# UTTARAKHAND POWER CORPORATION LIMITED


***SAFETY MANUAL***

***First Edition, December 2021***

**UTTARAKHAND POWER CORPORATION LIMITED**

VICTORIA CROSS VIJEYTA GABAR SINGH URJA BHAWAN

KANWALI ROAD, BALLIWALA CHOWK, DEHRADUN

UTTARAKHAND

उत्तराखण्ड पावर कारपोरेशन लि0
(उत्तराखण्ड सरकार का उपक्रम)
**Uttarakhand Power Corporation Ltd.**
(A. Govt. of Uttarakhand Undertaking)
CIN : U40109UR2001SGC025867
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# Safety Policy

UPCL accepts in full its responsibilities to implement and to comply with safety standards and will act positively to minimize the incidence of all workplace risk via our commitment to taking all reasonably practicable steps to protect the health, safety and welfare of our work force, service users and others who may be affected by our activities.

We also recognize that the effective management of safety and Integrated Safety Management is an integral part of our overall business performance and should be an integral every day part of our employee's activities. We expect therefore, that those employees and others who may visit or work on our premises, to share this commitment, by the exercise of personal responsibility in complying with company policies and procedures and to understand that they too, have legal and moral obligations to themselves and to others.

The company is committed to:

- Providing a safe working and living environment for all employees, service users and others who have access to our sites.
- Seeking continuous improvement in our safety management system, safety performance and safety culture.
- Conduct our business activities in a manner that prevents harm to people.
- Providing adequate safety instructions, supervision and information for employees whilst at work.
- Ensuring that all employees are competent to do their tasks and to provide them with adequate training to ensure their health and safety.
- Consulting with our employees on matters affecting their health and safety.
- Preventing incidents /accidents and cases of work related injuries, ill-health and disease.
- Review and update this policy as necessary

I and my fellow members of the UPCL are committed to this policy and to the implementation and maintenance of the highest standards of health and safety across the company. We expect every member of the Company to share this commitment and to work together to achieve it.

Signed .....  Date:- 31.12.2021

**(Anil Kumar)**
**Managing Director**

उत्तराखण्ड पावर कारपोरेशन लि0
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## FOREWORD

UPCL has completed over 20 years and has in this process initiated various measures aimed at improving operational, technical, financial and commercial efficiency of the organisation. It is the valuable services of the employees of UPCL which has led this organisation to the high level of regard it commands today. I congratulate every employee for bringing UPCL to where it stands.

While efficiency and effectiveness in all our processes are of prime importance, safety remains our first priority. We have to take our health and safety responsibilities very seriously. The requirements and responsibilities described within this Safety Manual must be implemented by all staff and contractors who work on behalf of UPCL.
We have done so many activities to bring awareness of safety at work places to make safety a habit. As we are aware of some occasions when our friends got injured and in some sad cases even lost their lives due to lack of awareness and practice of safety rules and procedures.

Keeping in mind the importance and priority of safety, UPCL decided to frame the safety guide lines as per CEA regulations 2010 and as directed by Hon'ble U.E.R.C. In framing the safety manual there was appreciable participation of all officers and staff and good inputs were received, for which I am thankful. In bringing the Safety Guide Lines to this shape appreciable efforts have been made by M/s Himtech Consultants Private Limited which are also acknowledged with thanks.

I appeal to every officers and employee to follow the safety rules and procedures of the company for the sake of safe working and happy long life. I hope the Safety Manual will go a long way in educating the employees on safety and will help in achieving high standards of safety.

Date:- 31.12.2021

**(M.L. Prasad)**
**Director(Operation)**

# DO's and DON'T FOR ELECTRICITY SAFETY:

**Do's:**

1. **DO** obey safety instructions given by the person in-charge.
2. **DO** obey all statutory rules and regulations in force for Line Clear (L/C) Requisition/Issue/Return of UPCL.
3. **DO** place safety tagging or other warning boards on main switch before commencing work.
4. **DO** always treat circuit as live until you have proved them to be dead, the insulator of the conductor may be defective.
5. **DO** thoroughly discharge to earth all cables before working.
6. **DO** use correct size and quality of fuse wire while replacing the blown out fuse.
7. **DO** keep away inflammables from electrical apparatus.
8. **DO** place rubber mats in front of electrical switchboard.
9. **DO** turn your face away whenever an arc or flash occurs.
10. **DO** ensure controlling switches are opened & locked or fuse holders are withdrawn before working on lines.
11. **DO** insulate yourself from earth by standing on rubber mat while attempting to get in contact with live line or apparatus.
12. **DO** work deliberately and carefully. Haste causes many accidents. Be sure of what you are doing.
13. **DO** ensure all portable appliances are provided with 3 pin plug and socket connections. Also the metal work of the apparatus is effectively grounded.
14. **DO** remove the casualty from the cause, render CPR, first aid, if applicable, and send for doctor or take the casualty to the nearest hospital.
15. **DO** report all accidents whether minor or major, fatal or non-fatal, departmental or non-departmental, related to the organization, immediately to the In-charge and he/she has to report the appropriate authorities in ladder including the Safety Cell of UPCL.

**DON'Ts:**

1. **DO NOT** work, being DRUG ADDICTED AND ALCOHOLIC.
2. **DO NOT** replace a blown fuse until you are satisfied with the cause and you have rectified the irregularity in the related system.
3. DO NOT connect single pole switch or fuse in a neutral circuit, but always connect in the live or phase wire.
4. DO NOT close any switch, unless you are familiar with the circuit which it controls and know the reason for its being open.
5. DO NOT work on energized circuits without taking extra precautions, such as use of rubber gloves and gauntlets. DO not use metal case flash light around apparatus which is energised.
6. DO NOT use wire with poor insulation and joints.
7. DO NOT work on pole or an elevated position if there is a live part on it, without the safety belt and rubber gloves and unless the authorised person stands on the ground nearby to direct operation and give warning.
8. DO NOT allow visitors and un-authorized person to touch or handle electrical apparatus or come within the danger zone of high voltage apparatus.
9. DO NOT disconnect earthing connection or make ineffective the safety gadgets installed on mains and apparatus unless you are sure or instructed by the appropriate authority.
10. DO NOT touch circuit with bare fingers.
11. DO NOT touch an electric circuit when your hands are wet, or bleeding from a cut or an abrasion.
12. DO NOT disconnect a plug by pulling flexible cable when the switch is on.
13. DO NOT use fire extinguisher on electrical equipment unless it is of proper class and desired for use for that purpose.
14. DO NOT throw/inject water on live electrical equipment in case of fire.
15. DO NOT touch the body of electrical shock victim. Push him with a piece of dry wood.
16. DO NOT discontinue artificial respiration until recovery or death is confirmed by the Doctor.
17. DO NOT trust luck, but trust safety.
18. DO NOT joke while working on any equipment live or dead. Joke begins in fun and ends in death.

