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GOVERNMENT NOTICE

No. 200 Electricity Control Board: Namibian Electricity Safety Code, 2009: Electricity Act, 2007 1

Government Notice

ELECTRICITY CONTROL BOARD

No. 200

2011

NAMIBIAN ELECTRICITY SAFETY CODE, 2009: ELECTRICITY ACT, 2007

The Electricity Control Board has under section 3(4) of the Electricity Act, 2007 (Act No. 4 of 2007), made the code set out in the Schedule which comes into operation on the first anniversary of the date of publication of this Notice.

J. NANDAGO
CHAIRPERSON
ELECTRICITY CONTROL BOARD

Windhoek, 12 October 2011

SCHEDULE

FOREWORD

This Code governs the minimum safety standards for the operating, maintenance, construction and installation of power systems in Namibia. The purpose of this Code is threefold, namely, to ensure the safety of all persons, to safeguard apparatus and to provide continuity of supply.

This Code is an extension of, and must be read in conjunction with, the provisions of the Electricity Act, 2007, and the Labour Act, 2007 (with particular emphasis on Health and Safety Regulations made thereunder), and all other applicable laws, and does not supersede, overrule or negate any provisions contained in the Electricity Act, the Labour Act or such other laws.

This Code has been produced in loose-leaf format to facilitate its updating as and when the need arises.

Service Issue 1
May 2009

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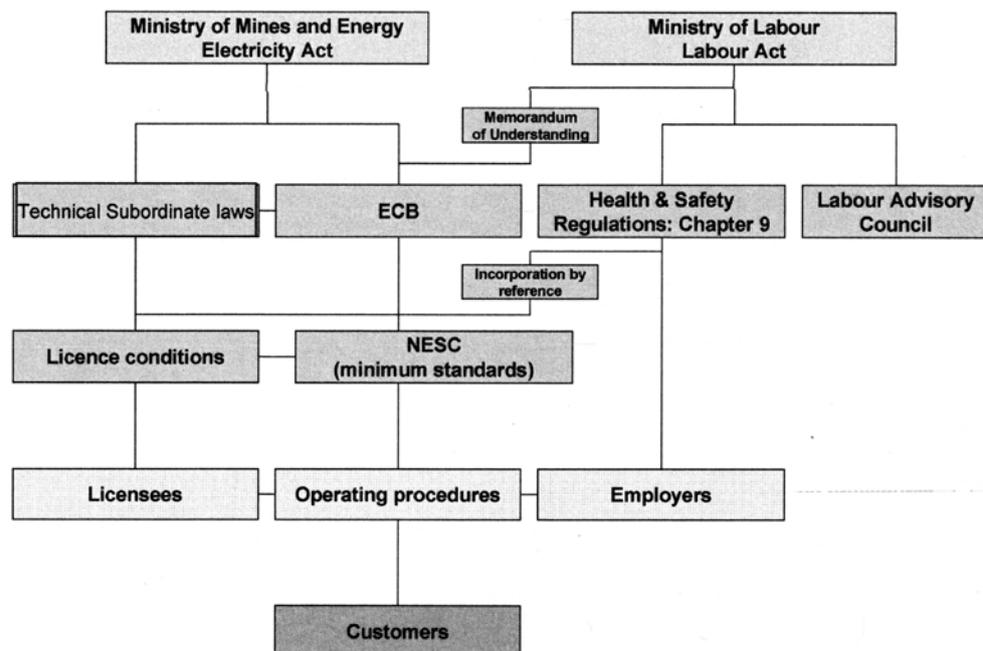
INTRODUCTION

A. PURPOSE OF CODE

- A.1 This Code governs the minimum safety standards for the operating, maintenance, construction and installation of power systems in Namibia. The purpose of this Code is threefold, namely, to ensure the safety of all persons, to safeguard apparatus and to provide continuity of supply.
- A.2 This Code is an extension of, and must be read in conjunction with, the provisions of the Electricity Act, 2007, and the Labour Act, 2007 (with particular emphasis on the Health and Safety Regulations made thereunder), and all other applicable laws, and does not supersede, overrule or negate any provisions contained in the Electricity Act, the Labour Act or such other laws.

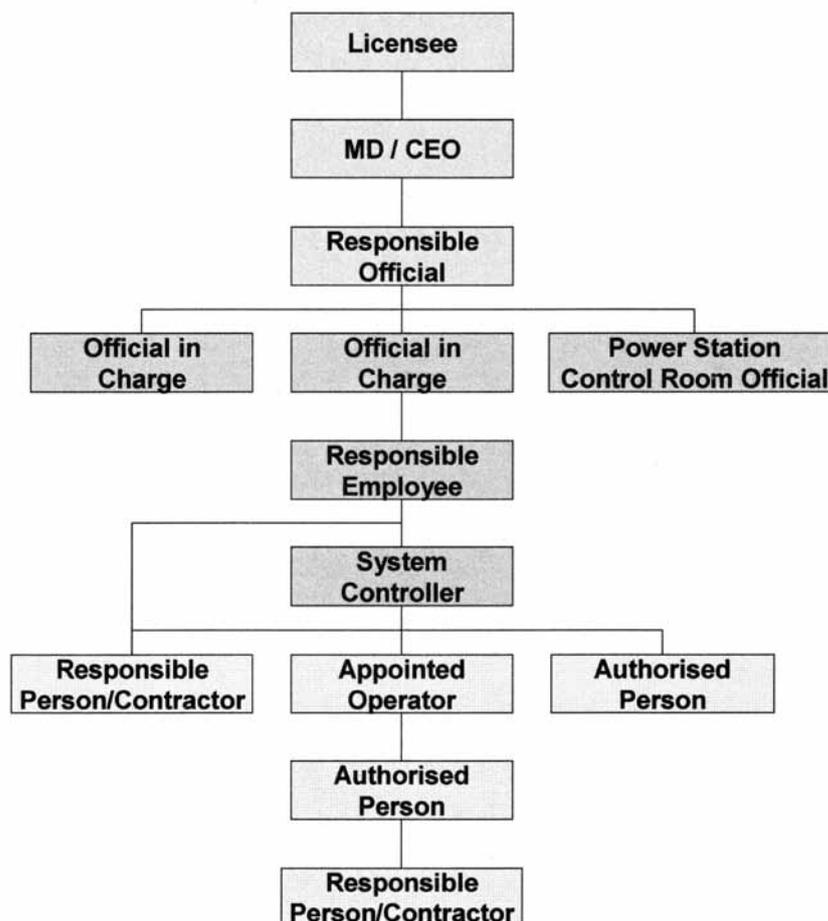
B. CODE GOVERNANCE FRAMEWORK

The following diagram illustrates the extent of interaction among the key stakeholders in the Namibian Electricity Industry as far as the administration and enforcement of electricity safety standards are concerned.



C. SAFETY GOVERNANCE ORGANISATIONAL STRUCTURE

- C.1 The following organogram serves to illustrate from a safety governance perspective, and its impact among the various 'Key role players within the organisational structure of a licensee.
- C.2 The vertical and/or horizontal extension or curtailment of this structure depends largely on the size and unique organisational structure of each licensee.



D. COMPLIANCE WITH CODE

This Code enters into force and becomes compulsory on the second anniversary of the date of publication thereof in the Government Gazette.

E. REVISION OF CODE

E.1 This Code is revised annually by the Electricity Control Board (ECB) on a date determined by the ECB after consultation with the Standing Working Group on Electricity Safety regarding its scope, content and implementation. The membership organisations of this Working Group are:

ECB (Chair)
 Ministry of Labour
 Ministry of Mines and Energy
 NamPower
 NORED
 Erongo RED
 CENORED
 Mariental Municipality/SORED
 City of Windhoek

E.2 A revision of this Code must, before the approval of the Minister responsible for mines and energy is sought under section 3(4) of the Act, be consulted with the Minister responsible for labour and the Labour Advisory Council.

- E.3 A revision of this Code, or part thereof, is issued in print, published in the Government Gazette in terms of section 3(4) and distributed by the ECB to all licensees. Revision control is exercised by the ECB.

F. GENERAL INSTRUCTIONS

- F.1 Every licensee shall be in possession of a copy of this Code and all relevant legislation pertaining to the Namibian Electricity Industry. The licensee is responsible for complying with the minimum safety standards prescribed in this Code and for ensuring that all relevant role players within the licensee's organisation are acquainted therewith.
- F.2 The licensee may assign in writing the responsibility for enforcing compliance and adherence to the safety standards prescribed in this Code.
- F.3 Where an interconnection exists between two or more power systems, whether between two licensees or between a licensee and another power producer or distributor, appropriate communication and coordination means must be established and maintained with regard to operational matters under joint authority.
- F.4 Abbreviations used in this Code are reflected in Annexure 9.
- F.5 If so required by the context, any reference to the singular includes the plural and vice versa, and any reference to the present tense includes the past and future tenses and vice versa.
- F.6 Where the word "include" or "including" is used in this Code, it means "includes without limitation" or "including without limitation".
- F.7 Where the word "should" is used in this Code, it means a requirement which needs to be equalled or exceeded so that an obligation is discharged. If this Code states that something "should be done", the requirement is to do what this Code requires or do it in a manner which is equal to or better (electrically safer) than prescribed in this Code.
- F.8 Where the word "must" is used in this Code, it means a mandatory requirement.
- F.9 Where the word "shall" is used in this Code, it means an obligatory action or series of actions without alternate course or deviation from the safety standard in question.
- F.10 A clear distinction must be observed between certain words, such as "earth" and "earthing", and must not be misinterpreted as being the same term or having the same meaning or referring to the same action, application or object.

SECTION 1: DEFINITIONS

1.01 OFFICIALS AND PERSONS

In this Code, including its introduction, unless the context otherwise indicates -

- 1.01.1 **appointed operator** (A/O) means a qualified person authorised to carry out safe operating on the power system of a licensee on instruction of the system controller in accordance with this Code;
- 1.01.2 **authorised person** (A/P) means a qualified person authorised to access a station to perform designated functions in accordance with this Code;

- 1.01.3 **competent person** means a person certified in writing by an inspector to be competent to perform a specific task;
- 1.01.4 **contractor** means a person contracted to do work on a power system in accordance with this Code;
- 1.01.5 **consumer** means an end user of electricity who consumes such electricity;
- 1.01.6 **customer** means a person to whom electricity is delivered by a licensee, and includes a consumer;
- 1.01.7 **inspector** means a person appointed as a labour inspector under section 124 of the Labour Act;
- 1.01.8 **licensee** means the holder of an electricity licence issued under the Electricity Act;
- 1.01.9 **Minister** means the Minister responsible for energy;
- 1.01.10 **official in charge** means a qualified person employed by a licensee, who is -
- 1.01.10.1 in charge of a defined section of a power system; and
- 1.01.10.2 authorised to make decisions and give instructions on deviations from normal operating procedures;
- 1.01.11 **power station control room official** means a person deployed by a licensee in the power station control room and generally in control of the operation of a power station in accordance with this Code;
- 1.01.12 **qualified person** means a person who is able to submit documentary proof that he or she has -
- 1.01.12.1 received appropriate theoretical and practical training; and
- 1.01.12.2 gained adequate experience in electricity safety;
- 1.01.13 **responsible official (R/O)** means a qualified person employed by a licensee, who is responsible for ensuring compliance and authorising persons to ensure compliance with this Code, and in the event of no such person being employed by the licensee, means, in the case of the licensee being:
- 1.01.13.1 A company, the managing director or chief executive officer;
- 1.01.13.2 a close corporation, the managing member;
- 1.01.13.3 a trust, the chairperson of the board of trustees;
- 1.01.13.4 a partnership, the managing partner;
- 1.01.13.5 a proprietorship, the owner;
- 1.01.13.6 an association, the chairperson of the executive committee or management committee; or
- 1.01.13.7 a co-operative, the chairperson of the board of directors;
- 1.01.14 **responsible person (R/P)** means a person who has been authorised to work on apparatus covered in a work permit or a live work declaration;
- 1.01.15 **responsible employee (R/E)** means a person employed by a licensee, who is responsible for ensuring that any work on apparatus in terms of this Code can be carried out with safety;

- 1.01.16 system controller (S/C) means a person on duty, who is responsible for-
- 1.01.16.1 the general operation and control of a power system; and
- 1.01.16.2 the issuing of instructions to an appointed operator or authorised person for the safe operation of generation, transmission and distribution systems in accordance with this Code;

1.01.17 **worker** means a person employed to work on a power system.

1.02 OPERATING TERMS

In this Code, including its introduction, unless the context otherwise indicates -

- 1.02.1 **access** means authorised entry into a prohibited area, live chamber or station on a power system;
- 1.02.2 **access lock** means a lock that forms part of a series of locks permitting access to prohibited areas or stations, which can only be opened with a master key for the series of locks;
- 1.02.3 **additional earth** means a registered earth or earthing gear that may be applied to a busbar or a line with the prior approval of a system controller;
- 1.02.4 **alive** means electrically charged, and live has a similar meaning;
- 1.02.5 apparatus means any -
- 1.02.5.1 electrical equipment such as generating plant, switch gear, transformer, regulating gear, busbar, cluster-bar, feeder, line, auxiliary apparatus, including all associated control and protection equipment, operated at different voltages; or
- 1.02.5.2 any other apparatus installed on a site, forming part of a power system;
- 1.02.6 **approved** means approved in writing by a licensee;
- 1.02.7 **authorised** means authorised in writing to perform predefined duties;
- 1.02.8 **authorised** operation means any work executed under instruction of the system controller;
- 1.02.9 **auto-reclose** (ARC) means a preset function applied on certain breakers or reclosers, which allows automatic reclosure of the breakers or reclosers after opening on fault occurrences;
- 1.02.10 **auxiliary apparatus** means secondary apparatus, and includes auxiliary supply or any supporting apparatus in a station for ensuring the proper function of apparatus, such as protection schemes, control systems, communication systems and AC/DC supplies;
- 1.02.11 **barricade** means barrier, and barricaded has a similar meaning;
- 1.02.12 **barrier** means an approved device designed to restrict approach to live apparatus;
- 1.02.13 **basic insulation level** (BIL) means a specific insulation level, expressed in kilovolt (kV), to which a power system is designed and constructed;

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- 1.02.14 **bay** means all the apparatus in the same circuit situated in one or more floors in a building or through a structure, from and including the busbar links;
- 1.02.15 **breaker** means a device designed to make, carry or break electric current both under normal and fault conditions, and recloser has a similar meaning;
- 1.02.16 **busbar** means a conductor or group of conductors that serves as a common connection for two or more circuits within a station;
- 1.02.17 **cable** means a feeder, normally underground, and includes the terminations;
- 1.02.18 **chamber** means an enclosure in which apparatus is separated from other apparatus by partition walls or other means, the access to which is restricted by interlocks;
- 1.02.19 **circuit** means the arrangement of conductors and apparatus from and including the blades of all links or the contacts of other apparatus provided for completing the connection to the busbar;
- 1.02.20 **circuit breaker** means breaker;
- 1.02.21 **close proximity** means a position in which any body part of a person or tool being used by a person may inadvertently breach the minimum safe working clearance;
- 1.02.22 **cluster-bar** means the central connection point, mounted on a pole at a point below a person's feet, where all the clamps of the portable earths between the earth spike and the conductors are connected;
- 1.02.23 **commissioning** means the pre-determined sequence of inspections, tests and energising procedures designed for the integration of new apparatus into a power system;
- 1.02.24 **communication set** includes a telephone, cellular phone, radio or any other device designed for communication purposes;
- 1.02.25 **connect** means making a connection or series of connections to obtain electrical continuity in a circuit, or between apparatus, or between apparatus and earth;
- 1.02.26 **conductor** means any bar, pin, tube, socket, wire, jumper, dropper, cable or line used for conducting electricity, which is so arranged to be connected to a source of electrical potential;
- 1.02.27 **consumption** means electricity consumed in kilowatt hour (kWh);
- 1.02.28 **control centre** means a place from where the safe operation of generation, transmission or distribution of electricity to customers is controlled or directed;
- 1.02.29 **control panel** means the panel on which auxiliary apparatus are mounted, such as control switches, protective relays, measurement devices or other equipment to control, measure and protect apparatus, and includes a protection panel, an interface panel, a supplementary panel, a mimic panel, a metering panel and an alarm panel;
- 1.02.30 **control switch** means a switch provided for controlling the operation and function of apparatus and auxiliary apparatus;

- 1.02.31 **danger** means a risk of loss of human life, bodily injury or damage to health from electric shock, burn or any hazardous condition, or loss of or damage to apparatus, arising from the provision or use of electricity;
- 1.02.32 **dead** means that any apparatus so described is at or about zero potential and disconnected or isolated from all possible sources of electrical potential or any live power system;
- 1.02.33 **de-energised** means that the apparatus is not electrically connected to a live power system and has not been discharged, isolated, safety tested or earthed;
- 1.02.34 **discharged** means -
- 1.02.34.1 connected to earth and that the apparatus is free of any residual or induced electrical potential; and
- 1.02.34.2 that stored energy has been released, such as a closing spring in a breaker, hydraulic, pneumatic or gas pressure in a system, or energy stored in a battery or capacitor bank;
- 1.02.35 **disconnected** means apparatus is not connected to a source of electrical potential achieved by the removal of a connection or series of connections thereby interrupting or breaking electrical continuity in a circuit, or between apparatus, or between apparatus and earth, but may still have to be discharged;
- 1.02.36 **distribution**, in relation to electricity, means the conveyance of electricity through a distribution system, which consists wholly or mainly of medium and low voltage networks, to a customer;
- 1.02.37 **distribution system** means the network of stations, transformers, lines and cables whereby electricity is distributed to a customer;
- 1.02.38 **double circuit structure** means a structure supporting two circuits of the same voltage on the same structure but situated on opposite sides of the centre of the structure;
- 1.02.39 **dropper** means a conductor installed to connect apparatus to a line or a busbar;
- 1.02.40 **drop out fuse** means a single phase pole mounted outdoor air insulated mechanically operated device charged with a fuse for protecting apparatus in the event of a fault occurrence;
- 1.02.41 **earth** -
- 1.02.41.1 as a noun, means the general mass of the earth and is regarded to be at zero potential;
- 1.02.41.2 as a verb, means applying earthing gear or connecting apparatus to earth in a manner that will ensure an immediate safe discharge of electrical energy at all times;
- 1.02.42 **earth mat** means the subterranean conductive material installed in a station, at a structure or on a transformer, pylon or pole or under a line to ensure that a connection can be made between apparatus and earth;
- 1.02.43 **earthing gear** means the fixed or portable earthing devices, such as earthing links/ switches or portable earths, used for earthing apparatus;
- 1.02.44 **earthing link/switch** means earthing gear, mechanically or electrically operated, permanently connected at one point to the earth mat and designed to earth apparatus;

