material or by insulation which is adequate under a relevant Standard specification for the voltage concerned;

**“exposure”** means the contact of a person with a hazard;

**“fault finding”** means the process of making measurements or carrying out tests on the electrical installation in order to prove operability or locate faults;

**“functional extra low voltage”** (FELV) means an extra-low voltage system in which not all of the protective measures required for SELV or PELV have been applied;

**“hazard”** means anything (including work practices or procedures) that has the potential to harm the health and safety of a person, livestock or property;

**“high voltage”** means a voltage normally exceeding 50,000 volts but equal to or not exceeding 230,000 volts;

**“installation”** means the whole of any plant or equipment under one ownership or, where a management is prescribed, the person in charge of the same management, designed for the supply or use, or both, as the case may be, of electricity; including prime movers, if any, with all necessary plant, buildings and land in connection therewith, pipe line, supply line and consuming apparatus, if any;

**“inspection”** means a conformity evaluation by observation and judgement accompanied as appropriate by measurement, testing or gauging of an electrical installation, electrical circuits, apparatus, associated equipment and other workplace;

**“isolated”** means disconnected from all possible sources of electrical energy by opening of switches, opening or withdrawal of circuit-breakers, removal of fuses, links, connectors, isolators and the like and rendered incapable of being energised unintentionally;

**“licensee”** means a person licensed under section 9 of the Electricity Supply Act 1990 (Act 447);

**“live” or “alive”**, applied to a system or any part of any system, means that a voltage exists between any conductor and earth or between any two conductors in the system;

**“low voltage”** means a voltage normally exceeding extra low voltage but not exceeding 1,000 volts alternating current or 1,500 volts direct current between conductors, or 600 volts alternating current or 900 volts direct current between conductor and earth;

**“maximum demand”** is the capacity of electricity usage, is measured in kilowatts, and is calculated as double the highest amount of electricity used (in kilowatt-hours) within any consecutive period of thirty minutes in a month;

**“medium voltage”** means a voltage normally exceeding low voltage but equal to or not exceeding 50,000 volts;

**“neutral conductor”** means a neutral line conductor connected to the neutral point of a system and contributing to the transmission of electrical energy;

**“protective extra low voltage”** (PELV) means an extra-low voltage system which is not electrically separated from earth, but which otherwise satisfies all the requirements for SELV;

**“personal protective equipment”** (PPE) means items that electrical workers can use to protect themselves against hazards. PPE includes insulating gloves, insulating mats or sheeting, safety helmet, safety glasses, safety shoes, face protection and flame-resistant and radiation retardant clothing;

**“plant”** means machinery, any non-electrical equipment or any non-electrical appliances;

**“risk”** means a combination of the probability that a hazard may cause an injury and the severity of an injury;

**“safety clearance”** means the distance to be maintained between the exposed live conductor to earth level or platform or access way to avoid danger;

**“separated extra low voltage”** (SELV) means 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;

**“substation”** means any premises or enclosed part which contains apparatus for either transforming or converting energy to or from voltages at medium voltage or higher voltage (other than transforming or converting energy solely for the operation of switching devices or instruments) or for switching, controlling or regulating energy at medium voltage or higher voltage and which is large enough to admit the entrance of a person after the apparatus is in position, and includes the apparatus therein;

**“system”** means an electrical system in which all the conductors and equipment are electrically or magnetically connected;

**“testing”** means implementation of measures to access an electrical installation by means of which its effectiveness is proved whereby this includes ascertaining values by means of appropriate measuring instruments, where measured values are not detectable by inspection;

**“TN-C system”** means a system in which neutral and protective functions are combined in a single conductor throughout the system and having a single earthing at a source whereby the single conductor is combined with neutral point of the source and earthed at the source earthing and all exposed metal parts shall be connected to single conductor and shall be earthed to source earthing via single conductor;

**“TN-S system”** means a system having separate neutral and protective conductors throughout the system and having a single earthing at a source whereby a neutral conductor and protective conductor are combined at neutral source and earthed at the source earthing and all exposed metal parts shall be connected to protective earthing conductor and shall be earthed to source earthing via single conductor;

**“TT system”** means a system having earthing point of the source of energy directly earthed at source point earthing and the exposed-conductive-parts of the electrical installation being separately earthed at consumer installation earthing electrode and all exposed metal parts shall be connected to protective earthing conductor and shall be earthed to installation earthing electrode via protective earthing conductor;

**“working clearance”** means the distance between any exposed live conductors to any part of the worker’s body or any working tools;

**“working space”** is the place of work, which shall be adequate means of access, well illuminated and ventilated and suitable for work execution.

## 2.0 INSTALLATION

### 2.1 Legal Requirements

2.1.1 All electrical installations have to be registered and/or licensed as required by the Electricity Supply (Amendment) Act 2015 [Act A1501] and Electricity Regulations 1994.

2.1.2 Work on electrical installations must be done by persons having the necessary competency as required by the Electricity Supply (Amendment) Act 2015 [Act A1501] and Electricity Regulations 1994.

2.1.3 Any apparatus, conductor or accessory for the purpose of connection to an installation shall be sufficient in size, power and number to serve the purpose for which it is intended and shall be installed, arranged, protected, worked and maintained in such a manner as to prevent danger.

2.1.4 An installation shall be maintained in good and working order and safety precautions shall be observed at all times to prevent danger.

### 2.2 Design

2.2.1 All parts of the electrical installation shall be designed so as to be suitable for the purpose intended for its use, without posing hazards, risks and dangers to safety and health of person, livestock, property and environment.

2.2.2 The installation shall be designed to: –

- i. be safe for operation by those operating or working on it;
- ii. ensure a reliable supply of electricity to the consumers connected to it;
- iii. ensure the security of the electricity supply flowing through it; and
- iv. be constructed and operated with little impact as possible to the effects of electromagnetic radiation and harmonics content.

2.2.3 Installations with small electrical loads shall be supplied by the utility licensee at low voltages.

2.2.4 Installations with larger electrical loads, generally with a maximum demand equal to or greater than 1 MVA, shall require its own dedicated transformer substation and be supplied by the utility at medium or high voltage.

2.2.5 Supply at medium or high voltage may also be necessitated if the quality of supply required is more than what can normally be available at lower voltage.

2.2.6 Premium power supply such as double feeders or triple feeders may be required for higher power quality supply system to the installation.

2.2.7 When deciding on the size/rating of the substation transformer, the following shall to be taken into account: –

- i. the maximum load demand of the installation, as determined according to part 2.7;
- ii. the anticipated future extensions to the installation;
- iii. standard transformer ratings; and
- iv. transformer rating factor or proper choice of K-factor transformer to take care of harmonics content.

## **2.3 Selection of Material and Equipment**

2.3.1 As required by subregulation 15(1) of the Electricity Regulations 1994, the material and equipment used for the electrical installation shall be suitable for the purpose intended for its use, without posing hazards, risks and dangers to consumers, public, person, livestock and property.

2.3.2 The material and equipment shall be adequate in terms of their: –

- i. thermal ratings, to carry the electrical load currents which they are designed for;
- ii. ability to withstand the short circuit levels of the circuit they are part of;
- iii. ability to operate efficiently in terms of energy consumption;
- iv. mechanical strength to withstand the environmental conditions they may be subjected to;
- v. ability to operate in a manner not to harmful the environment; and
- vi. ability to withstand the harmonics content.

## 2.4 Earthing of Installation

2.4.1 All exposed conductive parts of the electrical installation shall be earthed as required by regulation 34 of the Electricity Regulations 1994.

2.4.2 The method of the earthing shall be suitable for the type of supply system and loading in consideration and the material used for the earthing components shall be suitable for the purpose intended.

### 2.4.3 Type of Earthing System

Type of earthing system to be used: –

- i. where the earthing conductor of the installation is connected to earthed point of the source, a TN-S system shall be used with the load above 1 Mega Volt Ampere (MVA);
- ii. where the earthing conductor of installation is connected to separate earthing of earth electrode, a TT system shall be used for the load below and up to 1 Mega Volt Ampere (MVA);
- iii. where the earthing conductor is connected to the neutral of the source a TN-C shall not be used because it is not adequate for earth fault protection during the event of neutral breaking.

2.4.4 All extraneous conductive parts of the installation shall be equipotential bonded.

2.4.5 The earth resistance shall be sufficiently low to ensure the protective device operate to disconnect the supply from the installation during the earth fault event.

### 2.4.6 Connection to Earth by Earthing Conductor and Protective Conductor

All accessible metallic parts of the equipment shall be connected via the protective conductor to a main earthing terminal. The main earthing terminal shall be connected via an earthing conductor to earthing system. The earthing system shall be as per Figure 2.1 of BS 7671:2008 – IET Wiring Regulations (17<sup>th</sup> Edition) and Figure B.54.1 of MS IEC 60364-5-54:2004 – Electrical Installations of Buildings (See Figure 1 of Annex 3).



