



Bhutan Electricity Authority



Safety Code 2008

Table of Contents

- 1 PURPOSE2
- 2 INTERPRETATION2
- 3 DEFINITIONS2
- 4 SAFETY RULES.....3
- 5 SAFETY MANAGEMENT SYSTEM.....4
- 6 SAFETY EQUIPMENT5
- 7 ACCESS CONTROL.....5
- 8 EQUIPMENT DESIGN AND CONSTRUCTION5
- 9 MINIMUM APPROACH DISTANCES.....7
- 10 WORK PERMIT8
- 11 TEST PERMIT9
- 12 ISOLATION AND EARTHING9
- 13 WORK ON EQUIPMENT REQUIRING SPECIAL PRECAUTIONS.....10
- 14 CONNECTION OF SUPPLY TO CONSUMER PREMISES11

1 Purpose

- 1.1 This Safety Code specifies the Authority's minimum electrical safety requirements for the design, construction, operation and maintenance of electric power plant and equipment under the control of Licensees. These minimum requirements shall be incorporated by Licensees into the Safety Rules and Safety Management Systems developed by Licensees in accordance with the requirements of the Safety Regulation.
- 1.2 This Code is concerned only with electrical safety and does not impose requirements on Licensees in respect of non-electrical safety risks arising from the design, construction, operation and maintenance of electric power plant and equipment under the control of Licensees. Licensees are expected to manage non-electrical safety risk in accordance with good industry practice and the requirements of relevant laws of Bhutan.

2 Interpretation

- 2.1 For the purpose of this Code, any word or expression used to which a meaning has been assigned in the Safety Regulation shall have that meaning, unless explicitly indicated in the Code. Further reference is made to the definitions in Section 3 of this Code.

3 Definitions

“**Authority**” means the Bhutan Electricity Authority;

“**Bare Conductor**” means any conductor that is uninsulated or insulated to less than its full working voltage;

“**Competent Person**” means a person who can demonstrate to the Licensee knowledge of the hazards present in the workplace and that he or she has the necessary knowledge, skills and experience to undertake assigned work in a manner that is Electrically Safe and in compliance with the Safety Rules;

“**Electrically Safe**” means no significant risk of injury or death to any person, or of damage to any property, as a result of the use of electric power plant and equipment;

“**High Voltage**” means any voltage of 66 kV and above;

“**Licence**” means a Generation License, Transmission License, Distribution License or System Operation License issued by the Authority under the Electricity Act of Bhutan, 2001;

“**Licensee**” means the holder of a Generation License, Transmission License, Distribution License or System Operation License issued by the Authority under the Electricity Act of Bhutan, 2001;

“**Low Voltage**” means any voltage not exceeding 400 volts between phase to phase for three phase supply or 230 volts between phase to neutral in case of single phase supply;

“**Medium Voltage**” means any voltages of 6.6 kV or 11 kV or 33 kV;

“**Minimum Approach Distance**” means the minimum distance when approaching live Bare Conductors that shall apply to employees, contractors or other persons without the use of special safety precautions;

“**Safety Equipment**” means tools or other equipment specifically designed to protect persons from potential hazards;

”**Safety Management System**” is the means by which a Licensee ensures that employees and contractors comply with its Safety Rules;

“**Safety Observer**” means a person responsible for continuously observing a person who is within the Minimum Approach Distance of a live Bare Conductor to ensure that the person does not inadvertently contact the live Bare Conductor;

“**Safety Officer**” means the senior staff of the Licensee responsible for the operation of the Safety Management System and for liaison with the Authority on matters relating to electrical safety;

“**Safety Regulation**” means the regulation developed by the Authority in pursuant to the Electricity Act of Bhutan, 2001;

“**Safety Rules**” means the procedures or work instructions issued by a Licensee to ensure that the operation, maintenance and testing of power plant and equipment under the control of the Licensee is undertaken in a manner that is Electrically Safe;

“**Serious Breach**” means a non-compliance with the Safety Rules of a nature that could result in serious injury to any person or damage to property other than that of the Licensee;

“**Tagged**” means marked to safeguard against an inadvertent change to the state of isolation or earthing point;

“**Test Permit**” means the permit for access equipment that is not available for service but that may need to be energized or operated for testing. Under a test permit a work party has temporary access for work activities to specific isolated equipment, which is in a defined state; and

“**Work Permit**” means a permit for access to, and work on or within the Minimum Approach Distance of, equipment that has been isolated for work other than testing under a Test Permit. Under a Work Permit, a work party has temporary access to specific isolated equipment, which is in a defined state.