- 1.02.45 **earth spike** means a copper clad steel rod, of adequate current carrying capacity, which is driven into the ground to ensure that an electrical connection is made between apparatus and earth;
- 1.02.46 **electric fence** means a fence on which an electric fence energiser is connected to deliver a periodic non lethal amount of electricity to the fence to prevent unauthorised access to certain areas;
- 1.02.47 **electrical connection** means the permanent or temporary connection between apparatus or apparatus and earth thus providing a continuous path whereby any form of electrical energy, charge or current flow can be conducted safely;
- 1.02.48 **Electricity Act** means the Electricity Act, 2007 (Act No. 4 of 2007), as amended or substituted;
- 1.02.49 **emergency** means a situation where danger can only be avoided by immediate action;
- 1.02.50 **emergency switching** means the opening only of such breaker, recloser, switch or similar device as may be necessary to avoid danger;
- 1.02.51 **enclosure** means any room, chamber, yard or enclosed area in which it is possible for a person from ground/floor level to make inadvertent contact with, or come into close proximity of live conductors or apparatus;
- 1.02.52 **energised** means apparatus is connected to a live power system and is in service;
- 1.02.53 **export** means the provision of electricity to customers outside the physical borders of Namibia;
- 1.02.54 **factor of safety** means the ratio of a component's failing load to the maximum working load for which it has been designed;
- 1.02.55 **fault** means an unplanned occurrence or defect in an item which may result in one or more failures of the item itself or of associated apparatus;
- 1.02.56 **feeder** means a bay, a power line or a cable, whether underground or not -
- 1.02.56.1 in or from a station; or
- 1.02.56.2 between two or more stations; or
- 1.02.56.3 from a station to a customer, and includes all structures, supports, conductors and related hardware;
- 1.02.57 **footing resistance** means the resistance between a structure and earth;
- 1.02.58 **frequency** means the cyclic frequency of a sinusoidal waveform over a period of one second (cycles/second), expressed in Hertz (Hz);
- 1.02.59 **generation**, in relation to electricity, means the production of electricity by way of natural or artificial processes;
- 1.02.60 **generating plant** means apparatus designed for the purpose of generating electricity and includes all support apparatus;

- 1.02.61 **ground/floor level** means the general surface a person walks on, including a structure or apparatus plinth other than a structure or apparatus plinth that has been constructed to obtain safe working clearance or safe ground clearance;
- 1.02.62 **hand back** means the transfer of responsibility for apparatus, as specified in the hand out, by an appointed operator or authorised person to the system controller, detailing all work performed and thereby authorising the safe return of the apparatus to service;
- 1.02.63 **hand out** means the transfer of responsibility for specific apparatus by the system controller to an appointed operator or authorised person, whereby the appointed operator or authorised person is authorised to work safely on the apparatus;
- 1.02.64 **hand over** means the detailed confirmation by an appointed operator, authorised person or responsible person to the system controller that new or refurbished apparatus is ready to be commissioned and placed in service whereby such apparatus will become the responsibility of the system controller;
- 1.02.65 **Health and Safety Regulations** means the Regulations relating to the Health and Safety of Employees at Work, 1997, as amended or substituted;
- 1.02.66 **high voltage** means a voltage of more than 44 000 volt (RMS);
- 1.02.67 **human machine interface (HMI)** means a computer, normally in a station or control centre -
- 1.02.67.1 on which is displayed the layout and operational state of apparatus in a station or a power system; and
- 1.02.67.2 which records events and allows remote monitoring and operation of certain apparatus;
- 1.02.68 **import** means the supply of electricity to Namibia from electricity providers, independent power producers or power utilities outside the physical borders of Namibia;
- 1.02.69 **incident** means a work related detrimental occurrence;
- 1.02.70 **in commission** means apparatus is available for immediate use, although it may not actually be in service;
- 1.02.71 **induction** means the electrical charge produced in a conductor due to the variation of a magnetic field in its vicinity, such as in adjacent circuits and static charge build up due to weather conditions;
- 1.02.72 **in service** means apparatus is energised and in use;
- 1.02.73 **insulated** means covered, enclosed, surrounded or apparatus supported with insulating material of such thickness and properties that it will prevent the flow of electrical energy or potential between the object so covered and its surroundings or any external object in contact with it, including the prevention of making contact with earth;
- 1.02.74 **insulating material** means any non-conductive material such as glass, porcelain or other composite material used for covering, enclosing, surrounding or supporting apparatus or part thereof;

- 1.02.75 **insulator** means a device made from insulating material designed to -
- 1.02.75.1 obtain the required basic insulation level; and
- 1.02.75.2 prevent electrical contact between a live part and its surroundings;
- 1.02.76 **interlock** means a mechanism, whether operated mechanically, electrically, electronically, computer software driven or any combination thereof, designed to ensure the safe execution of a predetermined sequence of operations;
- 1.02.77 **interlocking lock** means a series of locks in a station for which only one specific key exists to perform safe operations on an interlocking system;
- 1.02.78 **in writing** means hand written, typed or printed, duly signed and dated, and includes a transmission to the intended recipient concerned by means of facsimile or electronic mail;
- 1.02.79 **isolate** means disconnecting apparatus from all possible sources of electrical potential to create a visible gap between a live part and a de-energised part, which may be obtained by -
- 1.02.79.1 opening or removing fuses or drop out fuses;
- 1.02.79.2 opening links, isolators or disconnectors;
- 1.02.79.3 removing droppers or jumpers;
- 1.02.79.4 opening air break switches;
- 1.02.79.5 withdrawing truck-type switch gear;
- 1.02.79.6 immobilising breakers having visible contact separation, and not fitted with grading capacitors;
- 1.02.79.7 utilising an approved changeover breaker, switch, link or similar device with mechanical interlock,
- and if contact separation is not visible due to design or physical construction criteria, isolation is deemed not to have been achieved unless a combination of at least two of the following displays indicate simultaneously that contact separation has indeed taken place:
- 1.02.79.8 External mechanical indicator;
- 1.02.79.9 electro-mechanical indicator;
- 1.02.79.10 electrical operated position indicator;
- 1.02.79.11 electronic display by HMI or bay controller;
- 1.02.80 **isolator** means a device provided for the purpose of isolating apparatus from the source of supply;
- 1.02.81 **jumper** means a conductor installed between various apparatus to create continuity;
- 1.02.82 **key** means a key or an electric, electronic, computer software driven or other device used in a station to operate locks;
- 1.02.83 **kilowatt-hour (kWh)** means the consumption of electrical energy equivalent to one kilowatt of power sustained for one hour;
- 1.02.84 **Labour Act** means the Labour Act, 2007 (Act No. 11 of 2007), as amended or substituted, and includes the Health and Safety Regulations;
- 1.02.85 **line** means an overhead feeder consisting of conductors, supports and related hardware between power stations, stations and customers;

- 1.02.86 **link** means a device, such as an isolator, disconnecter or similar disconnecting device, for making or breaking a circuit when no load current is flowing;
- 1.02.87 **linking** means the opening or closing of a link, isolator, disconnecter or similar disconnecting device when no load current is flowing;
- 1.02.88 **live chamber** means any chamber in which inadvertent human contact with conductors or live parts of apparatus working at high voltage is possible from ground/floor level;
- 1.02.89 **live part** means any conductive part of apparatus, which is alive and in normal use, and includes the neutral conductor;
- 1.02.90 **load current** means the current flowing in a circuit that is associated with electricity consumption;
- 1.02.91 **loading** means the matching of electricity generation and demand of a power system;
- 1.02.92 **local control centre** means a temporary location from where safe operations on a pre-defined section of a power system may be controlled or directed in accordance with paragraph 7.05 of this Code;
- 1.02.93 **lock** includes an access lock, an interlocking lock, a marriage lock, an operating lock, a safety lock, a servitude lock and a unique lock;
- 1.02.94 **low voltage** means a voltage of 1 000 volt (RMS) or less;
- 1.02.95 **made safe** means de-energised, isolated and earthed as required to allow the necessary work to be carried out without danger;
- 1.02.96 **marriage lock** means a lock placed in series with another lock allowing various persons to have access to servitudes and premises, and marriage locking has a similar meaning;
- 1.02.97 **medium voltage** means a voltage of more than 1 000 volt (RMS) but not more than 44 000 volt (RMS);
- 1.02.98 **operating** means switching, linking, safety testing and earthing operations in that specific order;
- 1.02.99 **operating diagram/mimic** means the permanent single line diagram in a control centre or station indicating the operating position and operational state of all apparatus;
- 1.02.100 **operating lock** means a lock forming part of a series of locks, operated by a master key that gives access to live chambers and to certain apparatus only for exclusive safe operations by an appointed operator;
- 1.02.101 **operating procedures** means approved detailed sequences for ensuring the safe operating of a power system, or part thereof, which are developed and maintained by the responsible official;
- 1.02.102 operating stick means an approved insulated rod or telescopic tube to -
- 1.02.102.1 enable links and fuses to be operated; or

- 1.02.102.2 carry out safety testing and earthing operations;
- 1.02.103 **operation** means the safe execution of a task, instruction, procedure and guideline in terms of this Code, and includes the general functions of system operations;
- 1.02.104 **out of commission** means apparatus taken out of service and not available for immediate use;
- 1.02.105 **out of service** means apparatus connected to a power system but not presently in use;
- 1.02.106 **piggyback system** means a system where more than one circuit of different voltages are supported on the same structure, excluding any double circuit structure and high voltage structure carrying low voltage conductors;
- 1.02.107 **point of supply** means any point where a power system or a section of a power system can be made alive;
- 1.02.108 **portable earth** means a mobile flexible earthing gear, which may be used as a registered earth, working earth, additional earth or any other safe earthing application as may be required, and portable earthing gear has a similar meaning;
- 1.02.109 **power line** means an electric line whose conductors are supported above ground, generally by means of insulators and appropriate supports erected to convey electricity for any other purpose than communication, but excluding the overhead contact or catenary conductors of an electric traction system, and overhead line has a similar meaning;
- 1.02.110 **power station** means a site on which electricity is generated;
- 1.02.111 **power station control room** means the permanent location at a power station from where the safe operations of the power station is controlled or directed;
- 1.02.112 **power system** means the interconnected system comprising power stations, feeders, stations and apparatus used in connection with the generation, transmission, distribution and supply of electricity;
- 1.02.113 **prohibited area** means a normally enclosed area in which live conductors or live parts of apparatus are accessible, but situated in such a position that inadvertent human contact therewith is not possible;
- 1.02.114 **registered earth** means any earthing gear applied or removed on instruction from a system controller;
- 1.02.115 **remote control** means the operation or operating of apparatus from a place not immediately adjacent to the related apparatus;
- 1.02.116 **restricted area** means an area other than a live chamber or a prohibited area, which is enclosed for the purpose of power system security and the safety of persons;
- 1.02.117 **safe working clearance** means the minimum safe distance to be observed between -
- 1.02.117.1 different live parts of apparatus; or
- 1.02.117.2 live parts of apparatus and earth,
- to prevent a short-circuit or inadvertent human contact with such live parts;

- 1.02.118 **safety lock** means a lock used for safe operations in a power station for which -
- 1.02.118.1 only one specific key is in use; and
- 1.02.118.2 a master key may be used under extreme circumstances to override the specific safety lock;
- 1.02.119 **safety panel** means apparatus or a line that has been isolated and earthed as a precautionary measure to prevent contact with the live high voltage apparatus or line where there is a risk of encroaching in person or with machinery or objects on the safe working clearance when work is being performed near or close to such apparatus or line;
- 1.02.120 **safety testing** means the testing of apparatus to ascertain whether it is alive or dead by means of approved test equipment provided for this purpose;
- 1.02.121 **sectionaliser** means a switch intended to open automatically to disconnect part of a power system, during the open time of a recloser or breaker, which has tripped, to clear a fault;
- 1.02.122 **servitude lock** means a lock forming part of a series of locks to gain access to line servitudes and is operated by a master key;
- 1.02.123 **shutter** means a mechanically operated safety cover for or on an orifice to prevent access to live parts of switch gear;
- 1.02.124 **single-line diagram** means a diagram depicting the layout of a system, whether polyphase or not, by use of equivalent single line symbols;
- 1.02.125 **source of supply** means that portion of a power system from which the apparatus can be made alive;
- 1.02.126 **special operating procedures** means an approved sequence for ensuring the safe operating of apparatus at identified stations, which are developed and maintained by the responsible official;
- 1.02.127 **station** means a power station, transmission station, distribution station, switching station, isolating station, mobile station or other station or substation with apparatus maintaining, controlling, supporting or forming part of a power system, and may contain generating plant, transformers or switching or linking apparatus;
- 1.02.128 **stay** means a steel wire, rope, rod or other device that supports a pole or structure;
- 1.02.129 **supervision** means overseeing the actions of a person to prevent any danger or contravention of this Code;
- 1.02.130 **supply**, in relation to electricity, means the delivery of electricity to a customer as a commodity;
- 1.02.131 **supply point** means the point at which electricity is received by a customer;
- 1.02.132 **switch** means a device, other than a breaker, designed for making and breaking a rated flow of electric current, and includes an air break switch, a spring operated link, a weight operated disconnecter, a load break link, a transrupter or any similar device;

- 1.02.133 **switching** means the opening and closing of a breaker, recloser, sectionaliser, switch or similar apparatus, and includes operating auxiliary apparatus;
- 1.02.134 **trading, in relation to electricity**, means the wholesale or retail buying and selling of electricity;
- 1.02.135 **transmission, in relation to electricity**, means the conveyance of electricity by means of a transmission system, which consists wholly or mainly of high voltage networks and electrical plant, from an energy source or system to a customer;
- 1.02.136 **transmission line** means an overhead power line operating at high voltage to transfer large amounts of electricity;
- 1.02.137 **transmission system** means the network of stations, transformers, feeders, lines, cables and other apparatus whereby electricity is transmitted;
- 1.02.138 **trip** means the opening only of a breaker, recloser, switch or similar device activated by means of installed protection on occurrence of a fault on apparatus;
- 1.02.139 **underground cable** means an electric line with insulated conductors buried directly in the ground, or laid in cable ducts, trenches, pipes or troughs;
- 1.02.140 **unique lock** means a dedicated lock for which only one key exists, to isolate and lock apparatus or a customer supply point from a power system to ensure safe separated operations;
- 1.02.141 **voltage** means the electric potential between two points that gives rise to the flow of electricity and where specified, the RMS value of the voltage;
- 1.02.142 **work** means all physical activities in connection with apparatus, excluding operating and other non-dangerous activities, which will not affect the health and safety of persons or the safe operation of apparatus;
- 1.02.143 **working earth** means the visible, supplementary, portable earthing gear applied on all sides and as close as possible to the point of work;
- 1.02.144 **workplace** means the place where physical work is done on a power system.

1.03 *PRINTED FORMS, BOOKS AND NOTICES*

In this Code, including its introduction, unless the context otherwise indicates -

- 1.03.1 **authority** means a letter of authority signed by the responsible official, stipulating the level of authority and responsibilities with regard to operations, services, access to prohibited areas or live chambers or live work on a power system, which letter of authority -
- 1.03.1.1 may extend to all voltage levels from the point of generation up to a supply point;
- 1.03.1.2 is valid for the maximum period specified by a licensee;
- 1.03.1.3 may be cancelled, altered or withdrawn at the discretion of the licensee at any time due to any misconduct, resignation, transfer or operational change;
- 1.03.2 **control panel label/tag** means a notice displayed on a control panel in a station indicating that apparatus is being worked on and may indicate the position of earthing gear;

- 1.03.3 **indemnity form** means a form that must be completed by all persons as required by the licensee;
- 1.03.4 **licence** means a licence for the generation, transmission, trading, distribution, supply, import or export of electricity, issued in terms of the Electricity Act;
- 1.03.5 **logbook** means a book provided for keeping a record of all events, incidents, operations, operation counter readings and related activities, which is accessible at all times;
- 1.03.6 **operating drawing** means a single line diagram that depicts the layout of a power system, station and lines between stations and customers for the issuing and execution of operating instructions;
- 1.03.7 **operating instruction form (OIF)** means the printed form used for recording instructions issued by a system controller to an appointed operator or authorised person relating to the operations to be carried out on apparatus;
- 1.03.8 **record** means any recording system, book, form or statement, whether printed or not, to keep all information and its daily activities up to date;
- 1.03.9 **warning notice** means a notice provided -
- 1.03.9.1 to indicate and warn that work is in progress on apparatus; or
- 1.03.9.2 to indicate any special operating condition in force;
- 1.03.10 **work permit** means a document permitting work to be carried out on specific apparatus, which has been prepared in accordance with this Code so that the Intended work may be carried out with safety;
- 1.03.11 **work permit form** means the printed form containing the application, permit, clearance and worker's declaration for the authorisation of work to be done on apparatus in accordance with this Code;
- 1.03.12 **worker's declaration** means a declaration signed by the appointed operator, the responsible person and the worker concerned, confirming -
- 1.03.12.1 that apparatus to be worked on was made safe; and
- 1.03.12.2 an understanding of the restrictions and details of the work to be carried out;
- 1.03.13 **workers register** means a register of workers assigned to do work, which is completed by an authorised person or a responsible person.

SECTION 2: CONTROL OF A POWER SYSTEM

2.01 DUTIES AND RESPONSIBILITIES OF A SYSTEM CONTROLLER

- 2.01.1 The system controller shall be responsible for the overall control of a power system and in addition to any other duties or responsibilities specified elsewhere in this Code, for carrying out the following duties:
- 2.01.1.1 Ensuring the safety of human life, safety of equipment and the continuity of power supply to customers, in that order of priority;
- 2.01.1.2 issuing instructions for the loading of generating plant and the control of frequency and voltage of the power system under his or her control;

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- 2.01.1.3 issuing instructions as set out in the special operating procedures;
- 2.01.1.4 issuing instructions for safe operations on the power system under his or her control.
- 2.01.2 The following operations are regarded as exceptions and are not executed under direct instructions from the system controller:
- 2.01.2.1 Emergency switching;
- 2.01.2.2 working earths on apparatus;
- 2.01.2.3 operating on auxiliary apparatus in stations below 1 000 volt (RMS);
- 2.01.2.4 operating via supervisory remote control performed by a system controller;
- 2.01.2.5 operating under the jurisdiction of an established local control centre.
- 2.01.3 Before issuing any operating instruction to an appointed operator or authorised person, the system controller shall ensure that all parties have corresponding updated operating drawings in their possession.
- 2.01.4 The system controller shall keep a record of -
- 2.01.4.1 the times and details of all operating carried out by the system controller or under his or her instructions; and
- 2.01.4.2 the names of the persons instructed to carry out the operating, and shall record and act upon all alarms that may appear as a result of such operating.
- 2.01.5 The system controller shall keep a record of -
- 2.01.5.1 the times and details of all emergency switching; and
- 2.01.5.2 the names of the persons who have carried out the emergency switching, and shall record and act upon all alarms that may appear as a result of such emergency switching.
- 2.01.6 The system controller shall -
- 2.01.6.1 update the operating diagram/mimic in the control centre in such a way as to indicate at all times the operational state of breakers, switches and links and the position of earths throughout the section of the power system under his or her control; and
- 2.01.6.2 keep a record of the names of the appointed operators to whom apparatus are handed out.
- 2.01.7 Switching of auxiliary apparatus or any work carried out on auxiliary circuits by an authorised person shall be confirmed with the system controller and the hand out and hand back procedures shall be followed.
- 2.01.8.1 The system controller shall give to the relieving system controller, for the proper discharge of his or her duties -
- 2.01.8.1.1 all the required information as to the state of the power system under his or her control; and
- 2.01.8.1.2 any other information that may be necessary,
- 2.01.8.2 The relieving system controller shall obtain this information from the system controller and read the relevant entries in the records.