#### 2.4.7 Earthing System for Lightning Protection (LPS)

The lightning earthing system shall be separated and bonded to the installation earthing system and shall not exceed 10 ohms. The LPS earthing system shall be separated from the consumer earthing system and shall have bigger size of earthing conductor than the consumer earthing conductor to adequately and safely carry out lightning discharge energy to the earth. The bonding shall provide the equipotential voltage between the two earthing system to reduce electrical shock that might happen during the event. The bonding is not needed if the earthing of LPS and consumer is more than 2 meter apart to avoid flashover from happening.

2.4.8 Inside any installation, building or premises, all extraneous metal parts such as metal work, metallic frame, metallic enclosure, metallic cover, metallic pipe work, etc, of any non-electrical installation or non-electrical equipment belonging to the owner such as: –

- i. be safe for operation by those operating or working on it;
- ii. water installation metallic pipe;
- iii. other installation metallic pipe work and ducting;
- iv. metallic central heating pipe work and air conditioning system; or
- v. exposed metallic structure parts of building;

shall be connected via a main protective bonding conductor to a main earthing terminal.

2.4.9 In a room containing a bath or shower, all metallic frames of electrical equipment and all metallic frames of non-electrical equipment which are simultaneously accessible such as: –

- i. metallic water pipe, metallic service pipe and metallic waste pipe;
- ii. metallic central heating pipes and air condition system; and
- iii. accessible exposed metallic structural parts of building,

shall be connected via a supplementary equipotential bonding conductor to the supplementary equipotential bonding terminal.

2.4.10 Where doubt exists regarding the effectiveness of supplementary equipotential bonding, it shall be resolved whereby the resistance between simultaneously accessible metallic frames of electrical equipment and metallic frames of non-electrical equipment fulfills the following condition: –

R is not exceeding  $\frac{50 \text{ Volts}}{I\Delta n}$  where;

- R** is the resistance of supplementary protective bonding conductor between simultaneously accessible metallic frames of electrical and non-electrical equipment.
- IΔn** is the operating current in Amperes of protective device of residual current device (RCD).

#### 2.4.11 Maximum Earthing Impedance Value of Earthing Installation

The earthing system shall be such that the value of impedance from a consumer's main earthing terminal to the earth electrode and to the mass of the earth shall not exceed the value of earthing impedance as calculated below, as the case may be: –

- i. for TN-S system where the fuse exceed 200 Ampere is being used for protection device, earthing impedance equals to phase voltage dividing earth fault current equals to phase voltage dividing 3 times the current rating of any semi-enclosed fuse, or any cartridge fuse having a fusing factor exceeding 1.5, used to protect the circuit; as per clause D.22(i) of The Institution of Electrical Engineers (14<sup>th</sup> Edition 1966) – Regulations for the Electrical Equipment of Buildings (See F1 of Annex 4); or
- ii. for TN-S system where the fuse exceed 200 Ampere is being used for protection device, earthing impedance equals to phase voltage dividing earth fault current equals to phase voltage dividing 2.4 times the rating of any cartridge fuse having a fusing factor not exceeding 1.5, used to protect the circuit; as per clause D.22(ii) of The Institution of Electrical Engineers (14<sup>th</sup> Edition 1966) Regulations for the Electrical Equipment of Buildings (See F2 of Annex 4); or
- iii. for TN-S system where the miniature circuit breaker (MCB) exceed 125 Ampere is being used as protection device, the value of earthing impedance for the fuse rating current of fuses not exceeding 200 Ampere shall be as per Table 41.3 & Table 41.4 of BS 7671:2008 – IET Wiring Regulations (17<sup>th</sup> Edition) (See Table 1 & 2 of Annex 3); or

- iv. for TN-S system where fuse and miniature circuit breaker (MCB) not exceeding 125 Ampere is being used for protection device, the maximum value of earthing impedance for the fuse rating current of MCB not exceeding 125 Ampere shall be as per Table 41.3 & Table 41.4 of BS 7671:2008 – IET Wiring Regulations (17<sup>th</sup> Edition) (See Table 1 & 2 of Annex 3).
- v. for TT system where the earth fault relay to be used as protective devices, the maximum earthing value for earthing impedance equals to phase voltage dividing earth fault current equals to phase voltage dividing 1.5 times the tripping current of any excess-current circuit-breaker times earth fault relay setting used to protect the circuit as per Electrical Engineering Protection System Practices (See F3 of Annex 4); or
- vi. for TT system where residual current device (RCD) being used as protection device, the maximum earthing value for earthing impedance equals to 50 Volts dividing earth leaking current used to protect the circuit as per MS IEC 60364-4-44: Electrical Installations of Building.

$$Z = \frac{50 \text{ Volts}}{I_{\text{leaking}}}$$

where;

Z = earthing impedance,

50 Volts = touch potential on the fault point,

$I_{\text{leaking}}$  = leaking current rating / residual current of residual current devices (RCDs), such as that the impedance value stipulated in Table 41.5 of BS 7671:2008 – IET Wiring Regulations (17<sup>th</sup> Edition) (See Table 3 of Annex 3).

#### 2.4.12 The Minimum Size of Earth Electrode

Materials and dimensions of the earth electrodes shall be selected to withstand corrosion and to have adequate mechanical strength. For commonly used materials, the common minimum sizes from the point of view of corrosion and mechanical strength for earth electrodes where embedded in the soil are given in Table 54.1 of MS IEC 60364 – Electrical Installations of Buildings (See Table 7 of Annex 3).

#### 2.4.13 Earthing rod for lightning protection system (LPS) shall refer to IEC 62305.

#### 2.4.14 Maximum Earthing Value of Transformer Substation or Generator

- i. earthing impedance of transformer substation or generator shall not exceed the value as calculated in IEC 60364-4-44 – Electrical Installations of Buildings (See F4 of Annex 4) to protect the low voltage system from over voltages when the high voltage system of transformer faulted to earth;
- ii. earth fault currents and protective conductor currents which may occur are carried without danger, particularly from thermal, thermo mechanical or electromagnetic stress;
- iii. it is adequately robust or having mechanical protection appropriate to the stress conditions of external influences, for example, precautions shall be taken against the risk of damage to other metallic parts due to electrolysis; and
- iv. the earthing impedance shall be sufficiently low to ensure the protective device operates to disconnect the power supply to the installation during the fault event.

### 2.5 Means of Isolation

2.5.1 Every part of the electrical installation shall have a means of isolation as required by regulation 18 of the Electricity Regulations 1994.

### 2.6 Safety Considerations

2.6.1 The provisions for safety shall generally be provided by the electrical installation and equipment being designed in accordance with the relevant standards and regulations.

### 2.7 Determination of Maximum Demand

2.7.1 Since the individual loads do not necessarily always operate at full load, nor do they operate at the same time, suitable diversity factors shall be applied at the design stage, to the loads, in determining the anticipated maximum demand.

2.7.2 Reactive power demand has also to be determined at loads. Such demands may have to be met within the electrical installation by, having suitable capacitor banks and proper switching arrangements.

## 2.8 Determination of Short-Circuit Currents

2.8.1 Three phase symmetrical short-circuit current values at strategic points of an installation has to be calculated to determine, switchgear fault current ratings, cables thermal withstand ratings and protective devices discriminative trip ratings.

2.8.2 Any installation owner or operator under infrastructure code, licensee for retail and licensee for a private installation shall upon the request of the owner or operator of non-domestic installation, as the case may be, provide details of the design short circuit level and the actual prospective maximum and minimum short circuit levels and the corresponding X/R ratio at the point of common coupling and any future changes envisaged.

2.8.3 If the transformer substation is available, the short circuit current value for dedicated line may be estimated from the formulas F1, F2 and F3 of Annex 4.

## 2.9 Protection

2.9.1 The installation shall have provisions for protection against: –

- i. electric shock;
- ii. thermal effects;
- iii. overcurrent and earth fault currents;
- iv. voltage disturbances;
- v. electromagnetic disturbances; and
- vi. supply disturbances.

2.9.2 The installation shall provide protection against electric shock for both direct contact (basic protection) and indirect contact (fault protection).

2.9.3 Protection against electric shock can be afforded by: –

- i. automatic disconnection of the power supply to the connected electrical equipment;
- ii. using extra low voltage by having Separated Extra Low Voltage (SELV), Protective Extra Low Voltage (PELV) or Functional Extra Low Voltage (FELV);
- iii. use of class II insulation or material, or an equivalent level of insulation;
- iv. non-conducting location, out of arm's reach or having barriers; and
- v. equipotential bonding; and
- vi. electrical separation by means of isolating transformers.