4 Safety Rules

- 4.1 Licensees shall prepare Safety Rules in accordance with the requirements of the Safety Regulation. Safety Rules shall be specific to the Licensee’s organization and shall reflect both the type of electric power plant and equipment under the control of

- the Licensee and the management structure and arrangements of the Licensee's organization.
- 4.2 Safety Rules shall ensure that work in the vicinity of electrical apparatus is undertaken in a manner that is Electrically Safe.
- 4.3 Safety Rules shall include requirements to ensure that precautions, such as roping off work areas or displaying warning signs, are taken to minimize risk to the general public when work is undertaken in a publicly accessible location and shall identify additional precautions necessary when a work site, such as a ground excavation, is left unattended.
- 4.4 The Licensee shall determine the scope and content of the Safety Rules, which shall cover electrical safety and may also cover non-electrical safety. The Safety Rules shall include the following:
- (a) Safety awareness;
 - (b) Identification of hazards;
 - (c) Safety equipment;
 - (d) Access control;
 - (e) Minimum approach distances;
 - (f) Work permits;
 - (g) Test Permits;
 - (h) Isolation and earthing;
 - (i) Work on equipment requiring special precautions.
- 4.5 The scope and content of the Safety Rules need not be limited by the requirements of this Safety Code.
- 4.6 Notwithstanding the Clause 4.3 of this Code, the Safety Rules shall include all requirements of this Safety Code to the extent that they are relevant to plant and equipment under the control of the Licensee.

5 Safety Management System

- 5.1 Licensees shall implement a Safety Management System to ensure compliance with their Safety Rules.
- 5.2 The Safety Management System shall include as a minimum requirement the following features:
- (i) a process by which employees and contractors are trained in the need for electrical safety and in the requirements of the Safety Rules that relate to the work to be performed;
 - (ii) a means by which compliance with Safety Rules is monitored by the Licensee on a regular basis;
 - (iii) a process for disciplining employees and contractors who fail to comply with the Safety Rules where the non-compliance is a Serious Breach;
 - (iv) a process for the regular inspection and testing of Safety Equipment; and

- (v) a process by which Safety Rules are regularly reviewed and updated.
- 5.3 All Licensees shall designate a senior staff as its Safety Officer. The Safety Officer shall be responsible for the operation of the Safety Management System and for liaison with the Authority on issues relating to electrical safety. Licensees shall inform the Authority of the name and telephone number of their Safety Officer.

6 Safety Equipment

- 6.1 Safety rules shall specify the Safety Equipment to be used by employees and contractors when doing particular types of work.
- 6.2 Licensees shall provide employees with Safety Equipment as required by their Safety Rules.
- 6.3 Safety Equipment shall be inspected and, where appropriate, tested on a regular basis to ensure that it is still fit for service. Equipment that is found not to be fit for service shall be withdrawn and replaced. Records shall be kept of all safety inspections and tests.
- 6.4 Failure to use Safety Equipment in accordance with the Safety Rules shall be regarded as a Serious Breach of the Safety Rules that may be subject to disciplinary action.

7 Access Control

- 7.1 Medium or High Voltage switchyards and other Medium or High Voltage equipment that is located less than 3 meters above ground level shall be surrounded by a locked enclosure to prevent unauthorized access. Control buildings and buildings containing Medium or High Voltage electrical equipment shall also be locked.
- 7.2 Keys allowing access to control rooms, switchyards and enclosed Medium or High Voltage equipment shall be issued only to Competent Persons. Other persons shall enter such areas only when under the direct and continuous supervision of a Competent Person.

8 Equipment Design and Construction

- 8.1 All electric power plant and equipment shall be designed and constructed in accordance with good industry practice to minimize the hazard to employees and to the general public.
- 8.2 Installations and equipment shall be designed so that metallic parts that might potentially become energized at a voltage above 125 volts alternating current shall be connected to earth. In particular:
 - (i) Medium and high voltage installations shall incorporate an earth system that (a) ensures the effective operation of protection devices, (b) limits step and touch potentials to safe levels, and (c) prevents danger due to the transfer of hazardous voltages through metallic conductors such as pipelines, fences etc located in the vicinity of the installation;

- (ii) Metal poles and towers of overhead transmission and distribution lines shall be effectively connected to earth;
- (iii) An earth connection shall be provided at all consumer installations with an earth resistance sufficiently low to provide adequate current to ensure the reliable operation of protective devices; and
- (iv) Neutral conductors of low voltage supply systems shall be connected to earth at the source of supply and at each consumer installation. In no case shall a neutral conductor be connected to earth at less than two locations.

8.3 Any live conductor of Medium or High Voltage electrical plant or equipment shall be protected by an automatic protective device.