2.02 *KEEPING OF RECORDS***2.02.1 *Operating records***

2.02.1.1 A record shall be maintained in the control centre of-

2.02.1.1.1 the names and contact details of all appointed operators, authorised persons and responsible persons, together with the extent of their authorisation; and

2.02.1.1.2 permanent and temporary settings of all relays and protective gear.

2.02.2 Logbook

2.02.2.1 The licensee shall provide a logbook at each station in which the appointed operator, the authorised person and the responsible person shall record all operating or work carried out on a power system.

2.02.2.2 All operating performed by an appointed operator must be written down on an operating instruction form, including the procedures for apparatus hand over, hand out and hand back, which procedures shall also be recorded in the logbook.

2.02.2.3 All switching operations performed on auxiliary apparatus by an authorised person must be written down on an operating instruction form, including the procedures for apparatus hand over, hand out and hand back, which procedures shall also be recorded in the logbook.

2.02.2.4 Every entry relating to the application of earthing devices shall state the location in the circuit where each earthing device is applied.

2.03 *ISSUE AND RECEIPT OF OPERATING INSTRUCTIONS AND THE USE OF OPERATING INSTRUCTION FORMS***2.03.1 *Permission to operate***

No person shall carry out any operating or operation on a power system without the prior authorisation by the system controller, except in cases as stipulated in paragraph 2.01.2 of this Code.

2.03.2 Issue and receipt of operating instructions

2.03.2.1 All instructions from the system controller to an appointed operator or authorised person relating to operating or operation of apparatus shall be given in detail and sequentially without abbreviation, stating -

2.03.2.1.1 the date;

2.03.2.1.2 the name of the station;

2.03.2.1.3 the apparatus to be worked on;

2.03.2.1.4 the nature of the operation to be carried out;

2.03.2.1.5 the time of receiving and completion of the instruction; and

2.03.2.1.6 the signature and printed name of the appointed operator or authorised person.

2.03.2.2.1 Each separate step in the instruction shall be written on a new line on the operating instruction form.

2.03.2.2.2 Operating instructions for switching and linking may be written on the same operating instruction form and in that order.

- 2.03.2.2.3 Safety testing and earthing instructions must be written on a separate operating instruction form.
- 2.03.2.3.1 The instructions must be read back by the appointed operator or authorised person to the system controller, who shall confirm or, if necessary, correct the instructions.
- 2.03.2.3.2 If both parties agree that the execution of the instructions can be performed safely, the operating instruction form reference number must be given to the system controller and the instructions confirmed with the issue of a time, which must be noted as the time received for commencement.
- 2.03.2.3.3 The form must then be signed by the appointed operator or authorised person.
- 2.03.2.4.1 The instructions may be pre-written on the operating instruction form by the appointed operator or authorised person doing the operating, or person authorised to transmit operating instructions.
- 2.03.2.4.2 If the instructions have been incorrectly pre-written, they must be cancelled and re-written completely on a new operating instruction form under instruction from the system controller.
- 2.03.2.5 A copy of the operating instruction form shall remain adjacent to the communication set until completion of the operating detailed on it.
- 2.03.2.6.1 The original of the operating instruction form shall be taken to the place where the operating is to be carried out.
- 2.03.2.6.2 The instructions shall be read by the appointed operator or authorised person carrying out the operating, who shall verify that the apparatus and the intended operating correspond with the written instruction before the operating detailed on the operating instruction form is commenced.
- 2.03.2.7 Each instruction on the operating instruction form shall be carried out in its entirety without undue delay and each item as detailed on the operating instruction form shall be ticked off as each step of operating is completed.
- 2.03.2.8.1 When a person is being trained, both the appointed operator or authorised person and the trainee shall satisfy themselves that the apparatus and intended operating correspond with the instruction as received from the system controller before the operating is commenced.
- 2.03.2.8.2 The operating instruction form shall be signed by the trainee and countersigned by the appointed operator or authorised person.
- 2.03.2.8.3 No operating instructions shall be issued by one trainee to another trainee.
- 2.02.2.9 In the event of an unforeseen delay in the execution of the instructions in their entirety, the operating must be terminated and the cause reported to the system controller whereupon the existing instructions must be cancelled and new instructions issued.
- 2.03.3 Report back on completed operating**
- 2.03.3.1 The system controller shall be informed as soon as possible after an operating instruction has been completed.

- 2.03.3.2 Report back on completed operating shall be given in full to the system controller by the appointed operator or authorised person and all details logged accordingly.
- 2.03.3.3 The system controller shall then issue the completion time to the appointed operator or authorised person.
- 2.03.3.4 The original operating instruction form relating to a completed operating shall be retained for a minimum period of six months at the location determined by the licensee.
- 2.03.3.5 Each completed operating instruction book containing the copies of operating instruction forms must be archived for a period of five years, whereafter it may be destroyed if no query has arisen regarding any entries during that time.

2.03.4 Relay of operating instructions through a third person

Where operations are required on a power system in the absence of direct communication between the system controller and the appointed operator or authorised person, the related operating instructions may be relayed through a third person, in which case the third person shall relay the precise operating instructions and in doing so, comply under the guidance of the system controller with the relevant requirements specified in this Code.

2.03.5 Issue and receipt of pre-authorised instructions

- 2.03.5.1 In the event of poor or no communication between the system controller and the appointed operator or authorised person when operating is required on a power system and the relay of operating instructions by a third person is not practicable, pre-authorised operating instructions may be issued.
- 2.03.5.2.1 Pre-authorised operating instructions may only be issued on the day that the operating takes place.
- 2.03.5.2.2 The system controller and the appointed operator or authorised person may discuss and pre-write the instructions beforehand.
- 2.03.5.2.3 The pre-authorised instructions shall only enter into force once the system controller has authorised the instructions by issuing a commencement time.
- 2.03.5.3.1 Pre-authorised operating instructions to an appointed operator shall be issued for the switching, linking, safety testing, earthing or work to be performed and upon completion, the sequential restoration of apparatus to service.
- 2.03.5.3.2 All operations and detail of the work performed shall be reported to the system controller as soon as possible whereupon the system controller shall issue a completion time.
- 2.03.5.4.1 Pre-authorised operating instructions to an authorised person shall be issued for the switching or work to be performed and upon completion, the sequential restoration of apparatus to service.
- 2.03.5.4.2 All operations and detail of the work performed shall be reported to the system controller as soon as possible whereupon the system controller shall issue a completion time.

- 2.03.5.5.1 In the event of loss of supply due to a trip to multiple customers on a feeder with only one source of supply, a pre-authorized operating instruction may be issued to an appointed operator.
- 2.03.5.5.2 The pre-authorized operating instruction shall apply to the affected feeder only.
- 2.03.5.5.3 Additional appointed operators may assist under instruction of the appointed operator in charge to restore the supply.
- 2.03.5.5.4 The pre-authorized operating instruction includes permission to operate the feeder breaker, other switch gear or links in the same circuit as required.
- 2.03.5.6.1 In the event of loss of supply to a single customer with only one source of supply, a pre-authorized operating instruction may be issued to an appointed operator to restore the supply.
- 2.03.5.6.2 The pre-authorized operating instruction shall apply to the affected customer supply point only as from the transformer drop out fuses to the customer.

2.03.6 Circumstances when an operating instruction shall be cancelled

- 2.03.6.1 Should the safety of persons or apparatus be in danger during the execution of any operating instruction in circumstances other than those indicated in paragraphs 2.03.2.4.1 and 2.03.2.4.2 and 2.03.2.9 of this Code, all operations must be terminated immediately and the operating instruction cancelled either by the system controller or the appointed operator or authorised person, who detected the danger.
- 2.03.6.2 The system controller shall then determine the further actions.

2.04 CONTROL OF LOADING OF POWER STATIONS UNDER NORMAL AND ABNORMAL CONDITIONS

- 2.04.1.1 The system controller and the power station control room official shall liaise closely regarding all events and conditions that may affect the loading of the generating plant and continuity of supply.
- 2.04.1.2 The system controller shall keep the power station control room official fully informed as to the probable demand which will be made on the generating plant in the power station and the capacity of such generating plant, which is required to be in reserve to ensure that the obligation of supply and demand are met.
- 2.04.2.1 The power station control room official shall notify the system controller regularly as to the condition of the generating plant.
- 2.04.2.2 Any change, which may affect loading arrangements previously made, shall be reported to the system controller immediately.
- 2.04.3.1 In the event of conditions arising which may affect the safety of the generating plant, the power station control room official shall be solely responsible for so handling and loading each portion of such generating plant to ensure its safety and shall immediately take corrective action.
- 2.04.3.2 The system controller must be notified, as soon as possible, of any change during the event and new arrangements shall be made for the loading of such generating plant.

- 2.04.4.1 For work on generating plant, the power station control room official shall make the necessary arrangements with the system controller for the generating plant to be taken out of commission.
- 2.04.4.2 On completion of the work, the power station control room official shall notify the system controller that the generating plant is available for service.
- 2.04.4.3 Should any delay arise in returning the generating plant to service as pre-arranged, the power station control room official shall immediately advise the system controller of the delay so that alternative arrangements may be made.
- 2.04.5 Generating plant shall be deemed to be -
- 2.04.5.1 out of commission immediately after the system controller has given permission for work to be commenced thereon;
- 2.04.5.2 in commission as soon as the system controller has been advised that such generating plant is available for service.
- 2.04.6.1 Should abnormal conditions arise requiring deviation from any pre-arranged work programme, all parties concerned shall adjust to the altered conditions in the most efficient and expeditious manner.
- 2.04.6.2 Any alternative arrangements shall be reported to the system controller and all parties concerned shall be informed of the alternative arrangements.
- 2.05 *CONTROL AND LOADING OF TRANSMISSION AND DISTRIBUTION APPARATUS***
- 2.05.1 Subject to paragraph 2.01 of this Code, the appointed operator or authorised person shall be responsible for apparatus in service and the loading thereof at each station.
- 2.05.2 Whenever apparatus has to be taken out of commission for whatever reason, the appointed operator or authorised person shall make arrangements with the system controller and the customers beforehand, where applicable, to prevent overloading of apparatus remaining in service.
- 2.05.3 In an emergency, the system controller shall take the required action and where necessary, in consultation with the appointed operator or authorised person at the station and shall, as soon as possible, notify the relevant senior officials.
- 2.06 *ORDER OF PRECEDENCE IN USE OF COMMUNICATION SYSTEM***
- All calls or messages in connection with the operation of a power system, to and from the system controller, appointed operator, authorised person or power station control room official on any communication system shall at all times be given preference by the system controller over all other calls or messages.
- 2.07 *COMMISSIONING OF APPARATUS ON FIRST INSTALLATION OR AFTER ALTERATION OR REPAIR***
- 2.07.1.1 No apparatus shall be placed in commission on first installation unless the apparatus has been handed over, with prior arrangement, by an appointed operator or authorised person to the system controller.

- 2.07.1.2 All apparatus and control panels must be suitably labelled and the corresponding operating diagram/mimic and operating drawings updated before apparatus are handed over.
- 2.07.2.1 The system controller shall confirm with the appointed operator or authorised person that all necessary tests for commissioning were conducted.
- 2.07.2.2 The system controller shall log all relevant information, including the names and designations of persons responsible for the tests.
- 2.07.3 The system controller shall be responsible for arranging, where necessary, for the application of temporary settings of relays on first installation of apparatus.
- 2.07.4.1 Where apparatus has been disconnected from a power system for purposes other than sectionalising, by the removal of droppers or jumpers or by the opening of links which are locked out with a unique lock, the key of which is in the custody of an appointed operator or authorised person not directly involved with the operating, the apparatus shall be deemed not to be part of the power system.
- 2.07.4.2 Any earths necessary on the apparatus shall be the responsibility of the person in charge of the work.
- 2.07.5.1 The apparatus being installed shall only become the responsibility of the system controller once a connection is made between such apparatus and the power system whereby it becomes possible for the apparatus to be energised.
- 2.07.5.2 Such apparatus shall then be handed over to the system controller as being ready for commissioning.
- 2.07.6 The appointed operator or authorised person shall report all required details of the apparatus to the system controller and the number and positions of applied earths when handing over or handing back such apparatus.
- 2.07.7 All earths applied on the apparatus to be commissioned shall henceforth resort under the system controller.

2.08 *USE OF OPERATING DIAGRAM/MIMIC*

- 2.08.1 The operating diagram/mimic at a control centre, power station control room or station shall be adjusted as may be necessary to indicate the exact operational state of all apparatus on the power system or in such station.
- 2.08.2 In the event of operating being performed in any of the depicted stations, such operating shall not be deemed to be completed until the operating diagram/mimic concerned has been adjusted and the required warning notices affixed to indicate the correct operational state of the apparatus affected.

SECTION 3: ACCESS

3.01 *ACCESS TO LIVE CHAMBERS AND PROHIBITED AREAS*

3.01.1 **Persons authorised to enter live chambers or prohibited areas**

Only persons authorised to do so, may enter live chambers or prohibited areas.

3.01.2 Informing the system controller when accessing a live chamber

An appointed operator shall inform the system controller after entering and before leaving a live chamber.

3.01.3 Informing the system controller when accessing a prohibited area

An appointed operator or authorised person shall inform the system controller after entering or leaving a prohibited area.

3.01.4 Locking of doors and gates

3.01.4.1 Every door and gate giving access to a live chamber or prohibited area must be closed and locked at all times, except when persons authorised to do so, have entered the live chamber or prohibited area whereby it is permitted to leave a gate or door unlocked but closed to facilitate emergency exit.

3.01.4.2.1 Under no circumstances shall marriage locking be applied to any access door, gate or apparatus at or in a live chamber.

3.01.4.2.2 Marriage locking may be applied at or within certain prohibited areas where apparatus, which belongs to more than one party, is housed.

3.01.4.2.3 Marriage locking may be applied at or within barricaded sections of prohibited areas only where a work permit has been issued.

3.01.4.2.4 Marriage locking of servitude gates is permissible in mutual agreement with the land owner.

3.02 *PROCEDURES FOR ACCESS TO LIVE CHAMBERS OF PERSONS OTHER THAN PERSONS AUTHORISED*

3.02.1 Access to a live chamber by a person other than an appointed operator shall only be permitted when the person is accompanied and directly supervised by the appointed operator so authorised for access and supervision.

3.02.2 When work has to be performed in a live chamber by a person other than an appointed operator, the person shall only be allowed to work under the direct supervision of an appointed operator so authorised for access and supervision.

3.02.3.1 No access or work may commence unless the live apparatus in a live chamber has been barricaded so as to afford reasonable protection to the workers concerned.

3.02.3.2 In addition, the workers shall sign the worker's declaration as stipulated in section 6 of this Code.

3.03 *PROCEDURES FOR ACCESS TO PROHIBITED AREAS OF PERSONS OTHER THAN PERSONS AUTHORISED*

Access to a prohibited area by a person other than an appointed operator or authorised person shall only be permitted when the person is:

3.03.1 Under supervision of an appointed operator or authorised person;

3.03.2 working on ground/floor level under a work permit with the worker's declaration duly signed and the workplace suitably barricaded;

3.03.3 protected by barricading, erected in such a way to ensure that inadvertent human contact with live apparatus adjacent to the barricaded area is not possible from within the barriers and within safe working clearance;

3.03.4 in a section of a prohibited area, segregated from the remainder of the prohibited area in which access or work must be carried out, in which case the section of the prohibited area no longer constitutes a prohibited area and no supervision by an appointed operator is required.

3.04 DUTIES TO PERFORM WHEN GAINING ACCESS TO PROHIBITED AREAS OR LIVE CHAMBERS

3.04.1 An appointed operator gaining access to a prohibited area, live chamber, station or building and an authorised person gaining access to a prohibited area, station or building must observe, log and report abnormalities on the condition of all warning notices, nameplates, locks and fencing, earthing, oil leakages, vegetation, obstacles, trenches, covers, air conditioning (if installed) and the general condition of the visited area.

3.04.2 An appointed operator or authorised person must deny access to any unidentified person.

3.05 STAYING OVERNIGHT IN LIVE CHAMBERS OR PROHIBITED AREAS

3.05.1 Staying overnight in a live chamber shall not be permitted under any circumstance.

3.05.2 Staying overnight within any prohibited area or building is normally not permitted to any person, but an appointed operator or authorised person with or without accompanying persons may under certain circumstances stay overnight, if -

3.05.2.1 the logbook is properly filled in depicting clearly the circumstances that requires this exception;

3.05.2.2 the system controller has been informed;

3.05.2.3 the person in charge has been informed.

3.05.3 The appointed operator or authorised person and accompanying persons, if any, shall observe the following restrictions at all times:

3.05.3.1 No open fire is permitted in the building;

3.05.3.2 open fires for heating or preparation of food shall only be permitted in an area outside the building demarcated for that purpose by the person in charge;

3.05.3.3 no alcoholic beverage is permitted in any prohibited area, live chamber or building.

3.06 ELECTRIC FENCES

3.06.1 Only a fence energiser that delivers impulses of electricity to an electric fence, which are equal to or within the following values, may be installed:

3.06.1.1 Peak value of voltage: 10 kilovolt (10 kV);

3.06.1.2 maximum duration of impulse: 50 milliseconds (50 ms);

3.06.1.3 minimum interval between impulses: 0,75 second;

3.06.1.4 maximum quantity of electricity per impulse: 2,5 millicoulomb (2,5 mC) (electrical charge);

3.06.1.5 maximum electricity discharge per impulse measured at a resistance of 500 ohms: 8 Joule (8 J).

- 3.06.2 A fence energiser -
- 3.06.2.1 must be constructed so as to exclude dust and water;
- 3.06.2.2 may not be installed in a dusty location or a location where there is a fire hazard.
- 3.06.3 A fence energiser, which receives its electrical charge from a power system, may not be installed -
- 3.06.3.1 in locations where the energiser is likely to sustain mechanical damage or be tampered with;
- 3.06.3.2 on any pole of a power or communication line except a pole that carries the conductor of the energiser; and
- 3.06.3.3 unless the output circuit is isolated from the supply by means of a double-wounded isolating transformer.
- 3.06.4 The earth of a fence energiser shall be free and at least two metres away from the earth of any other apparatus.
- 3.06.5.1 Barbed wire may not be electrified but only smooth wire or such article as will enable a person touching it to let go immediately.
- 3.06.5.2 Smooth wire attached to a barbed wire fence may be electrified.
- 3.06.6 In the case of a fence energiser receiving electricity from a battery charged by means of charging apparatus, which receives its electrical charge from a power system, the charging apparatus shall be of double-wounded isolation construction.
- 3.06.7 Where an electric fence is installed along a public road or in an urban area -
- 3.06.7.1 the electrified wires or articles shall, as far as is practicable, be mounted in such positions that persons cannot inadvertently come into contact therewith; and
- 3.06.7.2 notices shall be displayed conspicuously, warning people that the area is protected by an electric fence.

3.07 *PROCEDURES FOR ACCESS OF PERSONS TO RESTRICTED AREAS OTHER THAN PERSONS AUTHORISED*

Access to restricted areas shall be allowed only to a person who has obtained permission through an authorised method.

SECTION 4: KEYS

4.01 *ISSUING AND CONTROL OF MASTER KEYS*

The responsible official shall issue and control all master station keys.