# AMENDMENT SHEET

Amendment details if any:

| Amendment | | Discard | | Insert | | Notes on Amendments |
|---|---|---|---|---|---|---|
| No. | Date | Section No. | Rev. No. | Section No. | Rev. No. | |
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# CHAPTER 1:

# SAFETY PROVISIONS AND REGULATIONS

The history of Uttarakhand Power Corporation Limited (UPCL) can be traced back to erstwhile U.P. State Electricity Board (UPSEB).The State of U.P. was bifurcated by enforcement of U.P. Reorganization Act, 2000 (In short Reorganization Act) as a result there of the State of Uttarakhand came into existence. UPCL was incorporated under the Companies Act, 1956 on 12-02-2001. As per the mandate of Electricity Act, 2003, UPCL has been entrusted with the work of distribution of electricity in the State and is committed to provide continuous and quality power to all categories of consumers in Uttarakhand.

Safety procedures and practices are essential in electrical works. Basic approaches to electrical works from the point of view of ensuring safety which include inbuilt safety in procedures such as permit to work system, safety instructions and safety practices. It is essential that safety should be preached and practised in all times in the operation, maintenance and installations.

**STATUTORY PROVISIONS PERTAINING TO SAFETY**

Brief of relevant acts, rules and standards to be abided are quoted below:

## 1.1 ELECTRICITY ACT, 2003[1]

**A. Section 53: (Provisions relating to safety and electricity supply):**

Provision related to safety of supply- The Authority may in consultation with the State Government, specify suitable measures for-

(a) Protecting the public (including the persons engaged in the generation, transmission or distribution or trading) from dangers arising from the generation, transmission or distribution or trading of electricity, or use of electricity supplied or installation, maintenance or use of any electric line or electrical plant.

(b) Eliminating or reducing the risks of personal injury to any person, or damage to property of any person or interference with use of such property.

(c) Prohibiting the supply or transmission of electricity except by means of a system which conforms to the specification as may be specified.

(d) Giving notice in the specified form to the Appropriate Commission and the Electrical Inspector, of accidents and failures of supplies or transmissions of electricity.

(e) Keeping by a generating company or licensee the maps, plans and sections relating to supply or transmission of electricity.

(f) Inspection of maps, plans and sections by any person authorised by it or by Electrical Inspector or by any person on payment of specified fee.

(g) Specifying action to be taken in relation to any electric line or electrical plant, or any electrical appliance under the control of a consumer for the purpose of eliminating or reducing the risk of personal injury or damage to property or interference with its use.

**B. Section 73. (Functions and duties of Authority):**

The Authority shall perform such functions and duties as the Central Government may prescribe or direct, and in particular to-

a) Advise the Central Government on the matters relating to the national electricity policy, formulate short-term and perspective plans for development of the electricity system and co-ordinate the activities of the planning agencies for the optimal utilisation of resources to sub serve the interests of the national economy and to provide reliable and affordable electricity for all consumers.
b) Specify the technical standards for construction of electrical plants, electric lines and connectivity to the grid.
c) Specify the safety requirements for construction, operation and maintenance of electrical plants and electric lines.
d) Specify the Grid Standards for operation and maintenance of transmission lines.
e) Specify the conditions for installation of meters for transmission and supply of electricity.
f) Promote and assist in the timely completion of schemes and projects for improving and augmenting the electricity system.
g) Promote measures for advancing the skill of persons engaged in the electricity industry.
h) Advise the Central Government on any matter on which its advice is sought or make recommendation to that Government on any matter if, in the opinion of the Authority, the recommendation would help in improving the generation, transmission, trading, distribution and utilisation of electricity.
i) Collect and record the data concerning the generation, transmission, trading, distribution and utilisation of electricity and carry out studies relating to cost, efficiency, competitiveness and such like matters.

j) Make public from time to time the information secured under this Act, and provide for the publication of reports and investigations.

k) Promote research in matters affecting the generation, transmission, distribution and trading of electricity.

l) Carry out, or cause to be carried out, any investigation for the purposes of generating or transmitting or distributing electricity.

m) Advise any State Government, licensees or the generating companies on such matters which shall enable them to operate and maintain the electricity system under their ownership or control in an improved manner and where necessary, in co-ordination with any other Government, licensee or the generating company owning or having the control of another electricity system.

n) Advise the Appropriate Government and the Appropriate Commission on all technical matters relating to generation, transmission and distribution of electricity.

o) Discharge such other functions as may be provided under this Act.

**C. Section 177 (Powers of Authority to make regulations)**

The Authority may, by notification, make regulations consistent with this Act and the rules generally to carry out the provisions of this Act namely suitable measures relating to safety and electric supply under section 53.

## 1.2 CENTRAL ELECTRICITY AUTHORITY NOTIFICATION [2] & [3]

In exercise of the powers conferred by section 177 read with clause (c) of section 73 of the Electricity Act, 2003 (36 of 2003), the Central Electricity Authority framed the regulations:

1. Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010.

2. Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines) Regulations, 2011.