2.9.4 In the event that the first measure does not operate, a second/backup measure of protection against electric shock is required.

2.9.5 Protection against thermal effects shall protect persons, livestock and property against: –

- i. combustion or degradation of materials, the risk of burns and other possible thermal effects caused by the connected electrical equipment;
- ii. flames, in case of a fire being propagated from electrical installations to other fire compartments segregated by barriers in the vicinity; and
- iii. the impairment of the proper functioning of electrical equipment including safety services.

2.9.6 During fire event, emergency power supply system such as battery or standby generator set, shall operate and shall withstand the fire for three hours continuously. Wiring and cabling for emergency power supply system shall be fire retardant for three hours.

#### 2.9.7 Overcurrent Protection

Protection against overcurrent shall include protection during overload and short circuit conditions and shall protect both the phase and neutral conductors.

#### 2.9.8 Earth Fault Protection

2.9.8.1 Earth fault protection shall include protective devices to protect a person, livestock or property from electrical shock.

2.9.8.2 Proper coordination shall be inbuilt in the overload, short circuit and earth fault protection devices to ensure proper functioning of the overall protection system.

#### 2.9.9 Disconnection Time

Protective devices shall disconnect the power supply to the installation with a disconnection time as per section 411.3.2, of BS 7671:2008 – IET Wiring Regulations (17<sup>th</sup> Edition) and MS IEC 60364 – Electrical Installations of Buildings (See Table 4 of Annex 3).

2.9.10 The prospective short circuit current shall be determined at strategic points of the installation and the proper positioning of the short circuit current protection device shall be established.

2.9.11 Protection against voltage disturbances shall include protection during: –

- i. earth faults in the medium voltage or higher voltage system;
- ii. faults in the low voltage system;
- iii. loss of the neutral conductor or floating neutral in a power system;
- iv. short circuit between a line and neutral conductors;
- v. large load starting current and/or medium voltage or higher voltage switching;
- vi. electromagnetic interferences such as lightning strikes; and
- vii. other occasions.

2.9.12 The following shall be considered in designing protection against voltage disturbances:–

- i. use of earthing and equipotential bonding;
- ii. use of Surge Protective Devices (SPDs);
- iii. lightning protection systems, including lightning air terminal down conductors and the earthing system; and
- iv. any other methods of protection as deem as necessary by the Commission.

2.9.13 Generally, power supply disturbances may create problems for equipment if: –

- i. the equipment is designed to operate within narrow voltage limits; or
- ii. the equipment does not have adequate immunity systems or ride-through capabilities to filter out fluctuations in the electrical supply.

2.9.14 Mitigation for power supply disturbances as stated in part 2.9.13 can be afforded by, the installation of: –

- i. standby power supplies;
- ii. uninterruptible power supplies;
- iii. surge suppressors;
- iv. power conditioners;
- v. voltage regulators; and
- vi. isolation transformers.

## 2.10 Selection and Erection of Electrical Equipment

### General

2.10.1 The electrical equipment selected for installation shall be able to operate within the supply characteristics, namely: –

- Voltage: 230 V alternating current for single phase 2 wire system
- Voltage: 400 V alternating current for three phase 4 wire system
- For other range of voltages and variation, the supply characteristic shall be accordingly to requirement of the equipment used and manufacturer recommendation
- Voltage variation: +10% and -6%
- Frequency: 50 Hz  $\pm$  1%
- Wiring system: A TT wiring system is generally used in this country, where the consumer has to establish his own installation earth. For other earthing systems, the type of installation earth shall be determined by the consumer. A consumer who owns a transformer substation supplying low voltage power system is recommended to use TN-S earthing system. TN-C and TN-C-S system are not recommended to be used. If the consumer wants to have their own TN-C and TN-C-S system, they shall equipped voltage leaking indicator (VLI) in their system to avoid inadvertently energisation.



2.10.2 In addition to the requirements of part 2.10.1, the selected equipment shall be suitable for use under the operational conditions and other influences existing at the place of installation.

2.10.3 The electrical equipment selected shall comply with the regulatory requirements, including the Electricity Regulations 1994 and relevant standards as per Annex 2.

## 2.11 Wiring Systems

2.11.1 The following, shall be the factors to be considered when selecting and installing wiring systems: –

- i. prevention/reduction of eddy current effects;
- ii. protection against mechanical damages;
- iii. selection of suitable cable management system such as conduit systems, cable ducting systems, cable trunking systems, cable tray systems and cable ladder systems;
- iv. issues with regards to cables installed or concealed inside walls, within partitions and similar situations;
- v. issues with regards to cables not installed or concealed inside walls, within partitions and similar situations (surface wiring);
- vi. suitable arrangements for different circuits and for cables of different voltage levels;
- vii. suitability of cables with respect to external influences;
- viii. current carrying capacities of conductors, including use of space factors and other reduction factors;
- ix. cross sectional area of neutral conductors;
- x. cross sectional area of protective conductors and earth wires;
- xi. voltage drop in consumer's installations;
- xii. electrical connections and joints, including connection of conductors made of dissimilar metals;

- xiii. termination of circuits;
- xiv. selection and installation of wiring systems to minimise spread of fire;
- xv. proximity of wiring systems to other services;
- xvi. selection and erection of wiring systems in relation to maintainability, including cleaning;
- xvii. effect of harmonic currents;
- xviii. bending radius of cables;
- xix. proper colour coding, labelling of circuits and danger signs;
- xx. suitable fire barriers at wall/floor wiring penetrations and trunking; and
- xxi. other factors according to prudent industry practice or defined by the Commission from time to time.

## 2.12 Isolation, Switching and Control Equipment

2.12.1 The following, shall be the factors to be considered when selecting and installing isolation, switching and control equipment: –

- i. need to isolate a circuit or apparatus from the remainder of the energised installation, to enable work to be performed on the isolated part safely;
- ii. need to avoid or limit the effects of short circuits, overloading, earth faults, supply surges, insulation failure and other faults and to separate the defective circuit from the rest of the installation;
- iii. need for emergency switching, including emergency stops. For rotating machines, isolation means shall be provided within 3 meters of the machine;
- iv. ability to withstand fault currents/situations safely until the fault is cleared; and
- v. other factor according to prudent industry practice or defined by the Commission from time to time.

## **2.13 Discrimination**

2.13.1 There shall be proper coordination between isolation and switching devices, including appropriate discrimination abilities to minimise unnecessary isolation of parts of the installation.

## **2.14 Earthing Arrangements and Protective Conductors**

2.14.1 The following shall be the essential factors to be considered when selecting and installing earthing systems and protective conductors: –

- i. all extraneous conductive parts of the fixtures and all exposed conductive parts of the electrical appliances and equipment shall be connected to earth system for effective protection against electric shocks;
- ii. there shall be one main earthing terminal for each installation to which the various components of the earthing system are connected;
- iii. the components of the earthing system, including the earth electrodes, earthing conductors, earthing terminals, equipotential bonding and other protective conductors shall be of suitable material and size for them to function effectively;
- iv. a suitable value for the earth impedance and earth fault sensitivity of the earthing system.

## **2.15 Minimum Cross-sectional Area of a Protective Conductor or Earthing Conductor**

2.15.1 The minimum cross-sectional area of protective conductors and earth wires shall not less than the cross-sectional area as per Table D.2M of The Institution of Electrical Engineers (14<sup>th</sup> Edition 1966) – Regulations for the Electrical Equipment of Buildings (See Table 8 of Annex 3).

## **2.16 Integrity of Protective Conductors and Earthing Conductors**

2.16.1 If a protective conductor or earthing conductor is connected to earth or to any other reference point (such as DC supply), nothing which might reasonably be expected to give rise to danger by breaking the electrical continuity or introducing high impedance shall be placed in that conductor unless suitable precautions are taken to prevent that danger.

## 2.17 Earthing Conductor

2.17.1 Earthing conductors shall comply with part 2.16, and where buried in the soil, their cross-sectional areas shall be in accordance with Table 54.1 of BS 7671:2008 – IET Wiring Regulations (17<sup>th</sup> Edition) (See Table 5 of Annex 3).

Note: Dimensions for non-circular conductors are under consideration.

2.17.2 The connection of an earthing conductor to an earth electrode shall be soundly made and electrically satisfactory. Where a clamp is used, it shall not damage the electrode (e.g. a pipe) or the earthing conductor.

2.17.3 Neither an aluminium nor a copper-clad aluminium conductor shall be used for underground connection to an earth electrode.

