

ELECTRICAL SAFETY

Introduction

Only Designated persons shall be permitted to operate and carry out the work on electrical lines and apparatus.

No person shall be designated unless he possesses a certificate of competency or electrical work permit, issued by the Appropriate Government and his name is entered in the register.

Electrical Safety Officer

Any factory registered under Factory Act, 1948, where more than 250kW of electrical load is connected, the management of the factory shall designate a person having qualification for ensuring the observance of the safety provisions laid under the Act and the regulations made there under.

He shall periodically inspect such installation, get them tested and keep a record thereof and such records shall be made available to the Electrical Inspector if and when required.

General safety requirements, pertaining to construction, installation, protection, operation and maintenance of electric supply lines apparatus

All electric supply lines and apparatus shall be of sufficient rating for power, insulation and estimated fault current and of sufficient mechanical strength, for the duty cycle which they may be required to perform under the environmental conditions of installation.

They shall be constructed, installed, protected, worked and maintained in such a manner as to ensure safety of human beings, animals and property.

The material and apparatus used shall conform to the relevant specifications of the Bureau of Indian Standards or International Electro-Technical Commission where such specifications have already been laid down.

Cautionary Notice

A danger notice in Hindi or English and the local language of the District, with a sign of skull and bones of a design as per IS -2551 must be displayed permanently in a conspicuous position, in any installation of voltage exceeding 250V on every motor, generator, transformer and other electrical plant and equipment together with apparatus used for controlling or regulating the same.

Handling of electric supply lines and apparatus

- 1) Before any conductor or apparatus is handled, adequate precautions shall be taken, by earthing to prevent accidents to persons are working thereon.
- 2) Every person who is working on an electric supply line or apparatus or both shall be provided with tools and devices such as gloves, rubber shoes, safety belts, ladders, earthing devices, helmets, line testers, hand lines and the like for protecting him from mechanical and electrical injury .
- 3) Such tools and devices shall always be maintained in sound and efficient working condition.
- 4) No person shall work on any live electric supply line or apparatus and no person shall assist such person on such work, unless he is designated in that behalf and takes the safety precautions .
- 5) All non-current carrying metal parts of switch gear and control panels shall be properly earthed and insulating floors or mat conforming to IS-15652: 2006, of appropriate voltage level shall be provided in front of the panels for the safety of operating personnel.
- 6) All panels shall be painted with name description of its identification at front and at the rear.

Distinction of different circuits

Every generating station, sub-station, junction-box or pillar in which there are circuits or apparatus, whether intended for operation at different voltages or at the same voltage, shall have the indication of a permanent nature , so that the respective circuits are readily distinguishable from one another.

Provisions applicable to protective equipment

- (1) Fire buckets filled with clean dry sand and ready for immediate use for extinguishing fires in addition to fire extinguishers suitable for dealing with fires, shall be conspicuously marked and kept in convenient location.
- (2) The fire extinguishers shall be tested for satisfactory operation as per relevant Indian Standard at least once a year and record of such tests shall be maintained.
- (3) First-aid boxes or cupboards conspicuously marked and equipped with such contents as the State Government may specify, shall be provided.
- (4) They shall be kept in charge of responsible persons' who are trained in first-aid treatment and one of such persons shall be available during working hours.
- (5) Two or more gas masks shall be provided conspicuously and installed and maintained at accessible places for use in the event of fire or smoke.

Display of instructions for resuscitation of persons suffering from electric shock

- (1) Instructions, in English or Hindi and the local language of the District , for the resuscitation of persons suffering from electric shock, shall be displayed in a conspicuous place .
- (2) In every manned generating station, sub-station or switching station of voltage exceeding 650 V, an artificial respirator shall be provided and kept in good working condition.

Precautions to be adopted by consumers, owners, occupiers, electrical contractors, electrical workmen

All electrical installation work, including additions, alterations, repairs and adjustments, shall be carried out only by an electrical contractor licensed in this behalf by the State Government and under the direct supervision of a person holding a certificate of competency and by a person holding a permit issued or recognized by the State Government.