The brief description of the regulations framed are us under:

**A. Measures relating to Safety and Electric Supply Regulations, 2010.**

Some of the important clauses worth mentioning are as follows:

1. Clause No 3-Designating person(s) to operate and carry out the work on electrical lines and apparatus.

2. Clause No. 4- Inspection of designated officers and other safety measures by Electrical Inspector.
3. Clause No. 6- Safety measures for operation and maintenance of electric plants.
4. Clause No. 7- Safety measures for operation and maintenance of transmissions, distribution systems.
5. Clause No. 12- General Safety requirements pertaining to construction, installation, protection, operation and maintenance of electric supply lines and apparatus.
6. Clause No. 13- Service lines and apparatus on consumer's premises.
7. Clause No. 14- Switchgear on consumer's premises.
8. Clause No. 15- Identification of earthed and earthed neutral conductors and position of switches and switchgear therein.
9. Clause No. 16-Earthed terminal on consumer's premises.
10. Clause No. 17- Accessibility of bare conductors.
11. Clause No. 18- Danger Notices.
12. Clause No. 19- Handling of electric supply-lines and apparatus.
13. Clause No. 24-Distinction of different circuits.
14. Clause No. 25- Distinction of the Installations having more than one feed.
15. Clause No. 26- Accidental charging.
16. Clause No. 27- Provisions applicable to protective equipment.
17. Clause No.28- Display of instructions for resuscitation of persons suffering from electric shock.
18. Clause No.29- Precautions to be adopted by consumers, owners, occupiers, electrical contractors, electrical workmen and suppliers.
19. Clause No. 30- Periodical inspection and testing of Installations.
20. Clause No. 31- Testing of consumer's installation.
21. Clause No. 33- Precautions against leakage before connection.
22. Clause No. 34-Leakage on consumer's premises.
23. Clause No. 35- Supply and use of electricity.
24. Clause No. 36- Provisions for supply and use of electricity in multi-storeyed building more than 15 meters in height.
25. Clause No. 37-Conditions applicable to installations of voltage exceeding 250 Volts.
26. Clause No. 39-Precautions against failure of supply and notice of failures.

27. Clause 40 to Clause 42- Chapter V- Safety provisions for electrical installations and apparatus of voltage not exceeding 650 volts.
28. Clause 43 to Clause 54- Chapter VI- Safety provisions for electrical installations and apparatus of voltage exceeding 650 volts.
29. Clause 55 to Clause 77- Chapter VII- Safety provisions for overhead lines, underground cables and generating stations.

**B. Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines Regulations, 2011.**

Some of the important clauses and schedules worth mentioning are as follows:

1. Clause No. 4- Safety provisions relating to Owners.
2. Clause No. 5- Preparation of Safety Manual.
3. Clause No. 6- Safety officer and safety committee.
4. Clause No. 7- Safety provisions relating to contractor.
5. Clause No. 8- Reporting of accidents
6. Clause No. 9- Emergency management plan.
7. Clause No. 10- Medical facilities.
8. Clause No. 11- Safety training and awareness.
9. Schedule I- Minimum contents of safety manual for construction of electrical plants and electric lines
10. Schedule II- Minimum contents of safety manual for operation and maintenance of electrical plants and electric line.
11. Schedule III- Elements of on-site emergency management plan for electrical plants and electric lines.

Note: Details of the clauses have been mentioned in the manual at appropriate places.

# CHAPTER 2:

# TERMINOLOGY

2.1 The terms used in this manual shall be interpreted in the most commonly accepted sense consistent with the electrical industry.

a) ACT: "Act" means the Electricity Act, 2003.

b) **AUTHORIZED PERSON:** One who is authorized to perform specific duties under certain conditions or who is carrying out order from competent authority and as defined under clause 3 of Chapter II of CEA (Measures relating to Safety and Electric Supply) Regulations, 2010.

c) **AUTHORISED LINE STAFF:** One who receives salary and other benefits from the company from time to time and authorized by competent engineer to work at licensee's distribution system.

d) **CONNECTED LOAD:'** Connected' load means the sum of the ratings of the electricity consuming apparatus connected to consumer's installation.

e) **CUT OUT:** 'Cut out' means any appliance for automatically interrupting the transmission of electricity through the conductor when the current rises above a pre -determined amount, and shall also include fusible cut-out.

f) **DANGER:** "Danger" means danger to health or danger to life or any part of body from shock, burn or other injury, to persons or property or from fire or explosion, attendant upon the generation, transmission, transformation, conversion, distribution or use of electricity.

g) **DEAD:** 'Dead' means at or about earth potential and disconnected from any live system. Provided that the apparatus separated from a live conductor by a spark gap shall not be deemed to be 'Dead'.

Note: The term 'Dead' is used only with reference to current carrying parts, when these parts are not alive.

h) **EARTH:** 'Earth' means a conducting mass of earth or of any conductor in direct electrical connection therewith.

i) **EARTHED:** 'Earthed' means connected to earth in such a manner as it will ensure immediate discharge of electrical energy without danger at all times.

j) **EARTHING SYSTEM**: Earthing system means an electrical system in which all the conductors and appliances are earthed.

k) **EMERGENCY:** 'Emergency' for the purpose of this code means an unusual condition which exists that endangers life and/or property.

l) **EMPLOYEE:** 'Employee' means a person who is in receipt of pay, salary and other benefits from the company time to time in lieu of services rendered.

m) **FOREMAN:** 'Foreman or supervisor' shall mean Junior Engineer/Line Man, the authorized employee directly in charge of workmen doing the work regardless of title.

n) **GUARDED:** "guarded" means covered, shielded, fenced or otherwise protected by means of suitable casings, barrier, rails or metal screens to remove the possibility of dangerous contact or approach by persons or objects to a point of danger.

o) **HAZARD:** It is an unsafe act or unsafe condition that may lead to injury of persons or damage to property.

p) **INSTALLATION:** "installation" means any composite electrical unit used for the purpose of generating, transforming, transmitting, converting, distributing or utilizing electricity.

q) **INTRINSICALLY SAFE:** "intrinsically safe" as applied to apparatus or associated circuits shall denote that any sparking that may occur in normal working is incapable of causing explosion of inflammable gas or vapour.

r) **ISOLATED:** It means physically disconnected from all possible sources of supply.

s) **LIGHTENING ARRESTOR:** 'Lightning arrestor' means a device which has the property of diverting to earth any electrical surge of excessively high amplitude applied to its terminals and is capable of interrupting flow current if present and restoring itself thereafter to its original operating conditions.

t) **LIVE:** 'Live' means electrically charged.

u) **MESH VOLTAGE:** The maximum touch voltage within a mesh of a ground grid.

v) **NEUTRAL CONDUCTOR:** "neutral conductor" means that conduct of a multi-wire system, the voltage of which is normally intermediate between, the voltages of the other conductors of the system and shall also include return wire of the single phase system.