4.02 *ISSUING AND USE OF STATION KEYS*

- 4.02.1 Station keys shall only be issued to specially trained persons on the written authority of the person authorised by the responsible official to issue station keys.
- 4.02.2 Station keys shall only be issued to a person other than a specially trained person with the prior written approval of the responsible official.
- 4.02.3.1 The issuing of a station key must be recorded in a logbook, stating to whom the key is being issued and the time and date of issue.

- 4.02.3.2 In all cases the signature of the person receiving the key and that of the person issuing the key must be entered against the record.
- 4.02.3.3 Similarly, when a station key is returned, its receipt must be recorded in the logbook.
- 4.02.4.1 Any person to whom a station key has been issued, is held solely responsible for such key while in his or her possession.
- 4.02.4.2 The person may not let any such key pass out of his or her possession.
- 4.02.5 The special operating procedures shall include without limitation, procedures pertaining to -
- 4.02.5.1 the requirements of a key safe system;
 - 4.02.5.2 the marking of keys and locks;
 - 4.02.5.3 the issuing and use of keys at stations for live chambers and prohibited areas;
 - 4.02.5.4 the surrender or loss of keys; and
 - 4.02.5.5 the use of keys when changing over busbars.

SECTION 5: WORK PERMITS

5.01 CIRCUMSTANCES WHEN A WORK PERMIT IS REQUIRED

A work permit is required for all work on apparatus or in live chambers and prohibited areas at any place in a power station or on a transmission system, a distribution system or a low voltage system, except as provided for in paragraph 5.03.14 of this Code.

5.02 FORMS IN DUPLICATE

- 5.02.1 The appointed operator shall make out work permit forms in duplicate.
- 5.02.2 The authorised person, responsible person or contractor shall retain the original.
- 5.02.3 A copy shall be left in the work permit book, which shall be retained by the appointed operator until it is cancelled.

5.03 USE OF WORK PERMIT FORM

- 5.03.1 Application and permit
- 5.03.1.1 When work under the permit procedure is to be carried out, the responsible employee shall provide the appointed operator with all the details to be filled in on the application, confirm the details and sign the application stating -
- 5.03.1.1.1 the apparatus required to be made safe;
 - 5.03.1.1.2 the nature of the work to be carried out;
 - 5.03.1.1.3 the points of isolation;
 - 5.03.1.1.4 the number and position of earthing gear necessary; and
 - 5.03.1.1.5 the time and date on which the work has to commence.
- 5.03.1.2 After signing the application, the appointed operator shall make arrangements with the system controller to have the apparatus isolated, earthed and barricaded.

5.03.2 Work permit

- 5.03.2.1 The appointed operator must issue the work permit to the responsible person, after they have physically inspected and agreed that the required apparatus is isolated, earthed, barricaded (if required) and handed out according to the application.
- 5.03.2.2 The responsible person must ensure that all persons working under the work permit are informed about the safety of the apparatus to be worked on.
- 5.03.2.3 The worker's declaration has to be filled in and signed by all workers engaged in the work and the responsible person must keep the original declaration in safe custody.
- 5.03.2.4 The appointed operator and the responsible person must then sign and record the date and time of the work permit.
- 5.03.2.5 The original work permit form must be detached from the permit book and handed to the responsible person together with any keys necessary to give access to the apparatus concerned.
- 5.03.2.6 The work permit form reference number must be reported to the system controller, upon which the responsible person is deemed to have taken over the apparatus to be worked on.

5.03.3 Worker's declaration

- 5.03.3.1 The responsible person must explain the nature of the work covered by the work permit to all workers engaged in the work and must obtain all their names and signatures on the worker's declaration form.
- 5.03.3.2 The responsible person must keep the worker's declaration updated for the duration of the work permit.
- 5.03.3.3 Upon completion of the work, all workers engaged in the work must sign off the declaration understanding that the work has been completed and that nobody is permitted any longer in the workplace.

5.03.4 Clearance

- 5.03.4.1 On completion of any work for which a work permit was issued the responsible person must ensure that all workers engaged in the work are withdrawn from the apparatus or the live chamber or prohibited area concerned and must lock all doors or gates giving access to the apparatus, live chamber or prohibited area.
- 5.03.4.2 The responsible person must then fill in and sign the clearance section of the work permit form in his or her possession and must return any keys issued for the work, together with the original form of the work permit form to the appointed operator.
- 5.03.4.3 The appointed operator must -
- 5.03.4.3.1 inspect the completed work and the removal of all surplus materials and tools; and
- 5.03.4.3.2 check all electrical clearances; and
- 5.03.4.3.3 ensure that all contractors and workers are withdrawn, before the clearance is countersigned.

- 5.03.4.4 At power stations, when work is completed at more than one place in a circuit, each work permit must be cancelled by the issue of a clearance on the completion of each separate item of the work but no earths may be removed from any section of the apparatus until clearances are received for all work permits which were issued for work on the circuit.
- 5.03.4.5 Before the hand back of the feeder or apparatus for commissioning, the appointed operator must ensure that all warning notices have been removed.
- 5.03.4.6 Should the appointed operator to whom the feeder or apparatus was handed out for work not be available for any reason, the system controller must liaise with another appointed operator as to the present operational state of the feeder or apparatus and then decide which other available appointed operator must be instructed to do the hand back of the feeder or apparatus.
- 5.03.4.7 In either case the system controller must take all reasonable steps to ensure that no deviation from this Code will arise as a result of such transfer of responsibility.
- 5.03.4.8.1 If the responsible person to whom a work permit was issued, is not available to complete and sign the clearance section on the work permit form and to return the work permit form to the appointed operator concerned, the system controller must liaise with the official in charge as to which other responsible person must be instructed to supervise the completion of the work, if necessary, and to complete and sign the clearance section on the work permit form.
- 5.03.4.8.2 Such other responsible person must first countersign the work permit application section to indicate that he or she is fully aware of the work that was to be performed on the feeder or apparatus.

5.03.5 Return to service

The appointed operator must complete the clearance section by signing it and must notify the system controller that the clearance of the work permit of the feeder or apparatus and the original worker's declaration was received and that the feeder or apparatus is ready to be handed back.

5.03.6 Non-availability of original form

- 5.03.6.1 If the original of the work permit form is not available when the clearance of the work permit is required, the appointed operator must confirm that all workers have been withdrawn from the workplace and the appropriate section of the workers register has been signed.
- 5.03.6.2 The appointed operator must then countersign the copy of the work permit, which signature authorises the appointed operator to clear the work permit in question.

5.03.7 Non-availability of responsible person

- 5.03.7.1 In the event of the responsible person to whom a work permit has been issued not being available to clear the work permit, the system controller must liaise with the official in charge as to which other responsible person shall clear the work permit.
- 5.03.7.2.1 Such other responsible person shall first countersign the work permit, or complete the "change of responsibility" portion on the work permit form, to indicate that he or she is fully aware of what was to be done on the apparatus.

5.03.7.2.2 Such other responsible person shall supervise the completion of the work, fill in and sign the clearance on the work permit form and return the work permit form to the appointed operator concerned.

5.03.7.3 In either case the system controller must take all reasonable steps to ensure that no deviation from this Code will arise as a result of such transfer of responsibility.

5.03.8 Original forms

5.03.8.1 All original work permit forms shall be destroyed on completion of the work for which they were issued.

5.03.8.2.1 Each completed work permit book containing the copies of work permit forms shall be returned to the official in charge when a new book is put in use.

5.03.8.2.2 Such completed book may be destroyed on instructions from the official in charge after the expiry of the period determined by the licensee, if no query has arisen during such period regarding any entry contained in it.

5.03.9 Duration of permit

A permit shall remain in force until it is cancelled by the issuing of a clearance.

5.03.10 Application form made out in advance for planned work

5.03.10.1 Permit applications may be filled in and signed by the responsible employee at any time not exceeding three working days and not less than one working day in advance of the day on which the work will commence.

5.03.10.2 The appointed operator responsible for preparing the apparatus and issuing the necessary work permit shall sign such application when the necessary operating is to be done.

5.03.11 Work may only be done under one permit at a time

No person may work under more than one work permit at a time.

5.03.12 Issuing of more than one permit

A responsible person may be issued with more than one work permit at a time: Provided that the responsible person is not directly involved with the work and can exercise an adequate level of supervision at each workplace.

5.03.13 Work permits are required for each circuit

When it is necessary to perform work on apparatus at a power station in more than one chamber on the same circuit, a separate work permit shall be issued for the work in each separate circuit.

5.03.14 Work on apparatus involving licensees, customers and contractors

5.03.14.1.1 Where it is necessary to isolate and earth the supply apparatus of a licensee, customer or contractor to enable work on such apparatus, a work permit must be used.

5.03.14.1.2 A representative of the licensee, customer or contractor must sign the work permit as the responsible person.

- 5.03.14.2 In the event of apparatus being isolated by a licensee or customer without an established control centre and there could be a possible back feed into the supply system, the system controller and the appointed operator are responsible for rendering such isolating equipment inoperative, by locking out such apparatus with a unique lock for the period that the work is in progress.
- 5.03.14.3 If the licensee or customer has an established control centre, the work permit procedure does not apply and all required operating must be effected between the control centre and the related control centre concerned, but all apparatus on which work has to be performed must be locked with a unique lock.
- 5.03.15 Cases where a work permit is not required
- 5.03.15.1 No work permit is required when only an appointed operator carries out work on a feeder or apparatus together with the workers working under the direct supervision of the appointed operator.
- 5.03.15.2 No work permit is required when an authorised person is carrying out specific pre-defined work in a prohibited area.
- 5.03.15.3 No work permit is required where testing of equipment is carried out in accordance with paragraph 6.03.15 of this Code.

SECTION 6: AUTHORISED OPERATIONS

6.01 PERSONS AUTHORISED TO PERFORM SWITCHING, LINKING, SAFETY TESTING AND EARTHING OPERATIONS

- 6.01.1 Only appointed operators shall carry out switching, linking, safety testing or earthing operations to the extent of their authorisation under instruction of the system controller.
- 6.01.2 Persons being trained for operating authority shall operate under the direct supervision of an appointed operator, if the system controller has been duly informed of such arrangement.
- 6.01.3 Authorised persons in stations may render auxiliary services on pre-defined auxiliary apparatus, excluding the switching of auxiliary apparatus on auxiliary circuits by hand or remote control, and the hand out and hand back procedures must be confirmed with the system controller and must be logged.
- 6.01.4 If any work is to be performed on auxiliary apparatus, the hand out and hand back procedures must be followed and logged.
- 6.01.5 Changing of relay settings on apparatus must be confirmed with the system controller and is subject to prior hand out and hand back procedures.

6.02 PROCEDURE FOR WORK IN LIVE CHAMBERS

No person may enter or be allowed to perform any activity or work in a live chamber, unless the live apparatus in the chamber has been effectively barricaded or isolated and earthed.

6.03 MAKING FEEDERS AND APPARATUS SAFE TO WORK ON**6.03.1 All operating to be carried out under instruction from the system controller**

6.03.1.1 All operating on apparatus on a power system shall be carried out under instruction of the system controller.

6.03.1.2.1 Before any instructions are issued, the authorised person shall discuss in detail with the system controller, all work to be carried out, including potentially dangerous conditions which may exist.

6.03.1.2.2 All parties shall refer to corresponding operating diagrams and shall agree to the relevant operating.

6.03.2 Emergency switching

6.03.2.1 In the case of an emergency, any person may open any switch or circuit breaker, but only in so far as it is necessary to prevent loss of life or injury to persons or damage to property.

6.03.2.2 Full details of every such event shall be reported to the system controller as soon as possible after the event.

6.03.3 Isolating from supply under direct instruction from system controller

6.03.3.1.1 Where it is necessary to operate at two or more points, which are not at the same location, the operating may be performed by a corresponding number of appointed operators, but all the operating detailed in this Code must be performed by one appointed operator only for each point.

6.03.3.1.2 The system controller shall inform the authorised person that the breakers and isolators at each point controlling the feeder have been opened.

6.03.3.2 Where continuous shift working is in operation at a station, the appointed operator or authorised person may hand over the shift to another appointed operator or authorised person only if all operating instructions issued by the system controller to such appointed operator or authorised person have been fully carried out.

6.03.3.3.1 Where it is impracticable for one or more appointed operators to obtain direct communication with the system controller, instructions may be relayed through a third person to another appointed operator.

6.03.3.3.2 The third person must write down the operating instructions as issued by the system controller, and re-read them word for word to the appointed operator.

6.03.3.4 Where a breaker or links can be controlled from a remote point over which the appointed operator has no control, such facilities shall be switched off or otherwise made inoperative by the appointed operator before isolation is commenced.

6.03.3.5.1 No earthing operation shall be authorised by the system controller until isolation has been completed at all points of supply.

6.03.3.5.2 The system controller shall inform the appointed operator that the breakers and links at each point of supply controlling the feeder have been opened.

- 6.03.3.6 Effective isolation may only be achieved by -
- 6.03.3.6.1 the opening of an isolator or suitable switch;
 - 6.03.3.6.2 the racking out of a circuit breaker, in which case the opening only of a circuit breaker or sectionaliser (in tank) is not isolation;
 - 6.03.3.6.3 the removal of drop out fuses or opening of links on all phases;
 - 6.03.3.6.4 the physical removal of suitable connections on all phases.
- 6.03.3.7 Except in the case of an emergency, operating shall not be carried out until all persons not directly performing the operating have withdrawn to a reasonable distance in case of a fault while switching is taking place.
- 6.03.4 Links and drop out fuses**
- 6.03.4.1 Links which are accessible to persons not authorised to possess station keys shall be kept locked at all times except when being operated.
- 6.03.4.2 Links shall only be operated with all load removed from the circuit they control and, if possible, with the circuit de-energised.
- 6.03.4.3.1 Drop out fuses shall be operated with due regard to the likely load current and the power system conditions.
 - 6.03.4.3.2 If the prospective load current is high, the load shall be removed or the line de-energised before operating the fuses.
 - 6.03.4.4.1 Drop out fuses shall not be reclosed after a fault unless the line has been de-energised or the fault has been positively identified and corrected.
 - 6.03.4.4.2 Drop out fuses of single transformers may be reclosed with all load from the low voltage side removed.
- 6.03.4.5 Links and drop out fuses shall only be operated with an approved operating stick from outside the safe working clearance unless the circuit has been isolated, safety tested, earthed and handed out to the appointed operator.
- 6.03.5 Bypassing of interlocks**
- 6.03.5.1 Except as expressly permitted in this Code, interlocks shall not be bypassed or defeated without the express authority of the person in charge.
- 6.03.5.2 Each incidence of bypassing an interlock shall be specifically recorded in the logbook kept by the system controller, and the logbook in the station.
- 6.03.6 Safety-testing of feeders and apparatus after isolating from supply**
- 6.03.6.1 Immediately before applying an earth at a point, the appointed operator shall use a testing device provided for the purpose to ensure that the feeder or apparatus is dead at each such point where an earth is to be applied.
 - 6.03.6.2 The appointed operator must ensure that the testing device is in proper working order and suitably rated for the voltage levels before it is used.
 - 6.03.6.3 In the case of certain apparatus which cannot be safety tested before earthing, the earth shall be applied in a manner approved by the licensee to prevent danger.

- 6.03.6.4.1 Where cables have been isolated and earthed and work on either of the end terminals is necessary, without these end terminals having been tested, the terminal boxes will be opened and the terminals tested with an approved testing device.
- 6.03.6.4.2 Covered terminals shall be tested before any attempt is made to intrude on the covering.
- 6.03.6.5 Where a cable has to be cut, the cable shall be spiked using an approved spiking device before the cable is cut.
- 6.03.6.6 After a feeder or apparatus has been earthed, the appointed operator shall be satisfied that the feeder or apparatus is discharged.

6.03.7 Warning notices and earth labels

- 6.03.7.1 Exhibition of warning notices in stations
- 6.03.7.1.1 Before isolating a feeder or apparatus, a warning notice shall be affixed on each control panel corresponding with such apparatus.
- 6.03.7.1.2 No isolation of a feeder or apparatus shall be deemed to be complete until a suitable warning notice has been affixed at each point from which such feeder or apparatus can inadvertently be made alive.
- 6.03.7.1.3 The warning notice may not be detached until all earths have been removed and the feeder or apparatus is ready to be made alive.
- 6.03.7.1.4 A warning notice on the control panel shall be the last to be removed.
- 6.03.7.2 Use of control panel labels/tags at power stations
- 6.03.7.2.1.1 When any apparatus at a power station is earthed in preparation for work on it, or any feeder is earthed for work external to the station, as soon as the earthing operation has been reported to the system controller, a control panel label/tag shall be completed by the appointed operator stating the number and position of the earthing gear and the permit number, if one has been issued.
- 6.03.7.2.1.2 The original control panel label/tag shall be detached and affixed to the control panel of the apparatus so earthed.
- 6.03.7.2.2 The appointed operator shall on the instruction of the system controller remove the control panel label/tag after the apparatus has been handed back and when the operation or the removal of the earthing gear to which it relates, has been completed.
- 6.03.7.3 Use of warning notices at stations
- 6.03.7.3.1 After apparatus has been isolated and tested to be dead, earths must be applied in preparation to work on.
- 6.03.7.3.2.1 Warning notices must be affixed to the related control panel by the appointed operator.
- 6.03.7.3.2.2 The appointed operator must remove all the warning notices after the related earths have been removed as instructed by the system controller.

6.03.8 Earthing

6.03.8.1 All earthing must be so designed to be capable of withstanding the full fault current flowing through it for a specified period of time in such a manner as will ensure an immediate safe discharge of electrical energy at all times.

6.03.8.2 Only an approved means of earthing shall be used.

6.03.8.3 *Minimum earthing requirements*

6.03.8.3.1 Stations

6.03.8.3.1.1 Apparatus

When apparatus other than a line or a busbar has been isolated from all points of supply and tested in accordance with this Code, it shall be earthed at least at all such isolated points of supply.

6.03.8.3.1.2 Busbar

6.03.8.3.1.2.1 When a busbar has been isolated from all points of supply and tested to be dead, it must be earthed at least at one such isolated point of supply.

6.03.8.3.1.2.2 For work on busbars, prior arrangements must be made with the system controller for the application of an additional earth.

6.03.8.3.1.2.3 An additional earth may be applied and moved along the busbar as required during the course of work without further reference to the system controller.

6.03.8.3.1.2.4 Should any other earth be required on a busbar, working earths may be applied.

6.03.8.3.1.2.5 For earthing of busbars in switching stations, prior arrangements must be made with the system controller when sequence keys are used for the application of a busbar earth.

6.03.8.3.1.3 Transformers

6.03.8.3.1.3.1 When a transformer has been isolated from all points of supply and tested to be dead, each winding of the transformer must be earthed at its isolated points of supply, except when a transformer winding cannot be earthed at its point of supply or at any other part of the circuit between the winding and its point of supply.

6.03.8.3.1.3.2 It is permitted to work on the circuit if it has been isolated and the other windings of the transformer have been earthed at their isolated points of supply.

6.03.8.3.1.3.3 An auxiliary or tertiary low voltage supply from a transformer must be isolated at all points of supply and the breakers or isolators locked in the open position with an interlocking key, safety lock, unique lock or operating lock, where possible.

6.03.8.3.1.3.4 If it is not possible to lock out breakers or isolators, a warning notice must be affixed to the relevant breaker or isolator indicating that work is in progress on the circuit.