2.17.4 The connection of an earthing conductor to an earth electrode or other means of earthing shall be soundly made and be electrically and mechanically satisfactory and it shall be suitably protected against corrosion.

## 2.18 Other Equipment

2.18.1 Other equipment in the building, such as generator sets, water heaters, air conditioning equipment, pumping equipment, data processing equipment, photovoltaic systems, power factor correction equipment, luminaires and lighting installations intended to be part of the fixed installation, shall be appropriate for use in terms of safety, electromagnetic compatibility, and service provided and shall be constructed in a manner for it to function as intended, taking into consideration the environment where it is placed (wet/damp areas, such as bathrooms, swimming pools, saunas, explosive/hazardous sites, temporary installations, healthcare facilities).

## 2.19 Metering and Monitoring Equipment

2.19.1 Metering and monitoring equipment, including auxiliary circuits for measurement purposes shall be suitable in terms of safety, accuracy, vibration and ingress protection (IP) and other environmental protection needed. They shall be able to provide the information/data needed and be installed so as to serve the purpose intended, including the ability to be connected to the Building Management System (BMS), if available.

2.19.2 With respect to part 2.20.1, a suitable number of energy and power meters shall be installed so that the energy and power demand for different services and major equipment can be assessed for the purpose of energy auditing, planning and energy efficiency monitoring and upgrading purposes.

## **2.20 Harmonics Management**

2.20.1 The total harmonics distortion (THD) of the equipment and devices in the electrical installations shall not cause damage to other installations.

2.20.2 The equipment and devices in the installation shall be capable of operating normally in the presence of harmonics in the supply system.

## **2.21 Size of Neutral Conductor due to Third Harmonic Contents**

2.21.1 If a high value of third harmonic contents or multiple harmonics exist in the neutral conductor, the size of the neutral conductor shall be calculated as in Table 4Aa of BS 7671:2008 – IET Wiring Regulations (17<sup>th</sup> Edition) (See Table 6 of Annex 3).

## **2.22 Energy Management**

2.22.1 The installation shall be designed to be as energy efficient as possible and/or use renewable energy in an optimum manner.

2.22.2 For the purpose of part 2.23.1, the installation shall comply with good engineering practices and, as a minimum, with the requirements of MS 1525: Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings – Code of Practice and shall comply with the Efficient Management of Electrical Energy Regulations 2008.

## **2.23 Competent Control**

2.23.1 All electrical installation works shall be done by or under the direct supervision of competent persons as required by Regulation 12 of the Electricity Regulations 1994.

2.23.2 All person involved in any electrical work shall be trained to follow good engineering practices and apply safety procedures. Only those person who have received training and instruction shall carry out the work.

## **2.24 Precautions for Work on Equipment Made Dead**

2.24.1 Adequate precaution shall be taken to prevent electrical equipment which has been made dead, from becoming electrically charged during work on any electrical installation.

## 2.25 Work on or Within the Safety Clearance to Live Conductors

2.25.1 No person shall be engaged in any work or activity on or within safety clearance to any live conductor (other than one suitably covered with insulating material) that danger may arise unless: –

- i. it is unreasonable in all the circumstances for it to be dead;
- ii. it is reasonable in all the circumstances for him to be at work on or within safety clearance to live conductor while it is live; and
- iii. suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury.

## 2.26 Working Space, Access and Lighting

2.26.1 For the purposes of preventing injury, adequate working space, adequate means of access, and adequate lighting shall be provided at all electrical equipment on or near work is being conducted in circumstances which may give rise to danger.

## 2.27 Permit to Work

2.27.1 The owner of an installation shall ensure that there is an approved work certification system to allow work on the electrical installation. This shall include: –

- i. a system of authorisation for the issuance and cancellation of work permit for the component of the installation concerned;
- ii. access shall only be given for the parts or area of the installation which are safe to conduct work; and
- iii. knowledge and competency needed for the person requesting the work permit.

## 2.28 Supervision and Testing of Installations

2.28.1 All electrical installation works must be adequately supervised while being constructed, by competent person.

2.28.2 All newly constructed components of the electrical installation must be inspected and tested.

2.28.3 The tests must be carried out in accordance to test procedure prescribed in standards, and/or accepted best practices, and be done by competent person.

## 2.29 Initial Inspection, Testing and Commissioning

2.29.1 Upon completion of the electrical installation works, the installation shall be tested by competent person as required by regulation 13 of the Electricity Regulations 1994.

2.29.2 The electrical tests and visual inspections as required by part 2.28.3 shall include: –

- i. insulation tests of all cables, busbars and wiring conductors of the fixed installation, between phases, between phases and neutral, and between phases and earth;
- ii. continuity and conductivity tests of protective, equipotential and earth-bonding conductors;
- iii. polarity tests;
- iv. resistance tests of earthing electrodes with respect to remote earth;
- v. verification of the proper operation of switchgear and control gear assemblies, drives, controls and interlocks;
- vi. dielectric strength test of transformer oil (and switchgear oil if appropriate), if applicable;
- vii. pressure tests on all equipment, switchboards, cables, etc;
- viii. checks on correct protective-relay operation and settings;
- ix. check of allowable number of socket-outlets per circuit;
- x. cross-sectional-area check of all conductors for adequacy at the short-circuit levels prevailing, taking account of the associated protective devices, materials and installation conditions (in air, conduit, etc.);
- xi. verification that all exposed and extraneous conductive parts are properly earthed (where appropriate);
- xii. voltage drop; and
- xiii. check of clearance distances in toilets and washroom, etc.

## 2.30 Safety Clearance

2.30.1 All minimum safety and working clearance shall be as in IEC 60071 – Insulation Co-Ordination (See Table 9 of Annex 3).

## 3.0 OPERATIONS

### 3.1 General

3.1.1 This part of the Code is relevant for operational work on non-domestic electrical installations, installation of licensees for retail and licensees for private installation.

3.1.2 Employers and Operators of non-domestic installations, installation of licensees for retail and licensees for private installation shall ensure that their employees, staff and contractors comply with this part of the Code.

### 3.2 Safety Management Programme

3.2.1 Owners and Operators of the non-domestic installations, installation of licensees for retail and licensees for private installation shall establish their Safety Management Programme.

3.2.2 The Safety Management Programme, referred to in part 3.2.1 shall include, the aspects as stated in Annex 1 of this Code.

3.2.3 All operational works shall be in accordance with the requirements of this Code and the owner's and/or operator's Safety Management Programme. The procedures shall ensure: –

- i. compliance with essential safety requirements and appropriate standards;
- ii. safety of the occupants of the building and the general public;
- iii. safety of the employees; and
- iv. correct operation of the installation.

### 3.3 Competency Requirements

3.3.1 Persons who have to work, operate or be in control of any electrical installation work or operation shall have the required competency in accordance with regulation 60 of the Electricity Regulations 1994.



### 3.4 Reporting of Accidents and Fires

3.4.1 As required by section 33 of the Electricity Supply Act 1990, whenever an accident or fire causing or resulting in loss of life or hurt to any person or serious damage to property has occurred in connection with an electrical installation, the owner or the management shall report the accident or fire to the Commission by the quickest means available.

3.4.2 Subsequent to the report as in 3.4.1, with the least possible delay, a report in writing shall be made to the Commission, with the facts of the accident or fire as they are known to the owner or management.

3.4.3 Accidents/fire that shall be notified include: –

- i. a fatality (electrocution);
- ii. an incident where there has been a serious injury (electric shock, fractures, burns, etc.); or
- iii. serious damage to property.

## 4.0 MAINTENANCE

### 4.1 General

- 4.1.1 As required by regulation 110 of the Electricity Regulations 1994, all parts of the electrical installation shall be maintained to prevent danger to persons and property.
- 4.1.2 As required by regulation 111 of the Electricity Regulations 1994, only competent person or person under the control of competent person shall undertake maintenance work of any equipment which forms part of the installation.
- 4.1.3 The electrical installation shall be regularly visited and inspected by a competent person as required by regulation 66 of the Electricity Regulations 1994.
- 4.1.4 Electrical appliances used in construction works shall be regularly inspected, tested and maintained to ensure that they remain safe for use. When in use, such electrical appliances shall be protected by protective devices such as residual current device (RCD) and miniature circuit breaker (MCB).
- 4.1.5 As part of the maintenance procedures, the following shall be prepared by the owner or operator of the electrical installation: –
- i. list of installation assets and their locations;
  - ii. schedule of maintenance activities to be undertaken, prepared on a risk assessment basis;
  - iii. record of maintenance activities undertaken;
  - iv. access requirements for various electrical situations, such as access permits or safety clearances from exposed energised conductors;
  - v. isolation and tagging/locking out procedures;
  - vi. permit to work (PTW) and approval processes;
  - vii. safety rules to be followed before deciding to work on an energised installation;
  - viii. an emergency plan (e.g. fire, explosion, electric shock); and
  - ix. special precautions to be undertaken when working in confined spaces.