w) **PERMIT ISSUING PERSON:** 'Permit issuing Person' is a person who is authorized for ensuring that all controlling switches and circuits have been isolated, made dead and inoperative and that adjacent circuits have been made safe for the work to be carried out and who is authorized to issue the 'Permit to work'.

x) **PERMIT TO WORK:** 'Permit to work' means a form of affirmation issued by one authorized person to another authorized person for a work to be carried out on or adjacent to any electrical apparatus, mains or service lines in normal and breakdown conditions.

y) **QUALIFIED:** 'Qualified' means any person who has adequate knowledge of the hazards involved in any operation.

z) **SAFETY DEVICES:** 'Safety devices' means devices such as rubber gloves, rubber gauntlets, line hose, rubber boots or other insulating devices, which are especially designed for the protection of workmen and includes fire extinguishers also.

aa) **SPAN:** "span" means the horizontal distance between two adjacent supporting points of an overhead conductor.

bb) **STEP VOLTAGE:** The difference in surface potential experienced by a person bridging a distance of one meter between two feet without containing any other grounded objects.

cc) **SUPPLIER: "Supplier"** means any generating company or licensee from whose system electricity flows into the system of another generating company or licensee or consumer.

dd) **TOUCH VOLTAGE:** The potential difference between the ground potential rise (GPR) and the surface potential at the point where a person is standing while at the same time having a hand in contact with a grounded structure.

ee) **TRANSFERRED VOLTAGE:** It is a special case of the touch voltage where a voltage is transferred into or out of the substation from or to a remote point external to the substation site.

ff) **UNSAFE CONDITIONS:** Dangerous conditions, hazardous conditions, defective conditions or unusual conditions that could be conducive to accidents.

gg) **WORKING PARTY:** It means the persons under the immediate supervision of an Authorised Person.

hh) **LOW VOLTAGE:** Where the normal voltage is not greater than 250 Volts and in no circumstances exceeds 263 Volts.

ii) **MEDIUM VOLTAGE**: Where the normal voltage exceeds 250 Volts but is not greater than 650 Volts and in no circumstances exceeds 683 Volts.

jj) **HIGH VOLTAGE:** Where the normal voltage exceeds 650 Volts but is not greater than 33,000 Volts and in no circumstances exceeds 37,125 Volts.

kk) **EXTRA HIGH VOLTAGE:** Where the voltage exceeds 33,000 Volts under normal conditions subject to 12.5% variation.

# CHAPTER 3:

# SAFETY ORGANISATION AND RESPONSIBILITY ASSIGNMENT IN UPCL

Clause 5 of CEA (Measures Relating to Safety and Electric Supply) Regulations 2010 stipulates that all distribution companies shall designate an electrical safety officer for ensuring observance of safety measures specified under these regulations in their organisation, for construction, operation and maintenance of power stations, sub stations, transmission and distribution lines. The eligibility regarding qualification, experience and responsibilities are given in sub-clause 2 and 3.

Success in implementation of safety policy in the company lies in assigning clear responsibility for safety and health. Clear assignment of responsibility as described here in after will allow each employee to know what activities and behaviours are expected of him, rather than assumption or miss interpretation of what he needs to do. Unless it is explicitly understood, it will not be possible to establish accountability for the implementation of the safety policy.

## 3.1 SAFETY COMMITTEE

Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010, Clause 5 stipulates that:

I. All suppliers of electricity including generating companies, transmission companies and distribution companies shall designate an Electrical Safety Officer for ensuring observance of safety measures specified under these regulations in their organisation for construction, operation and maintenance of power stations, sub-stations, transmission and distribution lines.

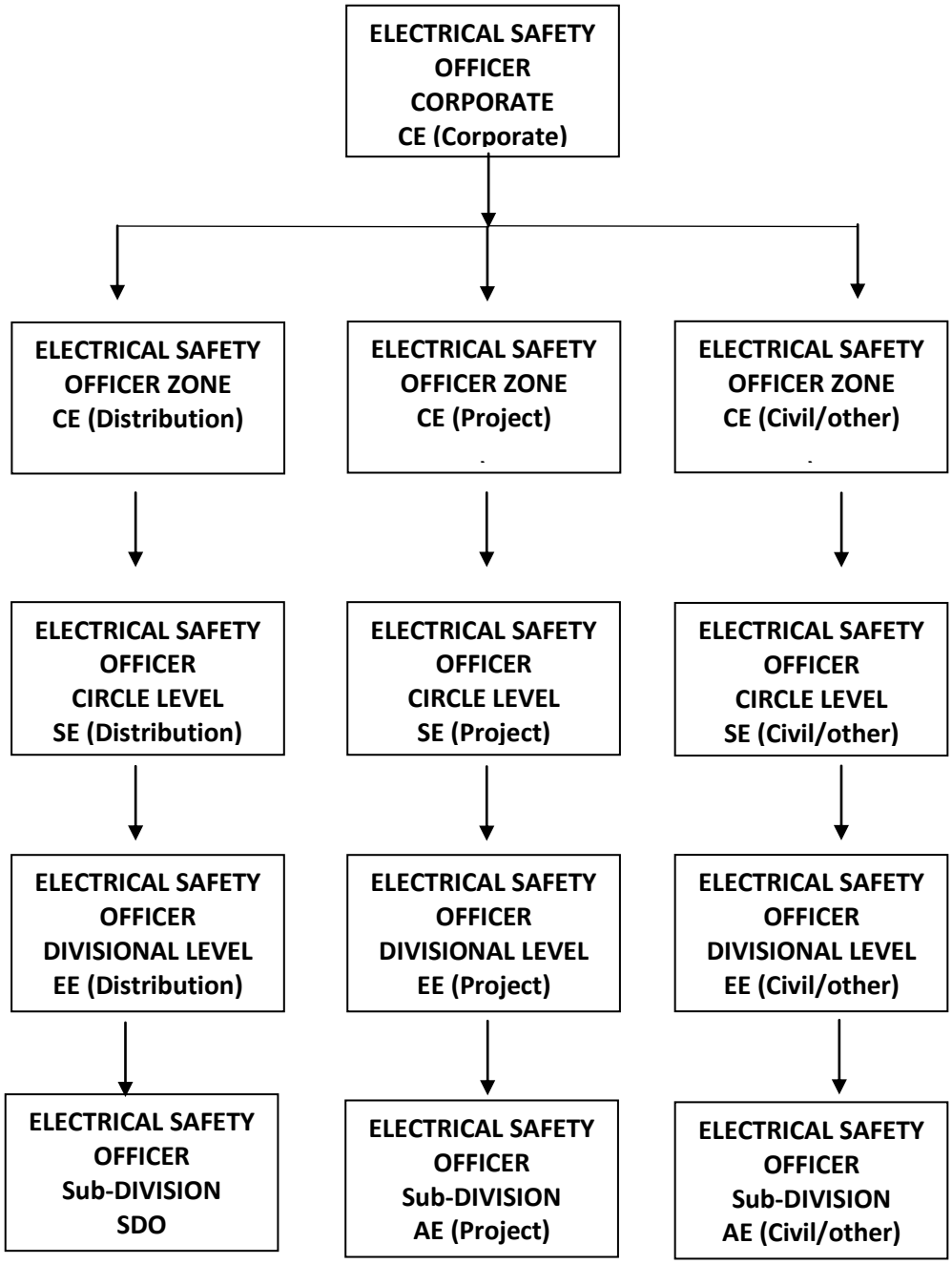
II. The Electrical Safety Officer shall be an Electrical Engineering degree holder with at least ten years of experience in operation and maintenance of electricity plants or an Electrical Engineering Diploma holder with at least fifteen years of experience in operation and maintenance of electric plant.