6.03.8.3.1.4 Metal clad switch gear

6.03.8.3.1.4.1 Totally enclosed metal clad switch gear shall be earthed only by means of the approved earthing gear provided as part of the switch gear.

- 6.03.8.3.1.4.2 If the earthing gear is not available then any alternative equipment must be approved before use.
- 6.03.8.3.1.4.3 The insertion of hands or any other tools into the contact spouts for this purpose is forbidden.
- 6.03.8.3.2 Lines
- 6.03.8.3.2.1 When a line or section of a line has been isolated from all points of supply and tested to be dead, it shall be earthed at all such points of supply.
- 6.03.8.3.2.2 Before any work may commence, the line must again be tested to prove that it is dead whereafter the appointed operator shall apply sufficient working earths on the line on all sides of the point of work, which are clearly visible from the point of work.
- 6.03.8.3.2.3 Where sections of the overhead guard conductor of a line are insulated from the tower, and the possibility of induction exists, the overhead guard conductor shall be earthed.
- 6.03.8.3.2.4 When a static var compensator (SVC) or capacitor bank has been isolated from all points of supply and tested, it shall be earthed at all points of supply.
- 6.03.8.3.2.5 Adequate earths shall be applied in accordance with equipment specific earthing procedure to ensure that all possible trapped charges will be discharged for the duration of the work.
- 6.03.8.3.3 Working earths
- 6.03.8.3.3.1 If work must be done on exposed conductors and it is not obvious from the workplace that the apparatus has an earth applied, an additional earth which is clearly visible from the workplace shall be affixed to the apparatus.
- 6.03.8.3.3.2 If the conductors are to be cut or otherwise separated, additional working earths shall be applied before separating the conductors so that one working earth is on each side of the break.
- 6.03.8.3.3.3 The person in charge of work may also at his or her discretion arrange for an additional earth to be affixed to the apparatus.
- 6.03.8.3.3.4 Working earths shall be applied and bonded on all sides of the workplace.
- 6.03.8.3.4 Portable earthing gear
- 6.03.8.3.4.1 Testing to be dead on all three phases, where applicable, as an operating instruction, must be performed before any earthing gear may be applied.
- 6.03.8.3.4.2 When using portable earthing gear, it must first be connected to earthed metal work, or a suitable earth spike driven to a minimum of 750mm into the ground where no earthed metal work is accessible.
- 6.03.8.3.4.3 The other tails of the portable earths shall then be connected to the feeder or apparatus to be earthed, making use of an approved operating stick suitably rated for the operating voltage.

- 6.03.8.3.4.4 All sides of the apparatus or feeder must be bonded and earthed.
- 6.03.8.3.4.5 The authorised person shall secure the portable earths to the phases by means of an approved operating stick suitably rated for the operating voltage and care must be taken to ensure that good contact is made.
- 6.03.8.3.4.6 Portable earths shall not be applied in any compartment, cell or switch bay in which there is any exposed live metal parts at medium or high voltage and where there is a chance of inadvertently bringing the earth connection within the safe working clearance of the live metal parts.
- 6.03.8.3.4.7 On removal of the earth, the procedure must be reversed by first removing the tails from the feeder or apparatus and lastly to disconnect the tail connected to the earthed metal work, earth mat or earth spike.
- 6.03.8.3.5 Earthing links/switches
- 6.03.8.3.5.1 When apparatus equipped with earthing links/switches are required to be earthed at more than one place, the earthing links/switches shall always be closed first and thereafter any necessary earthing gear may be affixed to the apparatus.
- 6.03.8.3.5.2 In removing earths for preparation to make the apparatus alive, all working earths must be removed first, followed by removing additional earths, if applicable, and then the earthing links/switches must be opened last.

6.03.9 Work on lines

- 6.03.9.1 *Handing over a line or section of a line for work*
- 6.03.9.1.1 Before handing out a line or section of a line for work, the system controller shall ensure that the auto-reclose features on all breakers controlling the supply to the line have been switched off or rendered inoperative and that warning notices are displayed on all the breaker control points.
- 6.03.9.1.2 The line shall then be handed over to the appointed operator by the system controller, who shall authorise the application of working earths, where required, and on completion of the work, the removal of all such working earths.
- 6.03.9.1.3 Immediately after a line or section of a line has been handed over to the appointed operator, the system controller shall affix the name of such appointed operator to the line or section of the line on the operating diagram/mimic.
- 6.03.9.2 *Isolated power lines*
- 6.03.9.2.1 Full understanding
- Before the commencement of any work on a power line, the responsible person in charge of that work shall ensure that every person who is to work on any part of the power line is fully informed of and understands on which components the work is to be carried out and that the person signs a worker's declaration form that he or she so understands.
- 6.03.9.2.2 Towers poles and high structures
- 6.03.9.2.2.1 Any person working on any tower pole or high structure shall make proper use of his or her safety belt.

- 6.03.9.2.2.2 No person shall work from a ladder at a high structure unless there is another person at the site to assist him or her, where necessary.
- 6.03.9.2.2.3 Before any pole is climbed, either directly or from a ladder, it shall be examined for any deterioration.
- 6.03.9.2.2.4 If the condition of a pole is doubtful, it shall not be climbed without the express permission of the authorised person in charge.
- 6.03.9.2.3 Working earths
- 6.03.9.2.3.1 No work shall be started on any power line until working earths in addition to the registered earths have been applied under the immediate personal supervision of the authorised person in charge of the work at each side of the workplace within his or her sight.
- 6.03.9.2.3.2 The working earths shall be issued by the authorised person, who shall be responsible for ensuring that they are all returned to him or her before the hand back to the system controller is given.
- 6.03.9.2.4 Disconnecting part of a power line
- 6.03.9.2.4.1 Before disconnecting part of a power line from the portion being worked on, additional working earths shall be applied as specified in paragraph 6.03.9.2.3 of this Code to ensure that each of the sections of the power line so disconnected complies with the earthing requirements.
- 6.03.9.2.4.2 The working earths shall be left connected to the power line for as long as anyone is working on either of the two disconnected sections.
- 6.03.9.2.5 Break in work
- If the authorised person in charge of the work leaves the workplace so that he or she cannot see the point of work and later returns to restart work, he or she shall personally verify that all working earths are still in place before work recommences.
- 6.03.9.2.6 Adverse weather conditions
- In the event of the near approach of a lightning storm or if the wind speed rises to a level where the authorised person in charge of the work considers it to be dangerous, all work shall be suspended and all workers withdrawn to ground/floor level until conditions become safe again.
- 6.03.9.3 *Special conditions for power lines*
- 6.03.9.3.1 If necessary because of distance and time constraints and if the authorised person in charge of the work is satisfied that there is no opportunity for misunderstanding, the following procedure may be used for power line work:
- 6.03.9.3.1.1 The authorised person in charge of the shutdown shall take the responsible person to the section of the line where work is to be carried out and ensure that the responsible person is fully aware of the work to be performed;
- 6.03.9.3.1.2 the authorised person shall give the responsible person a work permit which is complete in all details except the time, which has been omitted;

- 6.03.9.3.1.3 the responsible person shall then wait for notification from the authorised person by radio.
- 6.03.9.3.2 The authorised person shall then proceed to the point where supply is to be disconnected and in conjunction with the system controller have the feeder isolated and earthed and receive a hand out on the feeder.
- 6.03.9.3.3 Once the authorised person has had the feeder handed out to him or her, the authorised person shall instruct the responsible person to sign the work permit, fill in the time, apply working earths to the power line and proceed with the work required.
- 6.03.9.3.4.1 On completion, the responsible person shall remove all working earths, sign off the work permit and report back to the authorised person.
- 6.03.9.3.4.2 The authorised person shall sign his or her copy of the work permit to acknowledge that the responsible person has informed him or her of the completion of work.
- 6.03.9.3.5 When all the work permits issued for the power line have been cleared, the authorised person shall hand back the circuit to the system controller.
- 6.03.9.3.6.1 All communications for work in terms of this section shall be done over the telecommunication system of the licensee and, if possible, the messages shall be recorded.
- 6.03.9.3.6.2 The completed work permit shall be returned to the authorised person, who has issued it, within seven days from the date of issue.
- 6.03.9.4 *Work on a line at more than one place at the same time*
- 6.03.9.4.1 For work at several remote points on a line, which has been prepared in accordance with this Code, the line may be handed over to more than one appointed operator.
- 6.03.9.4.2 The system controller shall affix on the operating diagram/mimic the name of each appointed operator to whom the line has been handed out.
- 6.03.9.5 *Work in close proximity to live conductors of a line*
- 6.03.9.5.1 If the activity, task or action is of such a nature that it could inadvertently encroach on the minimum safe working clearance, then this is interpreted as close proximity.
- 6.03.9.5.2 If the minimum safe working clearance between persons, machinery or objects and live apparatus or lines cannot be maintained, the live apparatus or lines shall be isolated and earthed at a safety panel.
- 6.03.9.5.3.1 Where work is to be carried out on the structure of a line, the responsible person may not work on such structure unless he or she is supervised by an appointed operator, who will ensure that safe working clearances with respect to live conductors are maintained at all times.
- 6.03.9.5.3.2 The work shall only commence after the system controller has handed out the line to the appointed operator.
- 6.03.9.5.4 No breaker controlling the supply to the line shall be reclosed after a breaker trip until the system controller has confirmed with the appointed operator to whom the line has been handed out that it is safe to do so.

- 6.03.9.5.5.1 No work may be done on one circuit on a double circuit structure if the other circuit is alive.
- 6.03.9.5.5.2 Work may be done on the line links and the feeder bay in the station, after the equipment has been earthed using a special technique, as contained in an operating procedure.
- 6.03.9.6 *Special precautions for lines with live conductors*
- 6.03.9.6.1 Work may be carried out by an authorised person on a pole or structure which supports conductors alive at medium or high voltage if the authorised person does not go above ground/floor level and obtains a hand out.
- 6.03.9.6.2 If a worker is required to work on a structure supporting live conductors, the worker shall at all times be under the immediate personal supervision of a responsible person.
- 6.03.10 Work on insulated conductors and underground cables**
- 6.03.10.1 *Interference with conductors*
- No person shall interfere with the insulation that covers or supports any medium or high voltage conductor unless the conductor has first been isolated, earthed and handed out to him or her.
- 6.03.10.2 *Cutting into cables*
- 6.03.10.2.1 Before carrying out any work on medium or high voltage cables which involves cutting into or removing the insulated covering or earthed metal sheath of the cable, the authorised person in charge of the work shall ensure that the cable is isolated, earthed at both ends where possible and identified.
- 6.03.10.2.2 In all cases where there is any doubt as to identity, the cable shall be spiked with an approved spiking gun.
- 6.03.11 Work in stations with exposed live conductors
- 6.03.11.1 *Live chambers*
- 6.03.11.1.1 Except to the extent necessary for safety testing and earthing, no person shall be permitted to work in a live chamber until all apparatus in that chamber has been isolated and earthed.
- 6.03.11.1.2 Capacitors must discharge for at least 10 minutes.
- 6.03.11.2 *Prohibited areas*
- 6.03.11.2.1 Barriers and clearances
- 6.03.11.2.1.1 If a person is required to work in a prohibited area where a hand out or a work permit is required, unless all apparatus in that enclosure have been made safe, the section that has been made safe and earthed for work to be carried out shall be defined as far as possible by the use of barriers, danger tape or ropes with warning labels where deemed necessary.

6.03.11.2.1.2 The barriers, danger tape or ropes shall be so arranged that a worker cannot come within the safe working clearances of live parts from any position in which the worker is permitted by the barriers.

6.03.11.2.2 Additional precautions

If, in the opinion of the authorised person in charge of the work, the stated safe working clearances are not sufficient to avoid danger, other suitable means shall be taken to ensure the required degree of safety.

6.03.11.2.3 Distinguishing markers

6.03.11.2.3.1 The section that has been made safe for work, shall be distinguished by having red flags placed on the non-working side of the barriers, danger tape or ropes at a distance of 0,5 m to 1,0 m from the barriers, danger tape or ropes and separated by not more than 6 m.

6.03.11.2.3.2 The working area may also be barricaded with safety nets.

6.03.11.2.3.3 If work is to take place at night and the lighting conditions are such that the red flags cannot be adequately distinguished, the flags shall be replaced or supplemented by red lights.

6.03.12 Use of ladders and long objects

6.03.12.1 *Permission to use*

6.03.12.1.1 Ladders and other long objects may not be used without the permission of the authorised person in charge of the work.

6.03.12.1.2 No metal ladders may be used in high voltage yards.

6.03.12.2 *Type and size*

Ladders for use in a prohibited area shall be of an approved type and may not be of an excessive length for the work involved.

6.03.12.3 *Movement and erection*

6.03.12.3.1 The movement and erection of ladders and long objects shall be carried out under the immediate personal supervision of a responsible person.

6.03.12.3.2 When being moved at ground/floor level, they shall be carried in a horizontal position and not above waist height.

6.03.13 Metal clad switch gear

6.03.13.1 *Busbar spouts*

When work is to be carried out on busbar spouts, the following operations shall be carried out in strict sequence:

6.03.13.1.1 The section of the busbars to be worked on shall be made safe;

6.03.13.1.2 all shutters of live spouts shall be locked so that they cannot be opened. If, because of the design of the switch gear, it is not possible to lock the shutters, the authorised person shall take special precautions to mark any spouts that have not been made safe for work;

- 6.03.13.1.3 the busbars shall be tested by means of an approved voltage indicator to verify that they are dead. The voltage indicator itself shall be tested before and after use;
- 6.03.13.1.4 the isolated section of the busbars shall be earthed by means of approved earthing gear at a switch gear panel other than the one at which work is to be done;
- 6.03.13.1.5 the insertion of the hand or any tool apart from the approved earthing gear into the contact spouts for this purpose is expressly forbidden;
- 6.03.13.1.6 warning notices shall be attached at all points where the busbars can be made alive;
- 6.03.13.1.7 a work permit or hand out shall be issued;
- 6.03.13.1.8 working earths shall be placed in the contact spouts on all phases of the busbars at the point of work;
- 6.03.13.1.9 the working earths may be removed one phase at a time when necessary for testing but shall be replaced as soon as possible and in any case before the working earth on a second phase is removed, unless it is essential for the test to have more than one working earth removed.

6.03.13.2 *Feeder and voltage transformer spouts*

When work is to be carried out on feeder or voltage transformer spouts, the following operations shall be carried out in strict sequence:

- 6.03.13.2.1 The feeder shall be made safe;
- 6.03.13.2.2 the shutters of all live spouts on the circuit shall be locked so that they cannot be opened;
- 6.03.13.2.3 if, because of the design of the switch gear, it is not possible to lock the shutters, the authorised person shall take special precautions to mark any spouts that have not been made safe for work;
- 6.03.13.2.4 the circuit shall be tested by means of an approved voltage indicator to verify that it is not live;
- 6.03.13.2.5 the voltage indicator itself shall be tested before and after use;
- 6.03.13.2.6 the circuit shall be earthed by means of approved earthing gear at all points of isolation from the supply;
- 6.03.13.2.7 the insertion of the hand or any other tool apart from the approved earthing gear into the contact spouts for this purpose is expressly forbidden;
- 6.03.13.2.8 warning notices shall be attached at all points where the circuit can be made alive;
- 6.03.13.2.9 a work permit or hand out shall be issued;
- 6.03.13.2.10 the earths may be removed when essential for testing purposes but shall be replaced as soon as possible.

6.03.13.3 *Removal of covers*

No person may remove the covers of any chamber containing live parts until those parts have been isolated, safety tested and earthed and, where necessary, a hand out or work permit issued.

6.03.14 Work on transformers

6.03.14.1 *Isolation*

- 6.03.14.1.1 When work is to be carried out on or in the proximity of the conductors of a transformer, the isolators for all windings shall be opened, even when there is no alternative source of supply to a winding.
- 6.03.14.1.2 When there is a voltage or auxiliary transformer associated with the transformer, it shall be isolated or the low voltage fuses withdrawn to prevent the possibility of the transformer being made alive through the voltage or auxiliary transformer.

6.03.14.2 *Common neutral earthing equipment*

6.03.14.2.1 Where the transformer is connected to neutral earthing equipment, which is also used by other transformers, the isolating link between the transformer and the neutral equipment shall be opened before the transformer is made available for work.

6.03.14.2.2 The disconnection of solidly earthed neutrals or neutral equipment connected solely to the transformer on which work is to be carried out, is not required.

6.03.14.3 *Neutral bushing*

Where work is to be carried out on the tank of a transformer with an exposed neutral bushing, which is not solidly connected to earth, the transformer must be fully isolated and earthed.

6.03.14.4 *Tap changers*

6.03.14.4.1 Before work is carried out on tap changer mechanisms, which may operate automatically or by remote control, all secondary voltage supplies to the tap changer shall be isolated.

6.03.14.4.2 This requirement does not exclude tests and adjustments on the mechanism where the secondary supplies must be connected for the tests if all persons working on the equipment are aware of the situation.

6.03.15 Testing of medium and high voltage equipment

6.03.15.1 *Person in charge*

6.03.15.1.1 When any high voltage apparatus is to be subjected to a test voltage before being connected to the power system, the test shall be carried out under the immediate personal supervision of an authorised person.

6.03.15.1.2 The authorised person shall ensure that such apparatus is adequately guarded to prevent danger and that warning notices are attached in conspicuous places for the duration of the test.

6.03.15.2 *Discharging of equipment*

6.03.15.2.1 All apparatus shall be discharged before and after the application of the test voltage.

6.03.15.2.2 Earths shall be reconnected to all points so connected before the test.

6.03.15.3 *Test conductors*

Temporary conductors used for testing purposes shall be adequately rated for the purpose and shall be easily visible.

6.03.15.4 *Test connections*

6.03.15.4.1 Test connections shall not be applied in a compartment where there are any exposed live metal parts at medium or high voltage unless the safe working clearances are maintained between the apparatus to be tested and the live metal parts.

6.03.15.4.2 This requirement does not exclude the use of approved voltage indicators or approved devices for phasing out circuits.

6.03.16 Work on low voltage systems6.03.16.1 *Step down medium to low voltage stations and pole mounted transformers*

6.03.16.1.1 A work permit shall be issued to a responsible person or contractor before any operating is undertaken on the low voltage apparatus in any step down station or on any pole mounted transformer.

6.03.16.1.2 The work permit shall include the details of the work to be undertaken on the low voltage system and the appropriate procedures specified in section 5 of this Code shall be followed with the issuing and clearance of the work permit.

6.03.16.2 *Low voltage power lines*

6.03.16.2.1.1 No person shall be allowed to work on live low voltage power lines with exposed conductors.

6.03.16.2.1.2 The lines shall be isolated and a work permit issued as specified in paragraph 6.03.16.1 of this Code.

6.03.16.2.2.1 A person who has been trained and authorised to make live connections on insulated aerial bundle conductor power lines, may make connections on such power lines without a work permit being issued if such work is carried out using approved tools and insulated piercing connectors.

6.03.16.2.2.2 No other work may be carried out on aerial bundle conductor power lines without a work permit being issued and the feeder being isolated.

6.03.16.3 *Low voltage distribution kiosks*

6.03.16.3.1.1 No person shall be allowed to undertake work in a low voltage distribution kiosk without the supply to the kiosk either being isolated at the point of supply or locally in the kiosk if facilities have been provided in the kiosk for that purpose.