## 4.2 Maintenance Schedules

4.2.1 All parts of the electrical installation and associated equipment shall be maintained to be in a safe working condition and/or fit for its protection purpose while delivering the services required in a secure and reliable manner. Maintenance schedules shall include: –

- i. inspection and/or testing schedules, shall include the requirements of regulation 67 and regulation 110 of the Electricity Regulations 1994;
- ii. maintenance schedules; and
- iii. replacement schedules for components approaching the end of their operating life.

## 4.3 Precautions when Working on Installation

4.3.1 As required under regulation 112 of the Electricity Regulations 1994, the competent person responsible for the electrical installation shall take adequate precautions to prevent any part of the installation or equipment that is being worked on, from being accidentally or inadvertently made alive when persons are working on it.

4.3.2 For the purpose of part 4.3.1, the following shall be undertaken: –

- i. switching off the supply (de-energise);
- ii. isolating the supply (isolate);
- iii. taking precautions to ensure that the supply remains isolated by locking off and/or tagging, or by disconnecting the load side of the isolator and tying back disconnected conductors;
- iv. proving the supply is de-energised by using an approved test instrument (verify);
- v. earthing the de-energised conductor before carry out work or maintenance; and
- vi. removing the connection to the earth before doing insulation test on the conductor or equipment or cable before re-energise back the supply.

## 4.4 Use of Personal Protective Equipment

4.4.1 Persons undertaking maintenance work shall use electrical grade personal protective equipment (PPE) as needed, such as: –

- i. safety helmet with face shield (as appropriate);
- ii. safety glasses/face shields (anti flash);
- iii. safety boots;
- iv. protective clothing;
- v. approved insulating gloves;
- vi. safety harness;
- vii. approved insulated tools; and
- viii. approved insulating sheeting.

4.4.2 Persons undertaking maintenance work shall be trained to be competent in the use of PPE, tools and equipment.

## 4.5 Maintenance of Records

4.5.1 All records of the design, construction, operation, inspection, testing and maintenance of the electrical installation shall be kept, periodically updated and be accessible to relevant and authorised persons.

## 5.0 MISCELLANEOUS

- 5.1 Unless there are relevant requirements expressed in the Electricity Supply Act 1990, Electricity Regulations 1994, Grid Code, Distribution Code or this Code, the standards stated in Annex 2 may be consulted to meet the requirements of this Code. The publication dates of the standards are correct at the time of publication of this Code. The most current and appropriate issue of the standards shall be used at all times.
- 5.2 If there are any conflicts between the provisions of this Code and those in the Electricity Supply Act 1990, Electricity Regulations 1994, Grid Code or Distribution Code, the provisions of the Electricity Supply Act 1990, Electricity Regulations 1994, Grid Code or Distribution Code shall take precedence.



# ANNEXES



## **ANNEX 1 – SAFETY MANAGEMENT PROGRAMME**

A Safety Management Programme for Non-Domestic Electrical Installation required for managing electrical risks should incorporate essential management elements of an effective safety management system as follows. However, the specific programme may vary in their details depending on the nature of the electrical works and risks at the particular installation.

### **1. POLICY AND PROGRAMME**

#### **1.1 Electrical Safety Policy, Programme:**

The licensee/installation has a written policy, programme to ensure electrical safety. The policy, signed by the top management, reflects management commitment to implement the programme for the protection of employees and others who may be affected by the electrical installation. The objectives, responsibilities and arrangements for electrical safety management are spelled out.

#### **1.2 Documentation:**

Documents related to the electrical safety management system of the licensee/installation are maintained and readily accessible to employees and contractors. The documents contain information on electrical safety policy, programme, risks identification and control measures, legal and regulatory requirements, and other relevant internal guidelines.

### **2. ORGANISING**

#### **2.1 Responsibility:**

The top management of the licensee/installation demonstrates leadership for electrical safety programmes and activities, and clearly assigns duties and responsibility for electrical safety management to line management.

#### **2.2 Competence:**

Licensee/installation workers and contractors who are exposed to electrical risks are given adequate training and information on electrical safety. The company complies with the requirements under the Electricity Supply Act 1990 and Electricity Regulations 1994 pertaining to the need to engage registered electrical competent persons and contractors to perform electrical works according to their categories of competency.



## 2.3 Communication:

There is a communication programme to disseminate information on electrical risks and control measures to employees and others who may be affected by the risks. Warning signs are used to identify, warn and advise on electrical risks. Suitable administrative arrangements are in place for management to receive and follow up on suggestions and complaints on electrical safety matters.

## 3. PLANNING AND IMPLEMENTATION

### 3.1 Planning and Implementation:

The licensee's/installation's electrical safety management programme supports:

- a. compliance with the Electricity Supply Act 1990, Regulations, Codes and Guidelines;
- b. implementation of all elements of the electrical safety management system;
- c. continual improvement in electrical safety performance.

The programme provides details on programmes and activities to be implemented and the responsible personnel/units, budgets and targets in efforts to eliminate, minimise and control electrical risks at the installation.

## 4. RISK CONTROL MEASURES

### 4.1 Identification, Evaluation and Control of Risks:

Hazards and risks to workers and public are identified, evaluated and controlled on an ongoing basis. (*'Hazard' is a potential source of harm or adverse health effect on a person or persons. 'Risk' is the likelihood that a person may be harmed or suffers adverse health effects if exposed to a hazard.*) Implementation of preventive and corrective control measures for hazards/risks are done according to the hierarchy of risk control as follows:

- a. elimination (completely eliminate the hazard/risk at source);
- b. substitution (substitute the hazardous activity, process or equipment with a less hazardous one);
- c. engineering controls (isolate the hazard from people who could be harmed);
- d. administrative controls (change the way people work or prevent people's exposure to hazards/risks such as by implementing a permit-to-work system);
- e. personal protective equipment (PPE) (provide PPE to cover and protect an individual person from hazards. PPE can be used as a temporary control measure until more effective control measures are provided. In most cases, a combination of other control measures and PPE can effectively control the risks).

## 4.2 Permit-To-Work System:

- a. A written Permit-To-Work (PTW) system with suitable lock-out/tag-out procedures is effectively implemented for high risk electrical works that involves working with live equipment and systems. *(A 'permit-to-work' is a formal, written, safe system of work to control potentially hazardous activities. It aims to remove both unsafe conditions and human error by imposing a formal system which requires formal action. The permit details the work to be done and the precautions to be taken. It should state safety precautions to be taken before work can start and the authorising person should only sign and date the permit when he is satisfied that all precautionary measures have been taken. It should only be in place for a limited duration, be clearly dated and with specific conditions attached. Permits should be issued, checked and signed off as being completed by someone competent to do so, and who is not involved in undertaking the work)*

## 4.3 Emergency Preparedness:

A written emergency preparedness plan for the licensee/installation is available and made known to employees and regularly rehearsed. The Plan details how the licensee/installation and its employees deal with or manage electrical emergencies. It spells out preparedness, response and recovery activities and clarifies emergency management roles and responsibilities, strategies and procedures to manage electrical emergencies at the installation.

## 5. PERFORMANCE EVALUATION

### 5.1 Investigation of Electrical-related Accidents and Incidents:

Investigations of the direct causes and indirect causes of electrical-related accidents and near-miss incidents are carried out by competent persons, with the appropriate participation of management and workers. Contributing factors arising out of any shortcomings or failures in the electrical safety management system are identified and documented. Recommendations for improvement are communicated to the top management for follow-up corrective actions.

### 5.2 Performance Monitoring and Review:

A system for licensee's/installation's management to regularly monitor electrical safety performance are established. Records and statistics of electrical accidents and near-miss incidents are kept and analysed, and root causes of accidents and incidents are addressed via short-term and long-term measures. Periodic internal audits of each of the elements of the electrical safety management system are carried out to identify the strengths and weaknesses of the system and to put in place improvement measures. Management reviews are conducted periodically to evaluate the overall strategy of the electrical safety management system.

## **6. ACTION FOR IMPROVEMENT**

### **6.1 Preventive and Corrective Action:**

Arrangements for preventive and corrective actions are established and updated based on the outcome of the ongoing electrical safety performance monitoring and review programme. When the evaluation of the electrical safety management system shows that preventive and protective measures are ineffective, corrective measures are addressed according to the hierarchy of risk control (refer 4.1) in a timely manner. Directives and notices issued by the Energy Commission are acted upon promptly and effectively.