III. The Electrical Safety Officer designated under sub-regulation (I), shall ensure periodic inspection of such installations, get them tested and keep a record thereof and such records shall be made available to the Electrical Inspector if and when required.

For effective implementation of the safety practices to avoid accidents, the Safety Committee shall be formed at corporate level, zonal level, circle level, division level and sub-division level to campaign the safety of the employee, consumer and general public, to develop training module and imparting safety training to the employees which also includes the tools/ equipment's to be provided to the JE's, line men for effective usage of tools and plants.

1. Safety Committee shall meet once in a month to review the adoption of safety practice at all field work levels.
2. Safety committee shall ensure availability of all safety equipment/tools with the linemen and Section Officers.
3. Safety Committee shall ensure availability of Safety Manuals in all the sections.
4. The Safety Committees shall ensure imparting Safety Training to all the employees.
5. The Safety Committee shall also review whether periodical testing of safety equipment is done or not and ensure proper working condition of the safety equipment.
6. Safety Committees shall review the identification of hazardous and dangerous installations, Division wise, and the necessary recommendation for rectification to be carried out.
7. Will ensure that Safety Audit is carried out annually against each Substation. Safety Committee will appoint Safety Auditor.
8. Will ensure standard prescribed uniform code is being adhered by line staff.

**SAFETY STRUCTURE:-**




Having assessed the various activities in the company, task to be accomplished by each department is described below.

### 3.2 Corporate Office:

The corporate office will designate an officer of the rank of Chief Engineer who shall be the Electrical Safety Officer at the corporate level and his responsibilities shall be as under:

1. Promote a safe and healthy culture throughout the company.
2. Participate in the development and approval of health & safety policy and procedures.
3. Consider the practical implementation of this policy as a management function, at least, equal in importance to commercial or financial arrangements.
4. Ensure that the needed financial, material and personnel resources are provided to achieve the goals and objectives of safety and health programme.
5. Ensure that the programme is fully implemented and effective.
6. Ensure all personnel working under their control receive suitable and sufficient training which shall enable them to understand and discharge their health and safety duties.
7. Review each accident and conduct any investigation where in an accident has resulted in serious injury or property damage.
8. Ensure the companies compliance with all applicable central & local safety and health requirements.
9. Set a personal example by visiting operational sites and offices, raising the profile and demonstrating commitment to health and safety at work.
10. Promote safety & health and serve as a resource to all staff.
11. Near miss incidents are to be analysed scrupulously not for any repetition.
12. Ensure that safety/ health surveys are conducted in their organisation on regular basis with frequency of six months.

### 3.2 Zonal Office:

All the CZE'sor officers assigned by them shall act as Electrical Safety Officers of the respective zones and they shall:

1. Ensure that each element of programme is implemented within the periphery of the zone.
2. Ensure that all circles and down below up to JE/Lineman in the jurisdiction comply with the programme.
3. Ensure that all required documents as required by various statutory authorities are maintained.
4. Ensure that compliance with the health and safety policy and business procedures is a compulsory requirement of employment.

5. Reporting on matters relating to the management of health and safety to the Chief Executive and briefing the Board as appropriate.
6. Ensure that safety/ health surveys are conducted in their respective zones on regular basis with frequency once per quarter.

### 3.3 Circle Office:

All the SE's or the officers assigned by them shall act as Electrical Safety Officers of the respective circles and they shall:

1. Ensure that safety/health surveys are conducted in his/her circle on regular basis, with frequency once per month.
2. Ensure that each equipment in the jurisdiction of circle is properly maintained.
3. Ensure that each Division, S/D substation (substation & line maintenance) up to JE/Line man and employees comply with the programme.
4. Ensure that PPE (Personal protective equipment) are made available to respective employees.
5. Get the work permit and safety formats, pamphlets printed and supply to all the field units under their control.

### 3.4 Divisional Office:

All the Executive Engineers shall act as Electrical Safety Officers of the respective divisions and they shall:

1. Ensure that each employee in his/her division receives appropriate training upon initial assignment, and later on the changes in the process, procedures, equipment or assignment.
2. Ensure that each Engineer (Asst. Engineer / Jr. Engineer) and employee in his/her division complies with the programme.

### 3.5 Subdivision Level:

All the SDO's /AE's shall act as electrical safety officers of the respective sub-division and they shall:

1. Ensure that each employee receives refresher training whenever required by law, changed procedures or whenever circumstances indicate the need for training.

2. Ensuring suitable and sufficient risk assessments have been carried out and appropriate control measures are in place and are maintained.
3. Conduct a daily safety and health inspection of his/her work area.
4. Ensure that each workmen and engineer of the S/S or Line must attend the mock Safety, Fire & First Aid drill and this should be recorded in the register.
5. Ensured that all documents pertaining to safety are maintained at each sub-station and at Junior Engineer level.