Periodical inspection and testing of Installations

Any installation already connected to the supply system of the supplier or trader, every such installation shall be periodically inspected and tested at intervals not exceeding five years either by the Electrical Inspector or by the supplier as may be directed by the State Government in this behalf or in the case of installations belonging to, or under the control of the Central Government, and in the case of installation in mines, oilfields and railways, by the Central Government.

Precautions against leakage before connection

- (i) All equipments shall have the insulation resistance (IR) value as stipulated in the relevant Indian Standards.
- (ii) On application of 500 V DC between each live conductor and earth for a period of one minute the insulation resistance of installation and equipment of voltage not exceeding 650 V shall be at least 1 MEGA OHM or as specified in the relevant Indian Standard.
- (iii) On application of 2.5 kV-DC between each live conductor and earth for a period of one minute, the insulation resistance, of installation and equipment of voltage exceeding 650 V but not exceeding 33 kV shall be at least 5 MEGA OHM or as specified in the relevant Indian Standard.

Conditions applicable to installations of voltage exceeding 250 Volts

(i) All conductors, other than those of overhead lines, shall be completely enclosed in mechanically strong metal casing or metallic covering which is electrically and mechanically continuous and adequately protected against mechanical damage.

(ii) Every switchboard shall comply with the following:

- (a) A clear space of not less than one meter in width shall be provided in front of the switchboard.
- (b) if there are any attachments or bare connections at the back of the switchboard, the space, if any, behind the switchboard shall be either less than twenty centimeters or more than seventy five centimeters in width, measured from the farthest protruding part of any attachment or conductor.
- (c) if the space behind the switchboard exceeds seventy five centimetres in width, there shall be a passage way from either end of the switchboard, clear to a height of 1.8 meters.

(iii) In case of installations provided in premises where inflammable materials including gases and chemicals are produced, handled or stored, the electrical installations, equipment and apparatus shall comply with the requirements of flame proof, dust tight, totally enclosed or any other suitable type of electrical fittings depending upon the hazardous zones as per the relevant Indian Standard Specifications

EARTH CONNECTION

- (i) Neutral conductor of a 3-phase, 4-wire system and the middle conductor of a 2-phase, 3-wire system shall be earthed by not less than two separate and distinct connections with a minimum of two different earth electrodes or such large number as may be necessary to bring the earth resistance to a satisfactory value.
- (ii) The earth electrodes shall be inter-connected to reduce earth resistance
- (iii) Neutral conductor shall also be earthed at one or more points along the distribution system or service line in addition to any connection with earth which may be at the consumer's premises
- (iv) The connection with earth may be provided with facility for testing local fault.
- (v) For an alternate current system, connection with earth may be with impedance, other than that required solely for the operation of switch gear or instruments, cut-out or circuit breaker.
- (vi) Alternating current systems which are connected with earth as aforesaid shall be electrically interconnected:
- (vii) Each connection with earth should be bonded to the metal sheathing and metallic armouring.
- (viii) All the equipments working with voltage exceeding 250 V but not exceeding 650 V shall be earthed by two separate and distinct connections with earth.
- (ix) Neutral point of every generator and transformer shall be earthed by connecting it to the earthing system by not less than two separate and distinct connections.
- (x) All metal casing or metallic coverings containing or protecting any electric supply line or apparatus shall be connected with earth.
- (xi) They shall be so joined and connected across all junction boxes and other openings as to make good mechanical and electrical connection throughout their whole length.
- (xii) All plug sockets shall be of the three pin type, and the third pin shall be permanently and efficiently earthed.

Earth leakage protective device

All electrical line and equipments shall be protected by an earth leakage protective device so as to disconnect the supply instantly on the occurrence of earth fault or leakage of current.