### **6.2 Continual Improvement:**

Programmes and procedures are established for the continual improvement of the electrical safety management system. These take into account the results of risk assessments, performance measurements, investigations, audits, and changes in Electricity Supply Act 1990, Regulations, Codes and Guidelines, technical or administrative changes in the electrical installation, and the results of electrical safety protection and promotion programmes. The electrical safety procedures, and performance of the electrical installation are benchmarked with other similar organisations to improve electrical safety performance.

## ANNEX 2 – RELEVANT STANDARDS

1. MS IEC 60364-1:2003 Electrical Installations of Buildings – Part 1:Fundamental Principles, Assessment of General Characteristics, Definitions
2. MS IEC 60364-4-41:2003 Electrical Installations of Buildings – Part 4-41:Protection for Safety – Protection Against Electric Shock
3. MS IEC 60364-4-42:2003 Electrical Installations of Buildings – Part 4-42:Protection for Safety – Protection Against Thermal Effects
4. MS IEC 60364-4-43:2003 Electrical Installations of Buildings – Part 4-43:Protection for Safety – Protection Against Overcurrent
5. MS IEC 60364-4-44:2003 Electrical Installations of Buildings – Part 4-44:Protection for Safety – Protection Against Voltage Disturbances and Electromagnetic Disturbances
6. MS IEC 60364-5-51:2003 Electrical Installations of Buildings – Part 5-51:Selection and Erection of Electrical Equipment – Common Rules
7. MS IEC 60364-5-52:2003 Electrical Installations of Buildings – Part 5-52:Selection and Erection of Electrical Equipment – Wiring Systems
8. MS IEC 60364-5-53:2003 Electrical Installations of Buildings – Part 5-53:Selection and Erection of Electrical Equipment – Isolation, Switching and Control
9. MS IEC 60364-5-54:2003 Electrical Installations of Buildings – Part 5-54:Selection and Erection of Electrical Equipment: Earthing Arrangement and Protective Conductors
10. MS IEC 60364-5-55:2003 Electrical Installations of Buildings – Part 5-55:Selection and Erection of Electrical Equipment – Other Equipment
11. MS IEC 60364-6-61:2003 Electrical Installations of Buildings – Part 6-61:Verification – Initial Verification
12. MS IEC 60038:2006 IEC Standard Voltages
13. MS 1979:2015 Electrical Installation of Buildings – Code of Practice
14. MS 1936:2016 Electrical Installation of Building – Guide to MS IEC 60364
15. MS 1525:2014: Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-residential Building

## Protection against Lightning

16. MS IEC 62305-1:2007 Protection Against Lightning - Part 1: General Principles (First Revision)
17. MS IEC 62305-2:2007 Protection Against Lightning - Part 2: Risk Management (First Revision)
18. MS IEC 62305-3:2007 Protection Against Lightning-Part 3: Physical Damage to Structures and Life Hazard (First Revision)
19. MS IEC 62305-4:2007 Protection Against Lightning - Part 4: Electrical and Electronic Systems Within Structures (First Revision)

## Plug Top (Plugs)

20. MS 1578:2003 Specification for non-rewirable two-pole plug, 2.5A, 250A, with cord, for the connection of Class II – Equipment for household and and similar purposes
21. MS 589: Part 1: 1997 Specification for 13A plugs, socket-outlets, adaptors and connection units: Part 1: Specification for rewirable and non-rewirable 13A plugs (First revision)
22. MS 1577: 2003 Specification for 15A plugs and socket-outlets for domestic and similar purposes
23. MS 589: Part 3: 1997 Specification for 13A plugs, socket-outlets, adaptors and connection units: Part 3: Specification for adaptors
24. IEC 60998-1 (1999-04) Connecting devices for low voltage circuits for household and similar purpose – Part 1: General requirements
25. IEC 60998-2-1 (1990-05) Connecting devices for low voltage circuits for household and similar purpose – Part 2-1: Particular requirements for connecting devices as separate entities with screw-type clamping units
26. IEC 60998-2-2 (1991-10) Connecting devices for low voltage circuits for household and similar purpose – Part 2-2: Particular requirements for connecting devices as separate entities with screwless-type clamping units

27. IEC 60998-2-3 (1991-10) Connecting devices for low voltage circuits for household and similar purpose – Part 2-3: Particular requirements for connecting devices as separate, entities with insulation piecing clamping units
28. IEC 60998-2-4 (1993-05) Connecting devices for low voltage circuits for household and similar purpose – Part 2-4: Particular requirements for twist-on connecting devices
29. IEC 60998-2-5 (1996-01) Connecting devices for low voltage circuits for household and similar purpose – Part 2-5: Particular requirements for connecting boxes (junction and/or tapping) for terminals or connecting devices
30. IEC 60320-1 (1994-06) Appliance couplers for household and similar general purposes – Part 1: General requirements

### **Switches and Dimmers**

31. MS 616: Part 1: 1998 Switches for household and similar fixed-electrical installations: Part 1: General requirements (First revision)
32. MS 616: Part 2: Section 1: 2000 Switches for household and similar fixed electrical installations: Part 2: Particular requirements: Section 1: Electronic Switches
33. MS 616: Part 2: Section 2: 2000 Switches for household and similar fixed electrical installations: Part 2: Particular requirements: Section 2: Electromagnetic remote-control switches (RCS)
34. MS 616: Part 2: Section 3: 2000 Switches for household and similar fixed electrical installations: Part 2: Particular requirements: Section 3: Time relay switches (TDS)

### **Socket Outlets 15A and below (with or without ELCB/RCD)**

35. MS EN 60742: 1998 Isolating transformers and safety isolating transformers – Requirements
36. MS 589: Part 2: 1997 Specification for 13A plugs, socket-outlets, adaptors and connection units: Part 2: Specification for 13A switched and unswitched socket-outlet (First version)
37. MS 1577: 2003 Specification for 15A plugs and socket-outlets for domestic and similar purposes

38. MS 1579: 2003 Specification for portable 2 pin socket-outlets for Class II equipment for household and similar purposes
39. BS 4177: 1992 Specification for cooker control units

### **Lampholders**

40. MS IEC 60400: 1999 Lampholders for tubular fluorescent lamps and starterholders

### **Ceiling Roses**

41. MS 770: 1982 Specification for ceiling roses

### **Bayonet Caps and Multiways Adaptors**

42. MS 769: 1982 Specification for bayonet lamp-caps lampholders and B. C adaptors (lampholder plugs)

### **Fluorescent Lamps Fitting excluding Tubes if Imported Separately**

43. MS IEC 60598-1: 1997 Luminaires-Part 1: General requirements and tests
44. MS IEC 60598-2-1: 1997 Luminaires-Part 2: Particular requirements – Section One – Fixed general purpose luminaries
45. MS IEC 60598-2-2: 1998 Luminaires-Part 2: Particular requirements – Section Two – Recessed Luminaires
46. MS IEC 60400: 1999 Lampholders for tubular fluorescent lamps and starterholders
47. MS IEC 60155: 1996 Glow – Starters for fluorescent lamps

### **Capacitors for Fluorescent Lamps**

48. MS IEC 61048: 1999 Capacitors for use in tubular fluorescent and other discharge lamp circuits general and safety requirements
49. MS IEC 61049: 1999 Capacitors for use in tubular fluorescent and other discharge lamp circuit performance requirements

## Ballast for Fluorescent

50. MS 141: Part 1: 1992 Specification for ballasts for tubular fluorescent lamps: Part 1: General and safety requirement (First revision)
51. MS 141: Part 2: 1992 Specification for ballast for tubular fluorescent lamps: Part 2: Performance requirements
52. MS IEC 60928: 1995 Specification for a. c. supplied electronic ballasts for tubular fluorescent lamps – general and safety requirements
53. MS IEC 60929: 1995 Specification for a. c. supplied electronic ballasts for tubular fluorescent lamps – performance requirements
54. Circuit Breaker Including AC Current Operated Leakage Circuit Breakers and Miniature Circuit Breakers
55. MS IEC 61008-1: 2003 Residual current operated circuit without integral overcurrent protection for household and similar uses (RCCBs) – Part 1: General rules
56. MS IEC 60898: 1998 Electrical accessories - Circuit-Breakers for overcurrent protection for household and similar installations (MCB's)
57. IEC 61009-1(1996-12) Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – Part 1: General rules
58. IEC 61009-2-1 (1991-09) Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – Part 2 – 1: Applicability of the general rules to RCBO's functionally independent of line voltage
59. IEC 61009-2-2 (1991-09) Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – Part 2 – 2: Applicability of the general rules to RCBO's functionally dependent on line voltage
60. IEC 60269-1, Ed. 3 (1998-12) Low-voltage fuses-Part 1: General requirements
61. IEC 60269-2 (1986-09) Low-voltage fuses Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)
62. IEC 60269-2-1 (1998-03) Low-voltage fuses Part 2 – 1: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Section I-V: Examples of types of standardized fuses