### 3.6 Junior Engineer Level:

1. Ensure safe working conditions.
2. Ensure use of necessary equipment.
3. Ensure that tools and equipment's are properly maintained.
4. Ensure that work is carried out in a proper planned and safe manner.
5. Ensure that the special and general safety measures to be taken by the workmen.
6. Ensure that necessary corrective steps to be taken in violation of any safety rules observed or reported to them.
7. Ensure that periodic inspections of construction, operation and maintenance equipment, work areas, conditions and methods from safety point of view should be made by them as these are essential to prevent fires and accidents.
8. Ensure that maintenance of all the equipment's shall be carried out as per the maintenance schedule recommended by the Original Equipment Manufacturer (OEM).

### 3.7 Each Employee:

1. Be an active participant in the safety and health programme.
2. Perform all the tasks in accordance with established policies, procedures and safe work practices.
3. Question any unsafe and unhealthy practice, procedure or condition and act to correct and report it.
4. Inspect all the tools/equipment, prior to use, to identify any hazard. Also preserve those in a prescribed manner so that they can be the best friends at your workplace.
5. Report any injury/injuries, illness or accident to the appropriate authority.

# CHAPTER 4:

# EARTHING

Earthing System is essential for every stage of electricity generation, transmission and distribution. The objective of safe grounding system is to provide easy and shortest path to flow of fault as well as lightning currents without adversely affecting equipment's and continuity of service. It is also necessary to ensure that safety to the operating personals is provided against danger of electric shock.

**DEFINITIONS:**

**DEAD: -** The term used to describe a circuit/ equipment to indicate that a voltage is not applied.

**EARTH GRID: -** A system grounding electrodes consisting of inter connected connectors buried in the earth to provide a common ground for electrical devices and metallic structures.

**EARTH MAT: -** A grounding system formed buy the grid horizontally buried conductors/ plate and which serves to dissipate the earth fault to earth and also as equipment bonding conductor system.

**LIVE PART: -** A conductor or conductive part intended to be energised in normal use including a neutral conductor.

**NEUTRAL CONDUCTOR**: - A conductor connected to the neutral point of a system and capable of contributing to the transmission of electrical energy.

## 4.1 OBJECTIVES OF EARTHING-

The objectives of safe grounding are-

a) Persons in the vicinity of earthed structures and installations shall not be exposed to the dangers of electrical shocks.

b) To design and construct system that is capable to carry current under normal and fault conditions to the ground.

c) The earth plate should be capable of handling magnitude and duration of current as per the over-current protection of the system without any fire or flash or explosion.

## 4.2 CLASSIFICATIONOF EARTHING-

Earthing can be classified as under:

A. **Working Grounding/ Neutral Earthing**: It is done to reduce the voltage stresses due to switching and lightening surges and to control the fault currents to satisfactorily values.
B. **Protective Earthing**: When the insulation of electrical equipment fails, its enclosure becomes live and the person feels a shock if he or she contacts its enclosures. In order to guarantee the enclosures of all the equipment's are to be grounded.
C. **Lightning Protection Earthing**: In order to provide safety from lightning to human beings and power system this type of earthing is done by providing surge lightning and other lightning protection arrestors which are connected with the grounding systems.
D. **Functional Earthing**: The functional earth is used for interference suppression. It is a low impedance current path between the circuitry and earth and is only used to improve the equipment's performance and not for protective purposes. Functional earth should be established for the low frequency and the high frequency range. At the low frequency range the most important factors for a satisfactory functional earth are the cross section area of the earthing cable and the cable length to ensure a minimum over-all cable impedance. At the high frequency range a short cable length, high outer conductor surface (skin effect) and low inductance are important.

## 4.3 GUIDELINES FOR EARTHING-

A- Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010, clause 41, Connection with Earth stipulates that the following conditions shall apply to the connection with earth of systems at voltage normally exceeding 125 V but not exceeding 650 V:

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 both at the generating station and at the sub-station.
ii. The earth electrodes so provided, 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. In the case of a system comprising electric supply lines having concentric cables, the external conductor of such cables shall be earthed by two separate and distinct connections with earth.

v. The connection with earth may include a link by means of which the connection may be temporarily interrupted for the purpose of testing or for locating a fault.

vi. In the case of an alternating current system, there shall not be inserted in the connection with earth any impedance, other than that required solely for the operation of switchgear or instruments, cut out or circuit breaker and the result of any test made to ascertain whether the current, if any, passing through the connection with earth is normal, shall be duly recorded by the supplier.

vii. No person shall make connection with earth by the aid of, nor shall he keep it in contact with, any water mains not belonging to him except with the consent of the owner thereof and of the Electrical Inspector.

viii. Alternating current systems which are connected with earth as aforesaid shall be electrically interconnected: Provided that each connection with earth is bonded to the metal sheathing and metallic armouring, if any, of the electric supply lines concerned.

ix. The frame of every generator, stationary motor, portable motor and the metallic parts, not intended as conductors of all transformers and any other apparatus used for regulating or controlling electricity and all electricity consuming apparatus of voltage exceeding 250 V but not exceeding 650 V shall be earthed by the owner by two separate and distinct connections with earth.

x. 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.

xi. All metal casing or metallic coverings containing or protecting any electric supply line or apparatus shall be connected with earth and 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:

Provided that conditions mentioned in this regulation shall not apply where the supply voltage does not exceed 250 V and the apparatus consists of wall tubes or brackets, switches, ceiling fans or other fittings, other than portable hand lamps

and portable and transportable apparatus, unless provided with earth terminal and to class-II apparatus and appliances.

Provided further that where the supply voltage is not exceeding250 V and where the installations are either new or renovated, all plug sockets shall be of the three pin type, and the third pin shall be permanently and efficiently earthed.

xii. All earthing systems shall:

a. Consist of equipotential bonding conductors capable of carrying the prospective earth fault current and a group of pipes, rods and plate electrodes for dissipating the current to the general mass of earth without exceeding the allowable temperature limits as per relevant Indian Standards in order to maintain all non-current carrying metal works reasonably at earth potential and to avoid dangerous contact potentials being developed on such metal works.

b. Limit earth resistance sufficiently low to permit adequate fault current for the operation of protective devices in time and to reduce neutral shifting.

c. Be mechanically strong, withstand corrosion and retain electrical continuity during the life of the installation and all earthing systems shall be tested to ensure efficient earthing, before the electric supply lines or apparatus are energised.

xiii. All earthing systems belonging to the supplier shall in addition be tested for resistance on dry day during the dry season not less than once every two years.

xiv. A record of every earth test made and the result thereof shall be kept by the supplier for a period of not less than two years after the day of testing and shall be available to the Electrical Inspector when required.

B. Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010, clause 48, Connection with earth for apparatus exceeding650 Volts stipulates that:

1. All non-current carrying metal parts associated with an installation of voltage exceeding 650 V shall be effectively earthed to a grounding system or mat which shall:-

   i. Limit the touch and step potential to tolerable values.

ii. Limit the ground potential rise to tolerable values so as to prevent danger due to transfer of potential through ground, earth wires, cable sheath, fences, pipe lines, etc.

iii. Maintain the resistance of the earth connection to such a value as to make operation of the protective device effective.

2. 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.

      Provided further that in the case of multi-machine systems neutral switching may be resorted to for limiting the injurious effect of harmonic current circulation in the system.

   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.

3. 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.
4. Single phase systems of voltage exceeding 650 V shall be effectively earthed.
5. In the case of a system comprising electric supply lines having concentric cables, the external conductor shall be connected with earth.
6. Where a supplier proposes to connect with earth an existing system for use at voltage exceeding 650 V which has not hitherto been so connected with earth, he shall give not less than fourteen days' notice in writing together with particulars of

the proposed connection with earth to the telegraph-authority established under the Indian Telegraph Act, 1885 (13 of 1885).

7. Where the earthing lead and earth connection are used only in connection with earthing guards erected under overhead lines of voltage exceeding 650 V where they cross a telecommunication line or a railway line, and where such lines are equipped with earth leakage, the earth resistance shall not exceed twenty five ohms and the project authorities shall obtain No Objection Certificate (NOC) from Railway Authorities and Power and Telecommunication Co-ordination Committee before energization of the facilities.
8. 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 Electrical Inspector.

## 4.4 STATUTORY PROVISIONS FOR EARTHING

A. Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010 stipulates:

**1. Clause 15-Identification of earthed and earthed neutral conductors and position of switches and switchgear therein:**

Where the conductors include an earthed conductor of a two wire system or an earthed neutral conductor of a multi-wire system or a conductor which is to be connected thereto, the following conditions shall be complied with:

i. An indication of a permanent nature shall be provided by the owner of the earthed or earthed neutral conductor, or the conductor which is to be connected thereto, to enable such conductor to be distinguished from any live conductor and such indication shall be provided:

   a. Where the earthed or earthed neutral conductor is the property of the supplier at or near the point of commencement of supply.
   b. Where a conductor forming part of consumers system is to be connected to the suppliers earthed or earthed neutral conductor at the point where such connection is to be made.
   c. In all other cases at a point corresponding to the point of commencement of supply or at such other points as may be approved by an Electrical Inspector.

ii. no cut-out, link or switch other than a linked switch arranged to operate simultaneously on the earthed or earthed neutral conductor and live conductors shall be inserted or remain inserted in any earthed or earthed neutral conductor of a two wire-system or in any earthed or earthed neutral conductor of a multi-wire system or in any conductor connected thereto.

Provided that the above requirement shall not apply in case of –

a. A link for testing purposes.
b. Switch for use in controlling a generator or transformer.

**2. Clause 16-Earthed terminal on consumer's premises:**

i. The supplier shall provide and maintain on the consumer's premises for the consumer's use a suitable earthed terminal in an accessible position at or near the point of commencement of supply.

Provided that in the case of installation of voltage exceeding 250 V the consumer shall in addition to the a fore mentioned earthing arrangement, provide his own earthing system with an independent electrode. Provided further that the supplier may not provide any earthed terminal in the case of installations already connected to his system on or before the date to be specified by the State Government in this behalf if he is satisfied that the consumer's earthing arrangement is efficient.

ii. The consumer shall take all reasonable precautions to prevent mechanical damage to the earthed terminal and its lead belonging to the supplier.

iii. The supplier may recover from the consumer the cost of installation on the basis of schedule of charges published by him in advance and where such schedule of charges is not published the procedure laid down in regulation 63 shall apply.

**B. AS PER CODE OF PRACTICE FOR EARTHING IS 3043-1987:**

a) All medium voltage equipment shall be earthed by two separate and distinct earth connections.

b) As far as possible, all earth connections shall be visible for inspection.

c) Each earth system shall be so designed that testing of individual earth electrode should be possible.

d) Resistance of earth system shall conform to degree of shock protection desired.

## 4.5 SAFETY PRECAUTIONS FOR EARTHING

The following precautions shall be used to the extent applicable and possible:

a) Examine earthing devices periodically and always prior to their use.
b) Use only earthing switches or any other special apparatus where provided for earthing.
c) Verify that the circuit is dead by means of discharging rod. The indicator itself should first be tested on a live circuit or proving unit before and after the verification.
d) Earthing should be done in such a manner that the persons doing the job are protected by earth connections on both sides of their working zones.
e) All the three phases should be effectively earthed though work may be proceeding on one phase only.

## 4.6 TEMPORARY EARTHING [8]:

This section covers the detailed procedures for providing temporary earths for the protection of workmen and property while carrying out operation and maintenance works on the already existing lines or construction of new lines.

### 4.6.1 Temporary Earths:

Temporary earths are those applied at the actual location of the work during repair or construction of installations for the protection of workmen and property.

Following features of temporary earthing equipment shall be kept in view by persons using it: Earthing devices shall be of approved types, comprising properly designed clamps attached to insulated sticks of sufficient lengths to enable the clamps to be securely clamped to the conductors being earthed without an employee's hand approaching closer than the mini- mum safe working distances. Each such line clamp is to be connected by a flexible copper earthing lead or of equivalent copper section of aluminium cable to an adequate earth clamp or other device for attaching to a permanent connection or to a temporary earthing spike. The earthing should be connected to clean rust free nut bolts of tower/ Earthing Electrodes. All earthing jumpers shall be of annealed bare and stranded copper equivalent aluminium conductor. Earthing leads for use at sub-stations and lines for use at sub-stations and lines shall have a cross-section of at least 0.645 Sq.cm. (0.1sq.inch) copper equivalents.