8.4 Overhead electrical conductors shall at all times have a minimum clearance above ground level in accordance with Table 1 below:

Table 1: Overhead Electrical Conductor Clearances

| Particulars | 220 kV | 132 kV | 66 kV | 33 kV | 11 kV | LV |
|---------------------------|--------|--------|-------|-------|-------|--------|
| Ground clearance | | | | | | |
| Across street | 7.0 m | 6.1 m | 6.1 m | 6.1 m | 6.1 m | 5.5 m |
| Along street | 7.0 m | 6.1 m | 6.1 m | 5.8 m | 5.8 m | 5.5 m |
| Elsewhere | 7.0 m | 6.1 m | 5.5 m | 5.8 m | 5.8 m | 4.6 m* |
| Separation between phases | | | | | | |
| Horizontal | 8.4 m | 6.8 m | 3.5 m | 1.5 m | 0.7 m | # |
| Vertical | 4.9 m | 3.9 m | 2.0 m | 1.5 m | 0.6 m | # |
| Clearance from buildings | | | | | | |
| Horizontal | 3.7 m | 2.8 m | 2.1 m | 1.8 m | 1.2 m | # |
| Vertical | 5.5 m | 4.6 m | 4.0 m | 3.7 m | 2.5 m | # |

Note:

* *Applies to new construction with fully insulated conductors. For bare conductors minimum clearance should be 5 metres (m- metres).*

Not applicable to fully insulated ABC conductors.

** *The above clearances have been referred from Bureau of Indian Standards (BIS).*

8.5 The minimum depth of burial below ground level of underground electric power cables shall be in accordance with Table 2 below. Underground cable shall be protected by suitable mechanical protection such as bricks or concrete tiles, positioned directly above the cable along its whole length.

Table 2: Depth of Burial of Underground Cable

| Particulars | Minimum Depth |
|--------------------|----------------------|
| 33 kV | 1.0 metre |
| 11 kV | 1.0 metre |
| LV | 0.6 metre |

9 Minimum Approach Distances

9.1 Safety Rules shall include a table of Minimum Approach Distances, which shall specify the minimum distance employees must maintain between themselves and any live Bare Conductor, unless following an approved industry procedure and using appropriate safety equipment. Minimum Approach Distances shall apply to any part of the employee's body or clothing and to anything in contact with the employees such as vehicles, tools and ladders.

9.2 Minimum Approach Distances shall not be less than the values in Table 3 below:

Table 3: Minimum Approach Distances

| Nominal Design Voltage (kV) | Minimum Approach Distance (metre) |
|------------------------------------|--|
| 400 | 8.3 |
| 220 | 5.5 |
| 132 | 4.2 |
| 66 | 2.8 |
| 33 | 2.1 |
| 11 | 1.5 |
| 0.4 | 0.5 |

Note: The above minimum approach distances have been derived by adjusting values typically used in other jurisdictions to allow for the high altitudes in many parts of Bhutan.

9.3 No person shall work within the Minimum Approach Distance of a Bare Conductor, unless (i) the conductor has first been isolated and earthed in accordance with Section 12 of this Code, or (ii) the work is being undertaken in accordance with an approved industry safety procedure, or (iii) a Safety Observer ensures the person stays well clear of the live Bare Conductor, and acts in a safe manner. The Safety Observer shall remain outside the Minimum Approach Distance at all times.

10 Work Permit

- 10.1 Licensees shall establish a Work Permit system designed to ensure the safety of employees, contractors and other personnel working on or near electrical plant or equipment controlled by the Licensee when the plant or equipment is energized or put into service. The system shall be designed to ensure that before a Work Permit is issued, measures are taken to ensure that the plant or equipment cannot be energized or put into service. These measures shall remain in place until all Work Permits issued to employees and contractors have been returned. Safety Rules shall describe the operation of the Work Permit system and the measures to be taken to ensure that plant and equipment cannot be energized while a Work Permit is in place.
- 10.2 All personnel, except those working under close supervision, who are required to work within, or close to, plant or equipment for which Work Permits are required, shall be trained in the operation of the Work Permit system.
- 10.3 Special safety precautions are necessary to protect personnel who are working on or near Medium or High Voltage Bare Conductors, since it is possible for hazardous voltages to be induced in the conductors even though the primary supply source is switched off and locked. These precautions are described in Section 12 of this Code.
- 10.4 Where equipment being worked on needs to be energized or operated for testing, Safety Rules shall provide for a Test Permit in accordance with the requirements of Section 13 of this Code.
- 10.5 Licensees shall develop their own procedures and instructions for the issue and return of Work Permits and Test Permits. However the following minimum requirements shall apply:
 - (i) All Work Permits and Test Permits for a particular generation plant or area of a transmission or distribution network shall be issued from a single location;
 - (ii) A written record shall be kept of all Work Permits and Test Permits issued. As a minimum the record shall include:
 - (a) The day and time the permit is issued;
 - (b) The name of the person to whom the permit is issued;
 - (c) The location where the work is to be carried out, the point or points of isolation and any other required safety precautions;
 - (d) The day and time the permit is returned; and
 - (e) The day and time the plant or equipment is returned to service.
- 10.6 The employee receiving a Work Permit shall inform the permit issuer once work has been completed and the equipment can be returned to service. Such information shall not be given until all men and tools are clear of the equipment and all temporary earths and other safety precautions have been removed. Following return of a Work Permit, equipment shall not be returned to service except under the instruction of the permit issuer.
- 10.7 Notwithstanding the requirements of Clause 10.6 of this Code, in situations where direct communication from the work location between the issuer of a Work Permit and the