6.03.16.3.1.2 Live work may be undertaken if suitably rated safety gloves are used.

6.03.16.3.1.3 A work permit shall be issued and the appropriate procedures specified in section 5 of this Code shall be followed prior to the commencement of the work.

6.03.16.3.2.1 Meter readers shall be allowed access to metering kiosks to read the consumer meters if such meters are installed in a compartment where no live busbars, conductors or terminals are exposed or can be reached.

6.03.16.3.2.2 The kiosks shall have separate, different locks for the metering compartment and for the live compartment.

6.03.16.3.3.1 A person trained and authorised to do so, shall be allowed to disconnect any consumer from the supply for non payment by switching off the consumer circuit breaker.

6.03.16.3.3.2 The person shall not be authorised to isolate the supply by disconnecting live conductors.

6.03.16.3.3.3 Circuit breakers which have been switched off, for whatever reason, shall be tagged to indicate that the circuit has been switched off and that the circuit has not tripped.

6.04 RETURNING FEEDERS AND APPARATUS TO SERVICE**6.04.1 Under normal conditions**

6.04.1.1 Before returning any feeder or apparatus to service after work carried out thereon has been completed, the appointed operator shall personally be satisfied that all persons have been withdrawn from the feeder or apparatus and from all chambers and enclosures containing such apparatus and that any permanent barrier have been re-installed.

6.04.1.2 The appointed operator shall advise the system controller that the work has been completed and, where applicable, that all working earths have been removed and that he or she is handing back the feeder or apparatus.

6.04.1.3 The system controller shall remove from the feeder or apparatus on the operating diagram/mimic the name of the appointed operator and shall issue instructions for the removal of all other earths.

6.04.1.4 Where a line has been handed to more than one appointed operator, no earths may be removed from the line until all appointed operators involved have reported to the system controller the completion of their work and the removal of all working earths from their portion of the line.

6.04.1.5 At power stations, when work is done at more than one place in a circuit, each work permit shall be cancelled by the issue of a clearance on the completion of each separate item of the work but no earths may be removed from any portion of the apparatus until clearances have been received for all work permits which were issued for work on the circuit.

6.04.1.6 Before finally returning the feeder or apparatus to service, the appointed operator must ensure that all affixed warning notices have been removed.

6.04.2 When the responsible person or appointed operator is not available

6.04.2.1 If the responsible person to whom a work permit has been issued is not available to fill in and sign the clearance on the work permit form and to return the work permit form to the appointed operator concerned, the official in charge shall instruct another responsible person to supervise the completion of the work (if necessary) and to fill in and sign the clearance on the work permit form; in which case the other responsible person shall first countersign the work permit application to indicate that he or she is fully aware of what was to be done on the apparatus.

6.04.2.2 Whenever it is necessary to return a feeder or apparatus to service and the appointed operator to whom the feeder or apparatus has been handed out for work is not available for any reason, the system controller shall consult with the official in charge, who shall instruct another appointed operator to return the feeder or apparatus to service.

6.04.2.3 In either case the system controller shall take all reasonable steps to ensure that no danger arises from such transfer of responsibility.

6.05 EXEMPTION FROM GENERAL PROCEDURE**6.05.1 Work to be done on a line controlled from a single source of supply**

When work has to be done by an appointed operator on a line on the distribution system which is controlled from a single source of supply, the appointed operator

may, subject to paragraph 2.03.5 of this Code, make complete prior arrangements with the system controller and may receive pre-authorized instructions to open, isolate and earth the line and subsequently return it to service with the exception that it will not be necessary to advise the system controller that work has been completed before the line is made alive.

6.05.2 Replacing of drop out fuse links without reference to the system controller

6.05.2.1.1 An appointed operator may without reference to the system controller replace one or two drop out fuse links up to 33 kV on a three-phase circuit, when found blown, but must replace all three phase drop out fuse link fuses, and may thereafter close the drop out fuse links once only.

6.05.2.1.2 The appointed operator may not replace the drop out fuses if all three fuses are blown unless the consent of the system controller has been obtained.

6.05.2.2.1 An appointed operator may without reference to the system controller replace one fuse on a drop out fuse link up to 33 kV on a dual phase circuit, when found blown, but must replace both fuse link fuses, and may thereafter close the drop out fuse links once only.

6.05.2.2.2 The appointed operator may not replace the drop out fuses if both fuses are blown unless the consent of the system controller has been obtained.

6.05.2.3 An appointed operator may not replace the fuse of a drop out fuse link on a single-line circuit, as on SWER (single wire earth return) reticulations, when found blown, but must first report the situation to the system controller for further instructions.

6.05.2.4.1 An appointed operator may not replace blown fuses on drop out fuse links on circuits of 44kV or higher, unless instructed by the system controller to do so, in which case only the blown fuse or fuses may be replaced on sealed type fuses.

6.05.2.4.2 In the event of a single fuse being blown in a holder with a replaceable fuse element, all three fuses must be replaced.

6.05.2.5 The system controller shall be notified as soon as possible after the fuse has been replaced and closed.

6.05.3 Piggyback systems

When work has to be done by an authorised person on a piggyback system, all lines on the piggyback system shall be open, isolated and earthed and handed over in accordance with this Code before any work may commence on any of the lines.

6.05.4 Station isolation

6.05.4.1 Where total station isolation is requested, the station shall be isolated and earthed at all points of supply.

6.05.4.2.1 The station shall be handed over to one authorised person, with permission to apply and remove working earths as required.

6.05.4.2.2 The number of working earths that were applied and removed shall be declared at hand back.

6.06 SUPERVISION OF WORK

Responsible persons, contractors or workers shall be responsible for the execution of all work carried out on apparatus and feeders in compliance with this Code.

6.07 TEMPORARY ABSENCE OF PERSONS IN CHARGE OF WORK

6.07.1.1 In the event of an authorised person in charge of any work being unable to be present for the duration of the work in progress, the authorised person shall, in all cases, before departing, delegate to another authorised person to take charge during his or her absence.

6.07.1.2 The system controller must be informed prior to the departure of the change of responsibilities.

6.07.2 Should another authorised person not be available, all workers shall be withdrawn from the work during the temporary absence of the authorised person in charge.

6.08 TESTING APPARATUS

6.08.1.1 Where it is necessary for tests to be carried out on apparatus by a responsible person or a person authorised to do so, the system controller shall issue instructions for the apparatus to be isolated and earthed in accordance with this Code, after which the system controller shall permit the appointed operator to remove the earth, if necessary, for such tests.

6.08.1.2 Where the appointed operator is not also the responsible person, the appointed operator may only remove such earth under the supervision of the responsible person.

6.08.2.1 It shall be the responsibility of the person carrying out the tests to warn and, where necessary, to temporarily withdraw the workers from the apparatus for the duration of the tests.

6.08.2.2 Upon completion of the tests, the appointed operator shall replace the earth and inform the system controller that the apparatus has been restored to the original condition.

6.08.3.1 If it is necessary for the purpose of carrying out tests to energise the apparatus from the power system while such apparatus is in an abnormal condition, the responsible person and the appointed operator must make special arrangements with the official in charge so that the operating procedures may be agreed upon beforehand.

6.08.3.2 The agreed operating procedures must be carried out in accordance with this Code.

6.08.3.3 For the purposes of paragraph 6.08.3.1 of this Code, an abnormal condition is one in which the apparatus is not in a condition to take normal load due to jumpers being broken or temporary connections having been made, or for some similar reason.

6.09 NO OPERATING WHILE WORK IS IN PROGRESS IN LIVE CHAMBER

Should any operating other than emergency switching be necessary at any station on apparatus in a live chamber in which inspection or maintenance work is in progress, all workers shall be withdrawn from the chamber until such operating has been completed.

SECTION 7: ABNORMAL CONDITIONS**7.01 ABNORMAL CONDITIONS TO BE REPORTED TO SYSTEM CONTROLLER**

The system controller must be advised as soon as possible of any failure or interruption of supply to any part of a power system, or any abnormal conditions including signs of approaching adverse weather conditions.

7.02 EMERGENCY SWITCHING

7.02.1 When emergency switching has been carried out, all intended work shall be suspended and immediate attention shall be given to the cause of the emergency switching operation.

7.02.2.1 Sole attention must be given to injuries sustained by any person.

7.02.2.2 Prompt and effective first aid must be administered by a competent person and the patient must be evacuated and delivered for professional medical treatment.

7.02.3.1 The cause must be evaluated and reported to the system controller.

7.02.3.2 The system controller must report the matter to all relevant persons involved with incidents.

7.02.3.3 Thereafter the system controller may proceed to attend to the repair or replacement of apparatus, if necessary.

7.02.4 Continuity of supply must then be restored.

7.03 COMMUNICATION SYSTEM

7.03.1 Any message to and from the system controller shall be given preference at all times in accordance with paragraph 2.06 of this Code.

7.03.2 During periods of abnormal conditions, the system controller may interrupt, or instruct any person to defer or interrupt, calls or messages other than those relating to the control of a power system.

7.04 RESTORATION OF SUPPLY IN THE ABSENCE OF COMMUNICATION

7.04.1.1 In cases where communication with the system controller cannot be established, an appointed operator or authorised person may, at his or her discretion, close breakers in order to resume supply: Provided that where two or more feeders enter a station, only the breakers of feeders originating from one point may be closed without permission of the system controller.

7.04.1.2 The discretion of the appointed operator or authorised person must be led by the flags alarms and the stability of the power system.

7.04.2.1 The closing of a breaker to resume supply shall be reported to the system controller as soon as possible thereafter.

7.04.2.2 The operating instruction form must be duly completed.

7.05 ESTABLISHMENT OF LOCAL CONTROL CENTRE

- 7.05.1 If necessary, an authorised person may, subject to paragraph 7.05.2 of this Code, establish a local control centre and take over the duties of the system controller in respect of the area affected.
- 7.05.2 A local control centre shall not be established until either the system controller has given permission, or every possible effort has been made to contact the system controller but has failed and all appointed operators, who are operating in the area affected, have been advised of the establishment of the local control centre.
- 7.05.3 All operating must be logged during this period, and when communication or normal conditions are restored, the system controller must be given full details of the operating as well as the positions of all breakers, links and earthing gear at the time of handing back to the system controller.
- 7.05.4 The authorised person in charge of the local control centre shall be responsible for the operation of the section of the power system located in the area affected in accordance with this Code, but may not personally carry out any operating.

SECTION 8: LIVE WORK**8.01 DEFINITIONS****8.01.1 Officials and persons**

In this section, unless the context otherwise indicates -

- 8.01.1.1 **deputy team leader** means a person specifically authorised to take over the responsibilities of the team leader in respect of live work in progress for purposes of completing a specific task only;
- 8.01.1.2 **live worker** means a worker authorised to carry out live work;
- 8.01.1.3 **team leader** means the authorised person in charge of live work.

8.01.2 Operating terms

In this section, unless the context otherwise indicates -

- 8.01.2.1 **chassis** means a commercial vehicle or trailer (frame) on which the insulating aerial device is mounted to perform live work;
- 8.01.2.2 **electrical distance** means the electrical distance in air, which protects against electrical breakdown, namely the minimum distance between two electrodes required to ensure that the probability of electrical breakdown is negligible when subjected to the most severe electrical stress likely to arise under the conditions stipulated in this Code, which may refer to phase-to-phase or phase-to-earth distances and also to electrical distance, ergonomic distance and safe working distance;
- 8.01.2.3 **ergonomic distance** means the distance that allows for inadvertent body movement and judgment of distances during the work required to be carried out at the minimum safe working distance when performing live work, and includes electrical distance and safe working distance;

- 8.01.2.4 **insulate** means covered, enclosed, surrounded or supporting live conductors or apparatus with insulating material of such thickness and properties that it will prevent the flow of electricity or potential between the object so covered and its surroundings or any external object in contact with it including the prevention of making contact with earth;
- 8.01.2.5 **insulating aerial device** means an aerial device comprising an insulating boom designed to position the live worker and the equipment for live working, which device is mounted in a fixed position or on a trailer or more generally on a vehicle chassis;
- 8.01.2.6 **insulating boom** means that portion of an aerial device used for live work that insulates the live workers' platform from earth and from which a live worker may work safely on live apparatus;
- 8.01.2.7 **live part** means any conductive part of apparatus, which is alive and in normal use, and includes the neutral conductor;
- 8.01.2.8 **live work** means maintenance, repair, building and construction work carried out on live and operational apparatus using approved techniques and equipment as specified in this section, and live working has a similar meaning;
- 8.01.2.9 **platform** means the live worker-carrying component of an aerial device, such as a bucket;
- 8.01.2.10 **safe working clearance** means the minimum distance that must be maintained between any parts of the body of a live worker, or the conductive tool directly handled, and live parts at different potentials, which minimum distance is the sum of the electrical distance and ergonomic distance;
- 8.01.3 Forms, books, notices, documents and other printed media**
- In this section, unless the context otherwise indicates -
- 8.01.3.1 **live work declaration form** means a printed form containing declaration and clearance sections for the authorisation of all live work to be done on live, operational apparatus in terms of this Code;
- 8.01.3.2 **live work warning notice** means any portable warning notice provided to indicate that live work is in progress on apparatus and to indicate any special operating condition in force on any panel or circuit while live work is in progress.
- 8.02 ABNORMAL CONDITIONS TO BE REPORTED TO SYSTEM CONTROLLER**
- 8.02.1 Persons in charge of live work**
- Only persons who have been specifically authorised to be in charge of live work shall take over live apparatus for live working and issue a live work declaration form.
- 8.02.2 Persons who may perform live work**
- 8.02.2.1 Subject to paragraph 8.02.2.2 of this Code, live work may only be performed by persons who have been specifically authorised to do so.

8.02.2.2 Unauthorised persons may be permitted to perform live work while undergoing training if such persons are under supervision of an instructor, who has been authorised to perform live work.

8.02.3 Persons who may deputise for the team leader

Only a deputy team leader may take over the responsibilities of the team leader for purposes of completing the specific task.

8.03 LIVE WORK AT POWER STATIONS OR ON THE DISTRIBUTION SYSTEM

8.03.1 Circumstances requiring a live work declaration form

A live work declaration form shall be required for all live work on live high voltage apparatus at any power station or at any place on the transmission system or distribution system.

8.03.2 Forms in duplicate

8.03.2.1 A live work declaration form shall be made out in duplicate.

8.03.2.2 The original shall be retained by the authorised person in charge of the live work and the copy shall be left in the live work declaration book.

8.03.3 Preparation and handing over of apparatus for live work

8.03.3.1 When live work is to be carried out on any high voltage apparatus, the authorised person in charge of the live work shall notify the system controller of the following:

8.03.3.1.1 The apparatus to be worked on;

8.03.3.1.2 the nature of the work to be carried out;

8.03.3.1.3 the time that the work is to commence and the estimated duration of the work.

8.03.3.2 The authorised person in charge of the live work shall arrange with the system controller for live work warning notices to be affixed to all control panels of breakers controlling the supply to the apparatus concerned and for all auto-reclosing features on such breakers to be switched off or otherwise made inoperative.

8.03.3.3.1 Where the auto-reclose function of a line is made inoperative via supervisory remote control, it is not necessary to apply a live work warning notice to the control panel.

8.03.3.3.2 If the auto-reclose is made inoperative manually, the live work warning notice shall be applied.

8.03.3.3.3 All SCADA controls to the affected circuit shall be made inoperative.

8.03.3.4 When live work warning notices have been affixed to all control panels of breakers controlling the supply to the apparatus concerned and all auto-reclosing features on these breakers have been switched off or made inoperative, the system controller shall so inform the authorised person in charge of the live work and shall hand over the apparatus to the team leader.

8.03.3.5.1 For live work on lines of 33 kV and below, it may not be necessary for auto-reclose features to be switched off or otherwise made operative.

- 8.03.3.5.2 This must be recorded by the system controller and all SCADA controls to the affected circuit shall be made inoperative.
- 8.03.3.5.3 It will not be necessary to apply the live work warning notice if all work is done in strict accordance with the approved high voltage live working standards and procedures.
- 8.03.4 Issue of a live work declaration form**
- 8.03.4.1.1 The team leader to whom the system controller has handed over apparatus for live work, shall explain to all the persons who will be engaged in the live work the arrangements made with the system controller.
- 8.03.4.1.2 The authorised person in charge of the live work shall identify the apparatus to be worked on, the operational voltage of the apparatus to be worked on and the corresponding safe working clearance to be maintained.
- 8.03.4.2 The persons to be engaged in the live work shall acknowledge their understanding of these details and restrictions by signing the live work declaration form before they proceed with the live work.
- 8.03.5 Cancellation of a live work declaration form**
- 8.03.5.1.1 When live work has been completed, or is suspended for any reason, and the apparatus is to be returned to normal service, the authorised person in charge of the live work shall withdraw all persons from the live apparatus.
- 8.03.5.1.2 The authorised person in charge of the live work shall remove all tools and equipment to a safe position in relation to the live apparatus.
- 8.03.5.2 The authorised person in charge of the live work shall advise the persons engaged in the live work that the apparatus is to be handed back to the system controller and that no further work may be performed.
- 8.03.5.3 The authorised person in charge of the live work shall notify the system controller that the live work is complete or otherwise of the exact state of the apparatus and whether tools or equipment have been left on the apparatus.
- 8.03.5.4 The authorised person in charge of the live work shall complete and sign the clearance section on the original and duplicate live work declaration form.
- 8.03.6 Original and duplicate forms**
- Original live work declaration forms and completed books shall be retained for the period determined by the licensee.
- 8.03.7 Restrictions on re-closing breakers**
- 8.03.7.1 When the system controller has handed over any apparatus for live work, the name of the team leader shall be affixed to the operating diagram/mimic in the control centre.
- 8.03.7.2 No operating other than the emergency opening of breakers shall be performed on the breakers controlling supply to the apparatus until the authorised person in charge of the live work has handed back the apparatus to the system controller.

8.03.7.3 From the time that the apparatus is handed over to the time that the apparatus is handed back to the system controller, no breaker which controls the supply to the apparatus and which has tripped for whatever reason, shall be reclosed until such time as the authorised person in charge of the live work has contacted the system controller and has stated that it is safe for the breaker to be reclosed.

8.03.8 Duration of live work declaration

It is the responsibility of the team leader to decide when conditions are such that live work can no longer proceed safely, whereupon the live work declaration shall be cancelled in accordance with paragraph 8.03.5 of this Code.

8.03.9 When the team leader is not available

8.03.9.1 If the authorised person to whom apparatus has been handed out is for any reason not available, another person authorised in terms of paragraph 8.02.1 or 8.02.2 of this Code may take over the responsibilities of the authorised person in charge of the live work.

8.03.9.2 This person shall countersign the original of the live work declaration form to indicate that he or she is fully aware of what must be done on the apparatus and inform the system controller that he or she has taken over the apparatus.

8.03.9.3 The system controller shall remove the name of the original authorised person from the operating diagram/mimic in the control centre and shall record the name of the authorised person then in charge of the live work.

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8.04.1 The team leader shall be responsible for the safe execution of live work.

8.04.2.1 The team leader shall at all times observe the work in progress to ensure that it is carried out in a safe manner.

8.04.2.2 When the team leader needs to withdraw from the workplace, another person authorised in terms of paragraph 8.02.2 of this Code shall take charge of the live work and shall observe the live work in progress to ensure that it is carried out in a safe manner.