63. IEC 60269-3 (1987-06) Low-voltage fuses Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)
64. IEC 60269-3-1 (1994-08) Low-voltage fuses Part 3 - 1: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar application – Section I to V)

### **Domestic Light Fittings having Accessible Metal Parts**

65. MS IEC 60598-1:1997 Luminaires Part 1: General requirements and tests
66. MS IEC 60598-2-4:1997 Luminaires Part 2: Particular requirements – Section Four – Portable general purpose luminaires
67. IEC 60598-1, Ed. 4: 1996 Luminaires Part 1: General requirements and tests
68. IEC 60598-2-8, Ed. 2: 1996 Luminaires Part 2: Particular requirements – Section Eight: Hand lamps

### **Fans**

69. MS IEC 60335-1: 2013 Safety of household and similar electrical appliances: General requirements
70. MS 1597-2-80: 2010 Household and similar electrical appliances – Safety – Part 2 – 80: Particular requirements for fans (Third revision)
71. MS 1220: 2010 Performance and construction of electric circulating fans and regulators (Second revision)
72. IEC 60335-2-31 (2002-10) Household and similar electrical appliance – Safety Part 2 – 32: Particular requirement for range hoods
73. IEC 60335-2-98 Household and similar electrical appliance – Safety Part 2 – 98: Particular requirements for humidifiers

### **Wires/Cables/Cords (Non-armoured) 0.5 sq mm – 35 sq mm**

- 74. MS 140: 1987 Specification for insulated flexible cords and cable
- 75. MS 136: 1995 Specification for PVC insulated cables (non-armoured) for electric power and lighting (Second revision)

### **Air Conditioners (Air-cooled & water-cooled)**

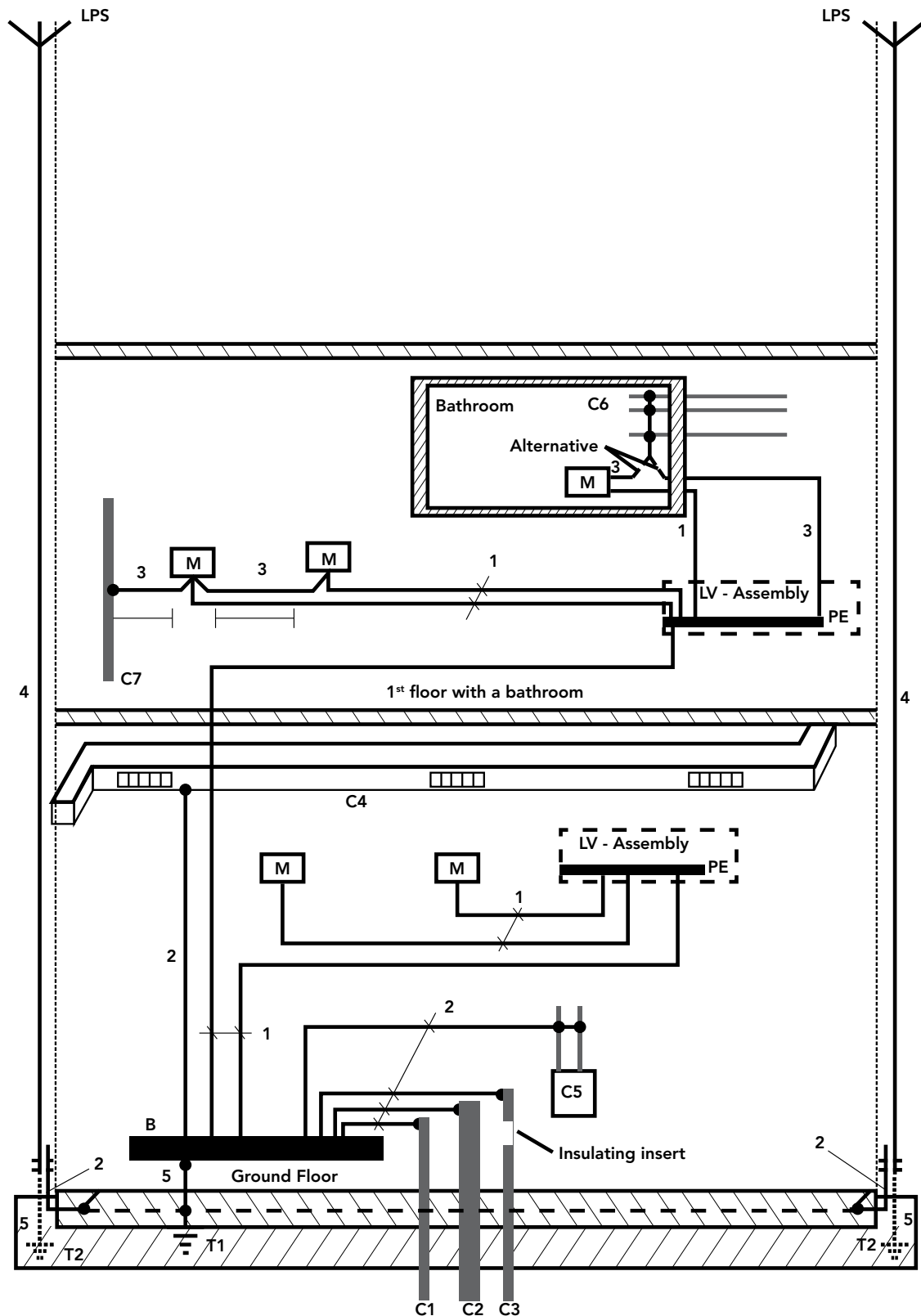
- 76. MS IEC 60335-1: 2013 Safety of household and similar electrical appliances: General requirements
- 77. MS 1597-2-40:2005 Household and similar electrical appliance – Safety Part 2 -40: Particular requirement for electrical heat pumps, air-conditioners and dehumidifiers

### **Water Heaters**

- 77. MS IEC 60335-1: 2013 Safety of household and similar electrical appliances: General requirements
- 78. MS 1597-2-21:2011 Household and similar electrical appliance – Safety Part 2 -21: Particular requirement for appliances for storage water heaters (Second revision).
- 79. MS 1597-2-35:2010 Household and similar electrical appliances - Safety - Part 2-35: particular requirements for instantaneous water heaters (second revision)

## ANNEX 3 – TABLES AND FIGURES

Figure 1: Illustration of earthing and protective conductor terms



## Key

- M Exposed-conductive-part  
conductive part of equipment which can be touched and which is not normally live, but which can become live when basic insulation fails
- [IEV 195-06-10]
- C Extraneous-conductive-part  
conductive part not forming part of the electrical installation and liable to introduce and electric potential, generally the electric potential of a local earth.
- [IEV 195-06-11]
- C1 Waterpipe, metal from outside  
C2 Waste, water, metal from outside  
C3 Gas pipe with insulating inset, metal from outside  
C4 Air-Conditioning  
C5 Heating-system  
C6 Waterpipe, metal e.g. in a bathroom  
C7 Extraneous-conductive-parts in arm's reach of exposed-conductive-parts
- B Main earthing terminal (main earthing busbar)  
terminal or busbar which is part of the earthing arrangement of an installation and enabling the electric connection of a number of conductors for earthing purposes
- [IEV 195-02-33]
- T Earth electrode  
conductive part, which may be embedded in a specific conductive medium, e.g concrete or coke, in electric contact with the earth
- [IEV 195-02-01]
- T1 Foundation earth  
T2 Earth electrode for LPS if necessary
- 1 Protective conductor  
conductor provided for purposes of safety, for example protection against electric shock
- [IEV 195-02-09]
- 2 Protective bonding conductor  
protective conductor provided for protective-equipotential-bonding
- [IEV 195-02-10]
- 3 Protective bonding conductor for supplementary bonding  
4 Down conductor of a lightning protection system (LPS)  
5 Earthing conductor  
conductor which provides a conductive path, or part of the conductive path, between a given point in a system or in an installation or in equipment and an earth electrode
- [IEV 195-02-03]

Note: For the purpose of this standard, an earthing conductor is the conductor which connects the earth electrode to a point of the common equipotential bonding system, usually the main earthing terminal.