Approval by Electrical Inspector

It shall be ensured that electric supply lines or apparatus of voltage exceeding 650 V are placed in position, properly joined and duly completed and examined and the supply of electricity shall not be commenced unless with and the approval in writing of the Electrical Inspector.

Safety in use of electricity at voltage exceeding 650 Volts

- (i) a sub-station or a switching station with apparatus having more than 2000 litres of oil shall not be located in the basement where proper oil draining arrangement cannot be provided.
 - (ii) where a sub-station or a switching station with apparatus having more than 2000 litres of oil is installed, whether indoor or outdoors, a baffle wall of four hours fire rating shall be provided.
 - (iii) where adequate clearance between the units is not available, provisions shall be made for suitable oil soak pit and where use of more than 9000 litres of oil in any one oil tank, receptacle or chamber is involved, provision shall be made for the draining away or removal of any oil.
- Spare oil shall not be stored in the vicinity of any oil filled equipment in any such sub-station or switching station.

All the transformers and switch gears shall be maintained in accordance with the maintenance schedules prepared in accordance with the relevant codes of practice of Bureau of Indian Standards.

Dry type of transformers only shall be used for installations inside the residential and commercial buildings.

Without prejudice to the above measures, adequate fire protection arrangement for quenching the fire in the apparatus shall be taken.

It shall be ensured that the transformers of 10 MVA and above rating or in case of oil filled transformers with oil- capacity of more than 2000 liters are provided with fire fighting system as per IS - 3034: 1993 or with Nitrogen Injection Fire Protection system.

It shall be ensured that cable trenches inside the sub-stations and switching stations containing cables are filled with sand, pebbles or similar non-inflammable materials or completely covered with non inflammable slabs;

It shall be ensured that all apparatus shall be protected against lightning and apparatus exceeding 220 kV shall also be protected against switching over voltages.

The following protection shall be provided in all systems and circuits to automatically disconnect the supply under abnormal conditions, namely

(i) over current protection to disconnect the supply automatically if the rated current of the equipment, cable or supply line is exceeded for a time which the equipment, cable or supply line is not designed to withstand;

(ii) earth fault or earth leakage protection to disconnect the supply automatically if the earth fault current exceeds the limit of current for keeping the contact potential within the reasonable values;

(iii) gas pressure type and winding and oil temperature protection to give alarm and tripping shall be provided on all transformers of ratings 1000 kVA and above;

(iv) transformers of capacity 10 MVA and above shall be protected against incipient faults by differential protection;

(v) all generators with rating of 100 kVA and above shall be protected against earth fault or leakage;

(vi) all generators of rating 1000 kVA and above shall be protected against faults within the generator winding using restricted earth fault protection or differential protection or by both

(vii) high speed bus bar differential protection along with local breaker back up protection shall be commissioned and shall always be available at all 132 kV and above voltage sub-stations and switching stations and generating stations connected with the grid

Testing, Operation and Maintenance

(1) All apparatus, cables and supply lines shall be maintained in healthy conditions and tests shall be carried out periodically as per the relevant code of practice of the Bureau of Indian Standards.

(2) Records of all tests, tripping, maintenance works and repairs of all equipments cables and supply lines shall be duly kept in such a way that these records can be compared with earlier ones.

(3) It shall be the responsibility of the owner of all installations of voltage exceeding 650 V to maintain and to operate the installations in a condition free from danger and as recommended by the manufacturer or by the relevant codes of practice of the Bureau of Indian Standards.

In the case of star connected system with earthed neutrals or delta connected system with earthed artificial neutral point,-

(i) the neutral point of every generator and transformer shall be earthed by connecting it to the earthing system not by less than two separate and distinct connections:

Provided, that the neutral point of a generator may be connected to the, earthing system through an impedance to limit the fault current to the earth:

(ii) the generator or transformer neutral shall be earthed through a suitable impedance where an appreciable harmonic current flowing in the neutral connection causes interference, with communication circuits.

(iii) in case of the delta connected system the neutral point shall be obtained by the insertion of a grounding transformer and current limiting resistance or impedance wherever considered necessary at the commencement of such a system.