8.04.3 Where the team leader cannot observe part of the work, the observation of that part of the work shall be delegated to another person authorised in terms of paragraph 8.02.2 of this Code.

SECTION 9: DESIGN AND CONSTRUCTION

9.01 GENERAL

This section covers the safety aspects and standards to be taken into account in the design and construction of power lines.

9.02 NORMATIVE STANDARDS

The following standards should be taken into account in the design and construction of power lines:

- 9.02.1 *SABS standards:*
- 9.02.1.1 SANS 088: Pile foundations.
- 9.02.1.2 SANS 0100-1: The structural use of concrete - Part 1: Design.
- 9.02.1.3 SANS 0100-2: The structural use of concrete - Part 2: Materials and execution of work.
- 9.02.1.4 SANS 0120-3-HC: Code of practice for use with standardized specifications for civil engineering construction and contract documents - Part 3: Guidance for design - Section HC: Corrosion protection of structural steelwork.
- 9.02.1.5 SANS 0121: Cathodic protection of buried and submerged structures.
- 9.02.1.6 SANS 0162-1: The structural use of steel - Part 1: Limit-states design of hot-rolled steelwork
- 9.02.1.7 SANS 0162-2: The structural use of steel - Part 2: Limit-states design of cold-formed steelwork.
- 9.02.1.8 SANS 0163-1: The structural use of timber- Part 1: Limit-states design.
- 9.02.1.9 SANS 0199: The design and installation of an earth electrode.
- 9.02.1.10 SANS 1200-F: Standardized specification for civil engineering construction - Section F: Piling.
- 9.02.1.11 SANS 1200-G: Standardized specification for civil engineering construction - Section G: Concrete (structural).
- 9.02.1.12 SANS 1200-HC: Standardized specification for civil engineering construction - Section HC: Corrosion protection of structural steelwork.
- 9.02.1.13 SANS IEC 60383-1: Insulators for overhead lines with a nominal voltage above 1 000 V - Part 1: Ceramic or glass insulator units for AC systems - Definitions, test methods and acceptance criteria.
- 9.02.1.14 SANS IEC 60815: Guide for the selection of insulators in respect of polluted conditions.
- 9.02.1.15 SANS 10280- Overhead power lines for conditions prevailing in South Africa.
- 9.02.2 *IEC standards:*
- 9.02.2.1 IEC 60071-1: Insulation co-ordination - Part 1: Definitions, principles and rules.
- 9.02.2.2 IEC 60071-2: Insulation co-ordination - Part 2: Application guide.
- 9.02.2.3 IEC 60826: Loading and strength of overhead transmission lines.
- 9.02.3 *NRS standards:*
- 9.02.3.1 NRS 000: Rationalized user definitions for use in the Electricity Supply Industry.
- 9.02.3.2 NRS 001: Cost of Supply methodology.
- 9.02.3.3 NRS 002: Graphical symbols for electrical diagrams.
- 9.02.3.4 NRS 034: Electricity Distribution - Guidelines for the application design, planning and construction of medium voltage overhead power lines up to and including 22kV, using wooden pole structures and bare conductors.
- 9.02.3.5 NRS 034: Guidelines for the provision of electrical distribution networks in residential areas.
- 9.02.3.6 NRS 040: High voltage operating regulations.
- 9.02.3.7 NRS 043: Code of practice for the joint use of structures for power and telecommunication lines.
- 9.02.3.8 NRS 044: Working procedures and standards in respect of the installation of new electrical works and telecommunication facilities, or the extension or modification of such existing works and facilities.
- 9.02.3.9 NRS 047: Quality of service.
- 9.02.3.10 NRS 048: Quality of supply.
- 9.02.3.11 NRS 057: Code of practice for electricity metering.
- 9.02.3.12 NRS 060: Code of practice for clearances for electrical systems with rated voltages up to and including 145kV, for safety reasons.

- 9.02.3.13 NRS 064: Guideline for the exchange of spatial information in the Electricity Supply Industry.
- 9.02.3.14 NRS 069: Code of practice for the recovery of capital costs for distribution network assets.
- 9.02.3.15 NRS 076: Earthing of distribution substations with nominal voltages up to and including 132kV.
- 9.02.3.16 NRS 080: Quantifying and reporting of energy losses in electricity distribution networks.
- 9.02.3.17 NRS 082: Recommended maintenance policy for electricity networks.
- 9.02.3.18 NRS 089 - 1: Maintenance of electricity networks - Part 1: Power cables.
- 9.02.3.19 NRS 089 - 2 - 1: Maintenance of electricity networks - Part 2: Overhead distribution systems, Section 1: Overhead lines.
- 9.02.3.20 NRS 089 - 2 - 2: Maintenance of electricity networks - Part 2: Overhead distribution systems, Section 2: Inspection and supplemental of treated wood utility poles.
- 9.02.3.21 NRS 089 - 2 - 3: Maintenance of electricity networks - Part 3: Overhead distribution systems, Section 3: The manual replacement of a rotten wooden pole structure.
- 9.02.3.22 NRS 089 - 2 - 4: Maintenance of electricity networks - Part 4: Overhead distribution systems, Section 4: Clearing and maintenance of servitude routes.
- 9.02.3.23 NRS 089 - 2 - 5: Insulators.
- 9.02.3.24 NRS 089 - 3.1: Maintenance of electricity networks - Part 3: Power substation, Section 1: General.
- 9.02.3.25 NRS 089 - 3.2: Maintenance of electricity networks - Part 3: Power substation, Section 2: Power transformers, Circuit breakers, isolators and instrument transformers.
- 9.02.3.26 NRS 089 - 3.3: Maintenance of electricity networks - Part 3: Power substation, Section 3: Miniature substations, distribution transformers and electrical enclosures.
- 9.02.3.27 NRS 089 - 4: Maintenance of electricity networks - Part 4: Control technologies.
- 9.02.3.28 NRS 089 - 5 - 2: Maintenance of electricity networks - Part 5: Street and area lighting, Section 2: Street lighting.
- 9.02.3.29 NRS 089 - 5 - 3: Maintenance of electricity networks - Part 5: Street and area lighting, Section 3: High mast.

9.03 ***EQUIPMENT AND MATERIAL***

Material and equipment to be used on power lines shall comply with the latest applicable standard specifications.

9.04 ***CLEARANCES OF POWER LINES***

9.04.1 ***Minimum clearances to other services***

The minimum clearances of electric conductors and other wires of power lines to other services shall not be less than the clearances indicated in the following table,
Table 1:

Table 1: Minimum clearances to other services

MINIMUM CLEARANCE IN METERS						
Highest system RMS voltage phase-to-phase kV	System nominal RMS voltage kV	Above ground outside townships	Above ground in townships	Above roads in townships, proclaimed roads outside townships and railways	To communication lines, other power lines or between power lines	To structures not forming part of power lines
1,1 or less	-	4,9	5,5	6,1	0,6	3,0
7,2	6,6	5,0	5,5	6,2	0,7	3,0
12	11	5,1	5,5	6,3	0,8	3,0
24	22	5,2	5,5	6,4	0,9	3,0
36	33	5,3	5,5	6,5	1,0	3,0
48	44	5,4	5,5	6,6	1,1	3,0
72	66	5,7	5,7	6,9	1,4	3,2
100	88	5,9	5,9	7,1	1,6	3,4
145	132	6,3	6,3	7,5	2,0	3,8
245	220	6,7	6,7	7,9	2,4	4,2
300	275	7,2	7,2	8,4	2,9	4,7
362	330	7,8	7,8	9,0	3,5	5,3
436	400	8,1	8,1	9,3	3,8	5,6
800	765	10,4	10,4	11,6	6,1	8,5
533 kV DC		8,6	8,6	4,3	4,3	6,1

Provided that these figure are based on the assumption that clearances shall be determined for a minimum conductor temperature of 50C and a swing angle corresponding to a wind pressure of 500Pa: Provided further that where under normal conditions power line conductors operate at a temperature above 50 CC, the clearance at the higher temperature at which the conductors operate shall be in accordance with the clearance indicated in **Table 1**.

For the purposes of **Table 1**:

- (a) Minimum clearance above ground in and outside townships means the minimum distance between live parts of apparatus and earth;
- (b) minimum clearance above roads and railways, in and outside townships means the minimum distance between live parts of apparatus and such roads and railways;
- (c) minimum clearance between power lines and communication lines means the minimum distance between live conductors and such lines;
- (d) minimum clearance to structures not part of power lines means the minimum distance between live conductors and such structures.

9.04.2 STANDARD MINIMUM ELECTRICAL CLEARANCES/DISTANCES

The standard minimum electrical clearances/distances shall not be less than the clearances/distances indicated in the following table, **Table 2**:

Table 2: Standard minimum electrical clearances/distances

System nominal voltage kV	Highest system voltage kV	Minimum electrical clearance/distance in mm		Minimum safe working clearance/ distance in mm		Minimum live work safe working clearance/distance in mm	
		Phase-to-earth	Phase-to-phase	Vertical	Horizontal	Phase-to-earth	Phase-to-phase
1	1.5	15	20	20	20	-	-
3.3	3.6	80	110	2500	1200	500	950
6.6	7.2	150	200	2600	1200	600	1100
11	12	200	300	2700	1300	700	1100
22	24	320	400	2800	1400	800	1100
33	36	430	500	2900	1500	800	1100
44	48	540	610	3000	1600	800	1100
66	72	770	890	3200	1800	900	1300
88	100	1000	1140	3300	1900	1000	1500
132	145	1450	1680	3700	2300	1200	1900
220	245	1850	2700	4300	2900	1700	2800
275	300	2100	3600	4800	3400	2000	3400
330	362	2500	4300	5400	4000	2300	4100
400	436	2900	4800	5700	4300	2800	4800
765	800	3200	8900	8500	7100	5500	9700
533 kV D.C.		3700	n/a	6200	5900	4250	-

For the purposes of Table 2:

- (a) Minimum electrical clearance means the minimum distance in clean dry air, between different live parts of apparatus or live parts and earth required to ensure that the possibility of electrical breakdown is negligible;
- (b) minimum safe working clearance means the minimum distance, vertically or horizontally, that must be maintained between any body part of a person, or a conductive tool directly handled, and live parts of apparatus at different potential;
- (c) minimum live work working clearance means the minimum distance between phase-to-earth and phase-to-phase.

9.04.3 MINIMUM SAFETY CLEARANCES

The minimum safety clearances shall not be less than the clearances indicated in the following table, **Table 3:**

Table 3: Minimum safety clearances

Highest system RMS voltage kV	System nominal RMS voltage kV	Safety clearance phase-to- earth m	Safety clearance phase-to- phase m	Minimum live line working clearances		Tower-top clearances		
				m		m		
				Phase-to- earth	Phase-to- phase	Still air conditions	Normal swing	Maximum swing
1.1 or less	-	-	-	-	-	-	-	-
7.2	6.6	0.15	0.2	-	-	-	-	-
12	11	0.2	0.3	-	-	-	-	-
24	22	0.32	0.4	-	-	-	-	-
36	33	0.43	0.5	-	-	-	-	-
48	44	0.54	0.61	0.8	1.1	0.54	0.5	0.15
72	66	0.77	0.89	0.9	1.3	0.77	0.71	0.2
100	88	1.00	1.14	1.0	1.5	1.00	0.92	0.24
145	132	1.45	1.68	1.2	1.9	1.45	1.3	0.35
245	220	2.1	2.7	1.7	2.8	2.1	1.88	0.6
300	275	2.5	3.6	2.0	3.4	2.5	2.2	0.7
362	330	2.9	4.3	2.3	4.1	2.9	2.6	0.86
436	400	3.2	4.8	2.8	4.8	3.2	2.9	1.0
800	765	5.5	8.9	5.5	9.7	5.5	5.2	1.9
533 kV DC		3.7	-					

9.04.3 Clearances between parallel independent structures

9.04.3.1 The separation between an overhead communication line and a power line or two power lines erected parallel to each other along the same route, shall be such that the clearance between any conductor of the higher voltage line and any conductor or earth wire of the lower voltage line is never less than the minimum phase-to-phase clearance applicable to the higher voltage line.

9.04.3.2.1 The separation between parallel lines shall be such that, should either line overturn, it will not touch any part of the adjacent line.

9.04.3.2.2 If this separation cannot be provided, the supports of the line that could touch the other line shall be designed to withstand the broken-wire condition.

9.044 Clearances between circuits on common structures

9.04.4.1 The higher voltage line shall be above the lower voltage line or communication line where lines are erected one above the other on common structures.

9.04.4.2 The vertical separation between the nearest conductors of any two lines shall be in accordance with the phase-to-phase clearances given in Table I for the higher voltage line.

9.04.5 Clearances between conductors of lines with a vertical configuration

Attention to ensure compliance with the phase-to-phase voltage clearances where a higher-mounted conductor could operate at full load and maximum sag with a lower-mounted conductor at ambient temperature.

9.04.6 Aerial bundle conductors

An aerial bundled conductor may be considered to be an insulated cable for determining clearances.

9.04.7 Induced voltages

The distance between the power line and any other system (such as a telecommunication, railway or pipeline) shall be such that induced voltages shall not exceed:

- 9.04.7.1 A RMS voltage of 50V in steady operational state;
- 9.04.7.2 a RMS voltage of 430V on power lines where an earth fault is cleared in more than 0,5s;
- 9.04.7.3 a RMS voltage of 1 000V on power lines where an earth fault is cleared in 0,35s to 0,5s: or
- 9.04.7.4 a RMS voltage of 1 200V on power lines where an earth fault is cleared in less than 0,35s.

9.04.8 Electrolytic corrosion

- 9.04.8.1.1 Where a risk exists of electrolytic corrosion of underground services in the proximity of a power line due to stray currents from DC services entering the earthing system of a power line erected close to the DC service, suitable protective measures shall be taken to reduce the risk of electrolytic corrosion.
- 9.04.8.1.2 This will usually take the form of separating the earthing system from the DC system and providing interposing insulating material.
- 9.04.8.2 Corrosion protection measures shall comply with I must be developed with due recognition of SANS 1200-HC, SANS 0120-3-HG and SANS 0121.

9.05 CONDUCTORS AND EARTH WIRES FOR POWER LINES**9.05.1 Corrosion**

All conductors and earth wires shall be of materials that have adequate corrosion resistance to the atmosphere to which they are likely to be exposed in service, or shall be suitably protected against corrosion.

9.05.2 Minimum size

- 9.05.2.1 The minimum size of the conductor or the conductor bundle shall be determined by the following key factors:
 - 9.05.2.1.1 The thermal rating that is required; and
 - 9.05.2.1.2 the short-circuit current.
- 9.05.2.2 The size of the phase single conductor or of the phase bundle shall be selected to limit voltage drop, audible noise, radio interference, television interference and loss due to corona.

9.05.3 Current-carrying capacity

- 9.05.3.1 The following are the three main operational states for which current-carrying capacity calculations can be done:

- 9.05.3.1.1 Long duration/normal operation: it is preferable to limit the conductor temperature to between 50°C and 60°C;
- 9.05.3.1.2 emergency operation: where it is expected that normal current-carrying capacity will be exceeded;
- 9.05.3.1.3 short-duration emergency operation: where temperatures exceeding 80°C are assumed, the thermal behaviour shall be assumed not to change.
- 9.05.3.2 In the case of copper conductors, the normal operating temperature limits should not be exceeded.

9.05.4 Maximum tensions

- 9.05.4.1 The maximum tension in conductors and earth wires at a temperature of -5°C and a wind pressure of 700 Pa on a shape factor of 0,6 of the projected area should not exceed 40% of the breaking strength of the conductors or earth wires.
- 9.05.4.2 If there is a possibility of conductor vibration which could lead to the failure of the conductor due to fatigue, the risk should be reduced by using a lower conductor tension than the maximum permitted.
- 9.05.4.3 The tension limits for conductors and steel earth wires are as follows:
- 9.05.4.3.1 Copper conductors: The tension at a temperature of 15°C should not exceed 26% of the ultimate tensile strength of the conductor;
- 9.05.4.3.2 ACSR and AAAC conductors: If vibration dampers are not used and the lines have relatively short spans, typically under 200 m, the initial tension at a temperature of -5°C should not exceed 25% of the ultimate tensile strength of the conductor. When vibration dampers are used, the following limitations are recommended:
- 9.05.4.3.2.1 The initial tension at -5°C should not exceed 33,3% of the ultimate tensile strength of the conductor;
- 9.05.4.3.2.2 the initial tension at 15°C should not exceed 25% of the ultimate tensile strength of the conductor; and
- 9.05.4.3.2.3 the final tension at 15°C should not exceed 20% of the ultimate tensile strength of the conductor;
- 9.05.4.3.3 earth wires: In the case of galvanized steel earth wires of minimum breaking strength in the range 700 MPa to 1 100 MPa, the maximum tension at 15°C should be such that the stress in the earth wire does not exceed 180 MPa. This criterion permits the use of tensions (at 15°C) of the following percentages of minimum breaking strength:
- 9.05.4.3.3.1 700 MPa wires: 25%; and
- 9.05.4.3.3.2 1 100 MPa wires: 15%.

9.05.5 Sag charts

Sag information and the correction table for increased time between stringing and regulating should be obtained from the manufacturer of the chosen conductor in order to produce sag charts.

9.05.6 Creep

Initial (or stringing) charts and final charts in which a maximum allowance is made for creep should be prepared before stringing commences.

9.05.7 Joints

9.05.7.1.1 All joints shall be such that their current-carrying capacity exceeds that of the conductors that are being joined.

9.05.7.1.2 Tension joints shall have a breaking strength of at least 95% of that of the conductor.

9.05.7.2 In areas that are conducive to corrosion, it is good practice to coat the joined ends and fill the fittings with chemically inert corrosion-inhibiting paste.

9.06 POWER LINE STRUCTURES**9.06.1 Factors of safety**

The minimum factors of safety to be applied for the type of structure and load are indicated in the following table, **Table 4**:

Table 4: Minimum factors of safety

Type of structure	Factor of safety		
	Based on type-tested structure	Based on ultimate breaking strength	Based on modulus of rupture
Steel lattice structures and cross-arms	2.5	2.5	
Solid-drawn steel poles	2.0	2.5	
Welded steel poles and steel poles with swaged or telescopic joints	2.2	2.5	
Stay-wire assemblies 2.5 2.5			
Reinforced concrete spun poles	2.4	3.5	
Mechanically vibrated reinforced concrete structures and components	2.5	3.5	
Other types of reinforced concrete structures and components	2.75	3.75	
Wooden members not continuously loaded	3.5	4.4	2.7
Wooden members subjected to continuous Loading	5.5	6.75	4.5

In the case of steel lattice structures and steel components such as built-up cross-arms and bracing members, the factor of safety shall be 2.5 on tested failing load or, when calculated, on tensile strength of tension members and on crippling strength of compression members.

9.06.2 Design Loading

The total load on a support consists of the following loads, which should be taken into consideration with the design of the support:

- 9.06.2.1 Wind loads on conductors and earth wires;
- 9.06.2.2 wind loads on supports;
- 9.06.2.3 wind loads on insulators and fittings;
- 9.06.2.4 vertical loads due to conductors;
- 9.06.2.5 vertical loads due to supports, insulators and fittings;
- 9.06.2.6 normal loads due to conductor tensions;
- 9.06.2.7 loads due to differential tension;
- 9.06.2.8 horizontal loads due to stay wires.