**Table 1: Maximum value of earthing impedance for rating current of MCB**

(a) Type B circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1														
Rating (amperes)	3	6	10	16	20	25	32	40	50	63	80	100	125	$I_n$
$Z_s$ (ohms)		7.28		2.73		1.75		1.09		0.69		0.44		$230 \times$
	14.57		4.37		2.19		1.37		0.87		0.55		0.35	$0.95/(5I_n)$
(b) Type C circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1														
Rating (amperes)	6	10	16	20	25	32	40	50	63	80	100	125	$I_n$	
$Z_s$ (ohms)	3.64		1.37		0.87		0.55		0.35		0.22		$230 \times$	
		2.19		1.09		0.68		0.44		0.27		0.17	$0.95/(10I_n)$	
(c) Type D circuit-breakers to BS EN 60898 and the overcurrent characteristics of RCBOs to BS EN 61009-1														
Rating (amperes)	6	10	16	20	25	32	40	50	63	80	100	125	$I_n$	
$Z_s$ (ohms)	1.82		0.68		0.44		0.27		0.17		0.11		$230 \times$	
0.4 secs		1.09		0.55		0.34		0.22		0.14		0.09	$0.95/(20I_n)$	
$Z_s$ (ohms)	3.64		1.37		0.87		0.55		0.35		0.22		$230 \times$	
5 secs		2.19		1.09		0.68		0.44		0.27		0.17	$0.95/(10I_n)$	

**Table 2: Maximum value of earthing impedance for rating current of fuses**

(a) General purpose (gG) and motor circuit application (gM) fuses to BS 88-2 – fuse systems E (bolted) and G (clip in)								
Rating (amperes)	2	4	6	10	16	20	25	32
$Z_s$ (ohms)	44	21	12	6.8	4.0	2.8	2.2	1.7
	40	50	63	80	100	125	160	200
	1.3	0.99	0.78	0.55	0.42	0.32	0.27	0.18
(b) Fuses to BS 88-3 fuse system C								
Rating (amperes)	5	16	20	32	45	63	80	100
$Z_s$ (ohms)	14.6	3.9	3.2	1.6	1.0	0.68	0.51	0.38
(c) Fuses to BS 3036								
Rating (amperes)	5	15	20	30	45	60	100	
$Z_s$ (ohms)	16.8	5.08	3.64	2.51	1.51	1.07	0.51	
(d) Fuses to BS 1362								
Rating (amperes)	3	13						
$Z_s$ (ohms)	22.0	3.64						

**Table 3: Maximum earth fault impedance ( $z_s$ ) for RCDs**

RCDs rated leaking current / residual current (mA)	Maximum earthing impedance (ohms)	
	120 Volts < Supply Phase Voltage, $V_p$ < 230 Volts	
30	1667	
100	500	

**Table 4: Maximum disconnection times**

	Disconnection time in seconds	
	TT system (second)	TN-S system (second)
Final circuit	0.2	0.4
Distribution circuit	1	5

**Table 5: Minimum cross-sectional area of a buried earthing conductor**

	Mechanically protected	Mechanically unprotected
	Protected against corrosion	25mm <sup>2</sup> Cu 50mm <sup>2</sup> Fe
Not protected against corrosion	25mm <sup>2</sup> Cu 50mm <sup>2</sup> Fe	

**Table 6: Size of neutral conductor due to third harmonic contents**

Third harmonic content of the phase current %	Rating Factor	
	Size selection is based on phase current	Size selection is based on neutral current
Exceeding 0 but not exceeding 15	1.00	-
Exceeding 15 but not exceeding 33	0.86	-
Exceeding 33 but not exceeding 45	-	0.86
Exceeding 45	-	1.00

**Table 7: Common minimum sizes for earth electrodes of commonly used material from the point of view of corrosion and mechanical strength where embedded in the soil**

Material	Surface	Shape	Minimum size				
			Diameter (mm)	Cross-sectional area (mm <sup>2</sup> )	Thickness (mm)	Thickness of coating/sheathing	
						Individual value (µm)	Average value (µm)
Steel	Hot-dip galvanized <sup>a</sup> or Stainless <sup>a, b</sup>	Strip <sup>c</sup>		90	3	63	70
		Sections		90	3	63	70
		Round rod for deep earth electrodes	16			63	70
		Round wire for surface electrode <sup>g</sup>	10				50 <sup>e</sup>
		Pipe	25		2	47	55
	Copper-sheathed	Round rod for deep earth electrode	15			2000	
	With electro-deposited copper coating	Round rod for deep earth electrode	14			90	100
Copper	Bare <sup>a</sup>	Strip		50	2		
		Round wire for surface electrode <sup>g</sup>		25 <sup>f</sup>			
		Rope	1, 8 for individual strands of wire	25			
		Pipe	20		2		
	Tin-coated	Rope	1, 8 for individual strands of wire	25		1	5
	Zinc-coated	Strip <sup>d</sup>		50	2	20	40

a Can also be used for electrodes to be embedded in concrete.

b No coating applied.

c As rolled strip or slit strip with rounded edges.

d Strip with rounded edges.

e In the case of continuous bath-coating, only 50µm thickness is technically feasible at present.

f Where experience shows that the risk of corrosion and mechanical damage is extremely low, 16 mm<sup>2</sup> can be used.

g An earth electrode is considered to be a surface electrode when installed at a depth not exceeding 0,5 m.

**Table 8: Minimum cross-sectional area of protective conductors and earth wires**

Minimum sizes of copper earthing conductor, copper bonding main protective bonding conductor and copper protective conductors not contained in a composite cable, flexible cable, or flexible cord.			
Nominal cross-sectional area of largest associated copper circuit conductor	Nominal cross-sectional area of earthing conductor	Nominal cross-sectional area of protective conductor	Nominal cross-sectional area of bonding main protective bonding conductor
mm <sup>2</sup>	mm <sup>2</sup>	mm <sup>2</sup>	mm <sup>2</sup>
1.0	6	1.0*	1.0*‡
1.5	6	1.0*	1.0*‡
2.5	6	1.0*	1.0*‡
4	6	2.5	1.0*‡
6	6	2.5	1.0*‡
10	6	6	2.5
16	6	6	2.5
25	16	16	6
35	16	16	6
50	16	16	6
70	50	50	16
95	50	50	16
120	50	50	16
150	50	50	16
185	70	70	50
240	70	70	50
300	70	70	50
400	70	70	50
500	70	70	50
630 and above	70	70	50

\* 1.5 mm<sup>2</sup> where the earth protective conductor or bonding conductor is unenclosed  
 ‡ 2.5 mm<sup>2</sup> for the bonding of metalwork or other services at points of entry to premises.



**Table 9: Minimum safety and working clearance**

Nominal Voltage $U_n$ (kV)	Maximum Voltage $U_m$ (kV)	Minimum safety phase to earth air clearance (mm)	Minimum work safety clearance (mm)
0.151-1	-	-	1,250
6	7.2	500	3,000
11	12	500	3,000
33	36	500	3,000
66	72.5	700	3,100
132	145	1,100	3,600
275	300	1,600	4,100
500	525	3,600	6,400

## ANNEX 4 – FORMULAS

$$F1) \quad Z = \frac{V_p}{I_{\text{fault}}} = \frac{V_p}{(3 \times I_{\text{rating}})}$$

where

Z = earthing impedance,

V<sub>p</sub> = phase voltage,

I<sub>fault</sub> = 3 × I<sub>rating</sub>

I<sub>rating</sub> = current rating of semi-enclosed fuse, or cartridge fuse exceed 200 Ampere

---

$$F2) \quad Z = \frac{V_p}{I_{\text{fault}}} = \frac{V_p}{(2.4 \times I_{\text{rating}})}$$

where

Z = earthing impedance,

V<sub>p</sub> = phase voltage,

I<sub>fault</sub> = 2.4 × I<sub>rating</sub>

I<sub>rating</sub> = current rating of cartridge fuse exceed 200 Ampere

---

$$F3) \quad Z = \frac{V_p}{I_{\text{fault}}} = \frac{V_p}{(1.5 \times I_{\text{rating}} \times E/F_{\text{setting}})}$$

where

Z = earthing impedance,

V<sub>p</sub> = phase voltage,

I<sub>fault</sub> = 1.5 × I<sub>rating</sub>

I<sub>rating</sub> = current rating of circuit breaker

E/F<sub>setting</sub> = the percentage setting of earth fault relay such as 10%, 20%, 40%

---

$$F4) \quad Z = \frac{V_p}{I_R}$$

where

Z = earthing impedance

V<sub>p</sub> = Phase voltage

I<sub>R</sub> = Rating current

and earthing impedance for transformer substation supplying low voltage system shall not exceed 1 ohm.

Z ≤ 1 ohm.



[www.st.gov.my](http://www.st.gov.my)

**Suruhanjaya Tenaga  
(Energy Commission)**

No. 12 Jalan Tun Hussein, Precinct 2, 62100 Putrajaya.  
Toll Free Number: 1-800-2222-78 (ST)  
T : (603) 8870 8500 F : (603) 8888 8637