person holding the permit is not possible, permission to return to service on completion of the work may be given at the time a permit is issued. In this case, the situation must be recorded on the written record of the permit required under Clause 10.5(ii) of this Code, and the person holding the Work Permit must advise the issuer that the plant or equipment has been reenergized as soon as reasonably possible after reenergization.

11 Test Permit

- 11.1 A Test Permit shall be issued where equipment that is being worked on must be reenergized or operated for testing before it is made available for service. A Test Permit shall only be issued if both the issuer and the recipient are satisfied that the testing can be carried out safely.
- 11.2 A Test Permit shall only be issued after all Work Permits relating to the plant to be tested have been returned to the permit issuer. Only one Test Permit on a plant item shall be issued at any time.
- 11.3 The requirements of Clause 10.5 of this Code apply to the issue of Test Permits. In addition, the documentation required under Clause 10.5(ii) shall record any special safety measures to be put in place during the period of the test.
- 11.4 The recipient of a Test Permit shall inform the permit issuer in writing once testing has been completed.

12 Isolation and Earthing

- 12.1 Prior to commencing work on de-energised Medium and High Voltage electrical equipment, isolation and earthing shall be applied to prevent hazard from causes that include but are not limited to:
 - (i) Inadvertent reconnection to the supply;
 - (ii) Interconnection with other parts of the power system or any other power system such as a back feed from a transformer;
 - (iii) Stored charge in capacitors, power cables and bushings;
 - (iv) Induction from adjacent circuits, atmospheric conditions or direct lightning strike; and
 - (v) Back feed from secondary circuits such as voltage transformers.

This may require isolation and earthing to be applied at a number of points around the equipment to be worked on, and not only at the point at which it is normally energized.
- 12.2 When disconnectors or other equipment are used to form isolation points for plant and equipment on which a work permit is to be issued, the equipment shall be:
 - (i) Locked in the open position where practicable; and
 - (ii) Tagged.

- 12.3 Earth switches or other dedicated earthing equipment shall be used where available but should not be relied on to protect a worksite unless:
- (i) The earth switch is locked in the earthed position and Tagged; and
 - (ii) The earthing equipment is visible from the work site.
- 12.4 Where the earthing point is not visible from the work site, properly designed portable earth connections shall be applied. All phase and neutral conductors shall be bonded together and connected to earth. It is not acceptable to earth only the conductor being worked on or to provide a separate earth connection for each conductor.
- 12.5 Conductors shall be proven deenergized on all phases prior to the application of portable earths to any set of conductors where an earth is not visible on those conductors at that location.
- 12.6 For work on overhead lines, portable earths shall be applied on both sides of the work location. One set of earths shall be placed as close as possible to the work site and shall be visible from it.

13 Work on Equipment Requiring Special Precautions

- 13.1 Before work starts on any power cable, it shall be identified beyond doubt before commencing work, and the person in charge of the work site shall be satisfied that safety measures have been applied to the correct cable. If positive identification is not possible the cable shall be spiked before the cable is cut or opened. Spiking shall be done using a proprietary cable spiking tool, which shall be operated in accordance with the manufacturer's recommendations.
- 13.2 Before any work (except testing) is undertaken on the windings or terminals of a distribution transformer, the transformer shall be isolated from the Medium or High Voltage supply on all phases and the Medium or High Voltage terminals shall be earthed and short circuited. The Low Voltage terminals or conductors shall also be isolated since inadvertent energization of the Low Voltage connection of a transformer can cause full line voltage to arise on the Medium or High Voltage side.
- 13.3 The secondary circuit of a current transformer shall not be open circuited while the primary side is live. The secondary terminals shall be short circuited before carrying out work on any part of the secondary circuit.
- 13.4 When working on earth or neutral conductors or connections care must be taken to avoid hazards arising from possible differences in voltage. If insulating gloves are not used, a bond should be applied across any proposed connection or disconnection before the connection or disconnection is made.
- 13.5 Metallic communication circuits that do not form part of an earth conductor but runs on the same poles, as live conductors shall be regarded as live.

14 Connection of Supply to Consumer Premises

- 14.1 A holder of a Distribution License shall not connect supply to a consumer's premises if the Licensee reasonably considers that the consumer's electrical installation is potentially hazardous.

Approved in the Ninth Commission Meeting held on March 28, 2008.