9.06.3 Loading due to broken conductors

With a line that has a single conductor per phase, the assumptions given in the following table, **Table 5**, in respect of the loads imposed on the structures that support the span in which the break occurs, expressed as percentages of the maximum design load at a temperature of -5°C and when subjected to a wind pressure of 700 Pa, can be used for the design loading of a structure.

Table 5: Loads imposed on structures owing to conductor breakage

Type of structure	Load imposed on structure, as a percentage of maximum design load	
	Conductor attachment point	Earth wire attachment point
Strain	100	100
Suspension	70	100

9.06.4 Erection loads

When a design does allow for the conductors and earth wires to be strung on one side only of a strain structure, the design should allow for the following conditions:

- 9.06.4.1 The conductor tension during erection would normally be that at about 15°C in still air and the strain structure should be capable of withstanding the load due to this tension, with a factor of safety of 1,5;
- 9.06.4.2 when the structure is strung on one side only, the structure should be capable of withstanding the load due to conductor tension, at a temperature of -5°C and when subjected to a wind pressure of 700 Pa, with a nominal factor of safety of, say, 1,2 during erection conditions;
- 9.06.4.3 all structures should furthermore be capable of withstanding, with a factor of safety of 1,5, the normal vertical loads plus an additional mass of 150 kg to 300 kg to allow for the weight of the workers and their equipment at each conductor attachment point during construction and the vertical component of loads due to back staying should also be considered.

9.07 FOUNDATIONS FOR POWER LINE

- 9.07.1 Structures erected on concrete foundations in the case of lattice steel structures or directly in the ground in the case of wooden, concrete or steel poles shall be so set in the ground that they are capable of withstanding, without appreciable movement in the ground and with an adequate factor of safety, the forces imposed by the loading on the structure under normal or broken conductor or erection conditions.
- 9.07.2.1 A safe bearing pressure of about 200 kPa can be assumed for checking resistance to downward or lateral forces in the case of ordinary soil and at the average foundation depths.
- 9.07.2.2 The value could be three or four times this value in hard rocky soil and, perhaps, one third of this value in sandy or boggy ground.
- 9.07.2.3 In the case of wooden poles, foundation failure before pole failure is desired, and a value of 345 kPa can be assumed.
- 9.07.3 The safe bearing pressure of the soil in which a foundation or a structure is to be installed, should be determined by site tests.

9.07.4 For checking resistance to upward forces, it is commonly assumed that the density of ordinary soil is about 1 600 kg/M³ and the angle to the vertical of the sides of the frustum of earth-resisting uplift may be taken as 25° in good soils to 0° in poor soils.

9.07.5 In the case of poles, an increased bearing area in the lateral direction is often obtained by the addition of kicking blocks at the bottom and at a point below ground/floor level that is equal to one-third of the buried depth of the pole, while an increased bearing area at the bottom is obtained by the addition of base plates.

9.08 INSULATORS AND FITTINGS

9.08.1 Mechanical strength requirements

9.08.1.1 The mechanical strength of insulators and fittings used in strain structures should be such that they are at least as strong as the minimum breaking strength of the phase or earth conductor to which they are attached.

9.08.1.2 The strength of suspension assemblies should be such that a factor of safety of at least 1.5 is provided under the loading imposed under broken conductor conditions.

9.08.2 Electrical insulation levels and footing resistance requirements

9.08.2.1 The basic insulation level required for a power line of a given voltage depends on many factors, such as the anticipated magnitude of voltages caused by switching surges or faults, the altitude of the line, the possibility of contamination of insulators and the desired degree of immunity from lightning.

9.08.2.2 Minimum insulation levels are given in the following table, Table 6, but it is emphasized that the insulation of each line should be designed for its specific conditions. The list of insulation levels is in accordance with IEC 60071-1 and IEC 60071-2.

Table 6: Minimum insulation levels for power lines

Highest system RMS voltage kV	System nominal RMS voltage kV	System fault level kA	Rated peak lightning impulse withstand voltage kV	Rated peak switching impulse withstand voltage (phase-to-earth voltage) kV	Phase-to-phase voltage ratio to the phase-to-earth voltage peak value	Rated peak switching impulse withstand voltage (phase-to-phase voltage) kV	60 s RMS power frequency peak switching withstand voltage (phase-to-earth voltage) kV
12	11	-	75	-	-	-	28
24	22	-	125	-	-	-	50
36	33	-	170	-	-	-	70
48	44	20	250	-	-	-	95
72	66	20	350	-	-	-	140
100	88	25	380	-	-	-	150
145	132	40	550	-	-	-	230
245	220	40	850	-	-	-	360
300	275	50	1050	850	1.5	1300	-
362	330	50	1300	950	1.5	1425	-

Highest system RMS voltage kV	System nominal RMS voltage kV	System fault level kA	Rated peak lightning impulse withstand voltage kV	Rated peak switching impulse withstand voltage (phase-to-earth voltage) kV	Phase-to-phase voltage ratio to the phase-to-earth voltage peak value	Rated peak switching impulse withstand voltage (phase-to-phase voltage) kV	60 s RMS power frequency peak switching withstand voltage (phase-to-earth voltage) kV
420	400	50	1425	1050	1.5	1550	-
800	765	50	2100	1550	1.5	2400	-

NOTE: The designed line insulation levels will determine line equipment clearances. The minimum safety phase-to-earth clearances shown in column 3 of Table 3 should not be interpreted as specifying line equipment clearances. In the range of rated voltage that is within the scope of this standard, there are three ranges with distinctive insulation criteria and therefore insulation levels. They are given in subparagraphs (a), (b) and (c) below:

- (a) *Range A, for line voltages less than 44 kV:* The main criterion is only the lightning impulse over voltages, which can be severe when the load is disconnected on the low voltage winding of a transformer connected to a transmission line. This impulse voltage is usually reduced by the use of surge arresters.
- (b) *Range B, for 44 kV to 220 kV lines:* The main criteria are the rated lightning impulse voltage and the rated 60 s power frequency voltage, which cover all internal overvoltages. The assumed footing resistances are -
- (i) 132 kV: 20 Ω and
 - (ii) 220 kV: 30 Ω .
- (c) *Range C, for 275 kV to 400 kV lines:* The main criterion is the switching overvoltage (representing internal overvoltage), including the rated lightning impulse overvoltage, based on footing resistances of -
- (i) 275 kV: 30 Ω ; and
 - (ii) 400 kV: 40 Ω .

9.08.3 Insulation levels in polluted areas

The criteria for insulation coordination in conditions of pollution are based on SANS IEC 60815 and on the corresponding proposed creepage distances given in the following table, **Table 7**.

Table 7: Creepage distance over external insulation

Highest system RMS voltage kV	System nominal RMS voltage kV	Creepage distance over external insulation for line, in accordance with SABS IEC 60815			
		Lightly polluted areas	Medium polluted areas	Heavily polluted areas	Very heavily polluted areas
1211	192	240	300	372	
2422	384	480	600	744	
3633	576	720	900	1116	
4844	770	960	1200	1500	
7266	1150	1400	1800	2200	
10088	1600	2000	2500	3100	
145132	2320	2900	3600	4500	

Highest system RMS voltage kV	System nominal RMS voltage kV	Creepage distance over external insulation for line, in accordance with SABS IEC 60815			
		Lightly polluted areas	Medium polluted areas	Heavily polluted areas	Very heavily polluted areas
245220	3920	4900	6100	7600	
300275	4800	6000	7500	9000	
362330	5800	7200	9000	11000	
420400	6700	8400	10500	13000	
800765	12800	16000	20000	25000	

9.09 STAY WIRES

9.09.1 Installation of stays

9.09.1.1 A stay should be attached to the structure at the point of application of the load which it is designed to counteract and should be installed in a direction opposite to that of such load.

9.09.1.2 The location should be such that the clearance from the stay wire to any live part of the line under all design conditions is not less than the appropriate phase-to-earth clearance given in **Table 3**.

9.09.1.3.1 Stay wires should not pass under, over or near communication lines or the associated poles.

9.09.1.3.2 Where this is unavoidable, stays should be installed in such a way that workers working on the poles or wires of the communication line cannot come closer than the appropriate phase-to-earth clearance to any portion of the stay that could become alive under fault conditions.

9.09.1.4.1 A stay insulator or an insulated rod shall be installed in the stay where the installation of a stay will affect the basic insulation level of a structure.

9.09.1.4.2 The stay insulator or insulated rod shall be installed such that in the advent of the stay touching any live part of a line installed below the attachment point of the stay that the lower portion of the stay will not be made alive.

9.09.2 Factor of safety

9.09.2.1 The strength of any stay wire used, should be such that its ultimate tensile strength is at least 2,5 times the maximum tension calculated as indicated in paragraph 9.05.4 above for normal conditions.

9.09.2.2 If stay wires are used to withstand loading due to a broken conductor or to erection conditions, the factor of safety may be reduced, but the ultimate strength should be at least 1,5 times the maximum tensile force for the appropriate condition.

9.09.2.3.1 Higher factors of safety should be used for stay rods than for stay wires, especially where threaded portions are in tension.

9.09.2.3.2 A factor of safety of 2,5 should be used for stay rods and one of at least 3 for their threaded portions.

9.10 EARTHING**9.10.1 Support structures for power lines**

9.10.1.1 All metal power line structures and any metal work on wooden or concrete structures, which could inadvertently become alive and which are within 2.4 m of the ground, shall be earthed.

9.10.1.2.1 The effectiveness of the earthing of a structure shall be determined by measuring its resistance to earth.

9.10.1.2.2 If this resistance is so high that the structure is not earthed, a supplementary earthing system should be provided in accordance with /with due recognition to SANS 10199.

9.10.1.3 A footing resistance of less than 10 U is recommended for terminal structures at stations and a footing resistance of less than 20 U is recommended for the second, third and fourth structures from a station.

9.10.1.4 Where it is not practicable to provide a sufficiently low earth resistance to ensure that there will be no danger to life in the event of a fault in a structure, the risk can be reduced by the use of fast and reliable protection.

9.10.2 Fittings

Power line fittings, which are more than 2.4 m above ground, do not have to be earthed.

9.10.3 Earth wires

9.10.3.1 To reduce the number of outages caused by lightning, earth wires should be located above the phase conductors in such a position that the cover angle is reasonably small.

9.10.3.2 Cover angles in the range 30° to 45° are recommended for single earth wire systems.

9.10.3.3 Cover angles of 30° or less for the outer conductors and a 60° cover angle to the conductors between the earth wires is recommended for two earth wires.

9.10.3.4 Where earth wires are only used to provide a return path for earth fault currents, they should preferably be located below the line conductors so that if a conductor breaks, there is a possibility that it will make contact with the earth wire.

9.10.3.5 Earth wires installed as lightning protection should be connected to earth at each power line support, either through the support in the case of metal supports, or by an earthing conductor in the case of supports of non-conducting materials.

9.10.3.6 Lightning protection on wooden poles of lines operating at voltages below 33 kV, can be improved by omitting earth wires and leaving the insulator assemblies unearthed, keeping the insulation level as high as possible.

9.10.3.7 Earth wire insulators fitted with a spark gap set to 6 mm shall be installed in the following circumstances:

9.10.3.7.1 At terminal structures not connected to the main station earth mat;

9.10.3.7.2 attraction station terminal structures;

- 9.10.3.7.3 on the second, third, fourth and fifth structures from the station if any or all of these structures have footing resistances of less than 10Ω ; and
- 9.10.3.7.4 at all structures within 800 m of electrified railway tracks or metal pipelines where the power line either crosses, or runs parallel to, the railway or pipeline.

ANNEXURE 2: OPERATING AUTHORITY

Subclause	Authorised duty	Restricted to
	Transmitting messages	
	Access to live chambers and prohibited areas	
	Right to possess keys	
	Perform switching, isolating, safety testing and earthing operations	
	Supervision of non-authorised staff-in-training carrying out the operating	
	Supervision of work	
	Restoration of supply in the event of the event of the failure or absence of communications	
	Supervision, as a team leader, of the safe execution of live work	
	Perform live work	
Other authorisation		

You are hereby authorised as a responsible person, restricted to

.....

This authority supersedes all other previous authorities.

Recommended: Signature Date

Authorised : Signature Date

I hereby understand the authority detailed above and I accept the duties and responsibilities set out therein.

Signature Date

ANNEXURE 3: WORK PERMIT FORM

APPLICATION TO WORK ON APPARATUS

Number

I, the responsible person, am required to carry out the work detailed below and I hereby request the appointed operator to prepare the necessary apparatus in accordance with the Safety Standards.

Apparatus to be worked on

Work to be carried out

Points of isolation 1

2

Position of required earthing devices 1

2

Responsible person Appointed operator

Date Time Required

WORK PERMIT

Number

I, the appointed operator, hereby notify the undersigned responsible person that the apparatus detailed in the above application has been prepared in accordance with the Safety Standards, and we mutually agree that the work can be carried out.

Special endorsements (if any)

Appointed operator Responsible person

Date Time

Responsible person	Appointed operator	Date	Time

Unique number(s) of key(s) used during isolation

Key cabinet number

CLEARANCE

I, the responsible person, hereby notify the undersigned appointed operator that the work detailed in the above work permit has been completed, all workers have been withdrawn from the chambers or apparatus, and the apparatus is ready to be returned to service in accordance with the Safety Standards.

Special comment on work performed:

.....

Responsible person Appointed operator

Date Time Required

ANNEXURE 4: WORKER'S DECLARATION

Number

I, hereby declare that the work to be carried out under Permit No has been explained to me by the undersigned responsible person and I thoroughly appreciate the nature and risk of the work.

Responsible person Date

WORKER'S SIGNATURE AND EXTENSIONS

Date Date Date Date

Signature	Time	Signature	Time	Signature	Time	Signature	Time
..... Responsible person	 Responsible person	 Responsible person	 Responsible person	
..... Authorised person	 Authorised person	 Authorised person	 Authorised person	

SPECIAL ENDORSEMENTS

I hereby declare that the undersigned responsible person has instructed me that I shall no longer continue to work on the apparatus as detailed under Permit No

Date Date Date Date

Signature	Time	Signature	Time	Signature	Time	Signature	Time
..... Responsible person	 Responsible person	 Responsible person	 Responsible person	

ANNEXURE 5: CONTROL PANEL LABEL/TAG**CONTROL PANEL LABEL/TAG**

No.

STATION**CONTROL PANEL****PERMIT NO. (if any)****EARTHING DEVICES IN USE**

No.	Type	Position	Time	Date

Appointed operator

Date

ANNEXURE 6: LIVE WORK DECLARATION FORM

No.

DECLARATION BY TEAM LEADER

Station/Line

I the team leader confirm that all auto-reclosing features of breaker(s) controlling the supply to are made inoperative, warning notices are affixed to the control panels of the breakers concerned, and the **HAND OUT** of the apparatus to me for live work is confirmed on:

Date: Time

The operational voltage is kV, the safe working clearance is meters

Live work to be done:

Date: Time

Authorised person in charge

Date: Time

Deputy authorised person

WORKER'S DECLARATION TO PERFORM LIVE WORK

I/We, the undersigned responsible person(s) performing live work confirm that the apparatus to be worked on is as stated above, and understand the restrictions and details of the work.

SIGN ON		SIGN OFF	
Name	Signature	Name	Signature
Date:	Time:	Date:	Time:

CLEARANCE

HAND BACK: Live work on the above mentioned apparatus has been* completed/suspended. The workers authorised to perform live work are withdrawn from the apparatus and the apparatus is handed back to the system controller on:

Date: Time

Authorised person in charge

** Delete which is not applicable*

** Worker's declaration must be used if above space is in sufficient.*

ANNEXURE 7: INDEMNITY FORM- SINGLE VISITORS

No.

I, the undersigned (full name and surname)
ID being an adult, do hereby on behalf of myself, my executors, my assigns, my heirs and all my dependents who are now entirely or partly dependent upon me or who may be in future be so dependent, acknowledge and declare that whenever I am allowed access to any power station, prohibited area, live chamber, station, building or other property of the licensee or any aircraft, helicopter or motor vehicle for whatever purpose, will do so at my own risk and on the express condition that the licensee, its shareholders, employees or agents shall not be liable to me or any dependents or any of them for damages arising out of loss of life or bodily injuries suffered by me as a result of any incident or cause which may occur or damage of whatever nature to property, whether or not such Incident or other cause arises from negligence, incompetence or any other intentional act on the part of such employees or agents.

I indemnify, hold harmless and absolve the licensee, its shareholders, employees or agents against and from any damages arising from loss of life or bodily injuries suffered as described above.

SIGNED AT ON THIS DAY OF 20

NAME (PRINTED):

SIGNATURE

COMPANY: TEL:

WITNESS (PRINTED):

SIGNATURE

ANNEXURE 9: ABBREVIATIONS

Advances	Adv.
Alternative current/direct current	AC/DC
Appointed operator	A/O
Authorised person	A/P
Auto Master	A/M
Auto Follower	A/F
Auto-reclose	ARC
Auxiliary	Aux.
Basic insulation level	BIL
Battery Charger	B/Chgr.
Being Open	B/O
Being Closed	B/C
Breaker	Bkr.
Bus Coupler	B/Coupl.
Bus Section Links	B.S.L.
Bus Strip Isolating Link	B.S.I.L
Bus Section	B/Sect.
Bus Link or Busbar Link	B.B.L.
Busbar	BB
Degrees Celsius	0C
Capacitor	Cap.
Carrier	Carr.
Coupling Transformer	Coupl./Trfr
Coupling Links	Coupl.L.
Diesel Gen. Transformer	DG.Trfr
Distribution Station	D/S
Diversion Weir	D/Weir
Drop Out Fuse Link	D.O.F.
Earth Link	EL.
Earth Fault	E/F
Feeder	Fdr.
Generator	Gen.
Hand Back	H/B
Hand Out	H/O
Hand Over	H/Over
Hertz	Hz
High voltage	HV
Human machine interlace	HMI
Isolated + Earth	I + E
Joule	J
Kilogram	kg
Kilovolt	kV
Kilowatt hour	kWh;
Line Link	L. L.
Low Voltage	LV
Maintenance	Mtce.
Medium Voltage	MV
Meter	m
Millimeter	mm
Millicoulomb	mC
Namibian Electricity Safety Code	NESC
Ohm	Ω

Operating Instruction Form	OIE
Out of Commission	OOC
Over Current	O/C
Pascal	Pa
Phase	or PH('s)
Power Station	P/S
Pre-authorized instruction	P/A inst.
Rack Out	RIO
Recloser	Recl.
Regulating Transformer	Reg. Trfr
Responsible employee	R/E
Responsible official	RIO
Responsible person	RIP
Root mean square	RMS
Single Wire Earth Return	SWER
Spring operated isolating links	S.O.1.
Static Var Compensator	SVC.
Station Transformer	Stn./Trfr.
Station Board	Stn./Brd.
Station	S/S
Supervisory	Superv.
Synchronised	Sync.
System Control	Syscon
System controller	sic
Tapchanger	T/Ch
Test to be dead on 3 Phases	T.D.3 HP's
Total of two bays (or more)	T2B or T'n'B
Transformer	Trfr
Unit Transformer	Unt./Grfr
Unit boards	Unt./Brd.
Weight operated isolating links	W.O.L.
Working Earths	W/E