In case of generating stations, sub-stations and industrial installations of voltage exceeding 33 kV, the system neutral earthing and protective frame earthing may be, if system design so warrants integrated into common earthing grid provided the resistance to earth of combined mat does not cause the step and touch potential to exceed its permissible values.

Every earthing system belonging to either the supplier or the consumer shall be tested for its resistance to earth on a dry day during dry season not less than once a year and records of such tests shall be maintained and produced, if so required, before the Inspector.

General conditions as to transformation and control of electricity

(i) substations and switching stations shall preferably be erected above ground, but where necessarily constructed; underground due provisions for ventilation and drainage shall be made and any space housing switch gear shall not be used for storage of any materials especially inflammable and combustible materials or refuse.

(ii) outdoor sub-stations except pole type sub-stations and outdoor switching stations shall, unless the apparatus is completely enclosed in a metal covering connected with earth, the said apparatus also being connected with the system by armoured cables, be efficiently protected by fencing not less than 1.8 meters in height or other means so as to prevent access to the electric supply lines and apparatus therein by an undesignated person and the fencing of such area shall be earthed efficiently.

Clearance above ground of the lowest conductor of overhead lines

No conductor of an overhead line, including service lines, erected across a street shall be at a height of less than-

(i) for lines of voltage not exceeding 650 Volts - 5.8 meters

(ii) for lines of voltage exceeding 650 Volts but not exceeding 33 kV - 6.1 meters

Clearance from buildings of lines of voltage and service lines not exceeding 650 Volts.

(1) An overhead line shall not cross over an existing building as far as possible and no building shall be constructed under an existing overhead line.

(2) Where an overhead line of voltage not exceeding 650 V passes above or adjacent to or terminates on any building, the following minimum clearances from any accessible point, on the basis of maximum sag, shall be observed, namely:-

For any flat roof, open balcony, veranda roof and lean-to-roof-

(a) when the line passes above the building a vertical clearance of 2.5 meters from the highest point, and

(b) when the line passes adjacent to the building a horizontal clearance of 1.2 meters from the nearest point.

Protection against lightning

(1) Every overhead line, sub-station or generating station which is exposed to lightning shall adopt efficient means for diverting to earth any electrical surges due to lightning which may result into injuries.

(2) The earthing lead for any lightning arrestor shall not pass through any iron or steel pipe, but shall be taken as directly as possible from the lightning arrestor "without touching any metal part to a separate-vertical ground electrode or junction of the earth mat already provided for the sub-station of voltage exceeding 650 V .

Best Practices of Operation Control Procedures (OCPs)

- All parts of electrical installation shall be of standard construction conforming to relevant IS codes.
- Install Earth trip device at main distribution board.
- Earth all power cables.
- Ensure earthing of all electrical construction equipment at two locations on the body.
- Certified electricians shall carry out all electrical connections and wiring.
- Ensure that all extension boards have earth wire connected and only three-pin metal clad industrial type sockets are mounted on the board.
- Never draw power from a socket by inserting wires into the socket.
- Always use metal clad three pin plug tops for drawing power for electrical hand tools.
- Use only three core flexible wire for electrical hand tools. Connect earth wire properly to the body of the hand tools as well as to the plug top
- Never use earth as neutral.
- Ensure that the flexible wires and power cables are properly insulated and are laid so that the insulation does not get damaged due to activities in the vicinity.
- All cable terminations should be properly tightened.
- Cover all power cables running on surface to prevent damage due to movement of materials and vehicles.
- Install power distribution boards at different location to avoid haphazard connection of electrical
- Frequent inspection should be carried out to identify damaged insulation, loose connections, improper fuses; lack of earthing etc. and remedial action should be initiated immediately.
- Introduce permit system for electrical safety. While men are at work on electrical lines or equipment for maintenance repair, main switch should be cut off and fuses should be removed. Warning signs should be displayed on the main switch boards.