Electrodes for installation of temporary earths shall be of iron or steel rods at least1.905 cm. (3/4") in diameter and 1.524 Mts. (5 ft.) in length. These shall have clear metal surfaces free from rust or any coating of paint or any other poor conducting material and be driven to a depth of at least 0.914 meters (3 ft.) in a spot considered to give good earth.

Grounding cable/ earth wire used for earthing shall be examined by the authorised line staff every time before use.

### 4.6.2 General Precautions to be taken in connection with the application of temporary earths

a) No electric apparatus or line shall be earthed until all reasonable precautions have been taken to ensure that it has been disconnected from all sources of supply.
b) The connections for earthing of an apparatus or line shall be applied or removed only by competent persons.
c) Earthing leads shall be connected to the system before being secured to the conductors.
d) Earthing leads shall not be applied in any cell or compartment in which there is an exposed live conductor.
e) When it is necessary to cut a line, bus bar or loop or to repair a broken conductor or damaged loop, earths shall be placed on both sides of the work.
f) Before working on underground cables, they shall be disconnected from the source of energy, discharged and then earthed. To discharge them, use an earthed wire and make contact with it to each terminal in turn repeatedly.
g) When removing earthing leads they shall be disconnected from the line conductors first and the earth system last. The removal shall be carried out in are verse order to that adopted for the connection of various conductors to earth.
h) All works on dead circuits shall be done between two sets of temporary earths.
i) Earths shall never be attached or removed with bare hands. Rubber gloves, gauntlets or approved protective equipment shall always be used.
j) In so far practicable, the person applying the earths on poles and structures shall maintain his position below the level of conductors to be earthed in order

to keep the body away from any arc that may occur when the earthing device is applied.

k) No temporary earths shall be removed from the equipment while the work is in progress.

l) Employees shall not touch any conductors from which protective earths have been removed.

m) Earthing of one conductor does not render other conductors safe for work. All phases shall be earthed even if work is to be carried out only on one phase.

### 4.7 EARTHING OF SUBSTATION [4]& [11]:-

Earthing is an important aspect of every sub-station. The earthing installations required at sub-station are as below:

a) The neutral points of each separate electricity system which has to be earthed at the substation.

b) Apparatus framework or cladding or other non-current carrying metalwork associated with each system, for example, transformer tanks, power cable sheaths.

c) Extraneous metalwork not associated with the power systems, for example boundary fences, sheaths of control or communication cables.

For safety, the objective of earth bonding is to ensure that, in normal or abnormal conditions, any voltage appearing on equipment to which there is access should be below a dangerous level. It is not practicable to ensure that metal parts are earthed and remain near true earth potential during the passage of earth fault currents, particularly on high voltage systems with directly earthed neutrals. The objective should, therefore, be to provide effective bonding of low impedance and adequate current-carrying capacity between parts with which anyone may be in simultaneous contact, and to arrange, as far as possible, that large fault currents do not flow between such points.

To minimize risk of damage to certain auxiliary plant, the rise of potential of a station earthing installation above the potential of true or remote earth should be as low as practicable, since this potential will be applied across protective insulation of any plant with connections to earth external to the substation, for example, plant with connections to pilot or telephone cables or cable sheaths. For similar reasons, the potential difference between earthed points in the station should also be kept to a

minimum. Where surge protection is provided, the connection of the protective devices to earth should be as direct as possible. The discharge of high currents with high-frequency components requires earth connections of low resistance and reactance, that is, short connections with as few changes of direction as possible.

Where the neutral points of two electrically separate electricity systems are connected to a common earth electrode system at a site, there is a coupling of the systems in the event of an earth fault occurring on either system by virtue of the rise of earth potential due to the passage of the fault current through the earth electrode system. Similarly, if non-current carrying metalwork is bonded to the same earth electrode as the neutral point of the supply the metalwork will experience the same rise of earth potential. If complete separation of electrical systems were required, it would be essential that the neutral points of each system and its associated metalwork be separately earthed. If such a method were adopted, each earthing system would require insulation from other earthing systems to withstand the maximum rise of earth potential occurring in any system by virtue of lightning currents or power system fault currents. Insulation to this level is rarely practicable.

The choice of using a common earth or separate earths for the system of different voltages at a transforming point affect:

a) The probability of breakdown occurring in a transformer between the higher and lower voltage sides due to lighting or other surges.

b) The safety of consumers or their property supplied by any low voltage system distributed from the station against a rise of potential of the earthed neutral by a high voltage system earth fault at the station.

The former risk is reduced by use of a common earth system, and the latter danger only arises if the resistance of the earth electrode system is not sufficiently low to limit the rise of earth potential to a safe value. There is advantage in using a common earth where the earth electrode resistance, including the parallel resistance of any bonded metalwork etc, to earth is 1 Ω or less, as is usual at power stations, large outdoor substations or substations supplying a network of cables whose sheaths have a low impedance to earth.

In the substation earth system rise of potential will not be excessive if the resistance of the earth electrode system is small compared to the total earth fault circuit impedance.

Systems of higher voltage (66 kV and above) generally have the neutral directly earthed, since the increase in costs of insulation that would be required for the transformer winding would be considerable.

The requirements are, therefore, best considered separately for substations:

a) Where low voltage is confined to auxiliary supplies within the substation.

b) Substations that provide an external low voltage supply.

c) Power stations.

**4.8 EARTHING OF OVERHEAD LINES:**

Clause 72 of Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010 clause 72 stipulates that:

a) All metal supports, all reinforced and pre-stressed cement concrete supports of overhead lines and metallic fittings attached thereto shall be permanently and effectively earthed. For this purpose a continuous earth wire shall be provided and securely fastened to each pole and connected with earth ordinarily at three points in every kilometre, the spacing between the points being as nearly equidistance as possible. Alternatively, each support and the metallic fitting attached thereto shall be efficiently earthed.
b) Metallic bearer wire used for supporting insulated wire of low and medium voltage overhead service lines shall be efficiently earthed or insulated.
c) Each stay wire shall be similarly earthed unless insulator has been placed in it at a height not less than 3.0 meters from the ground.

**4.9 Permissible Current through a Human Body during Fault**

Humans are quite sensitive to AC currents ranging from 50-60 Hz. The effects of the AC current going through a human body depend on the magnitude, duration and also frequency. The threshold of perception for the human body is about 1 mA. Currents between 1-6 mA, often called let-go currents, usually do not impair a person from controlling his muscles and releasing the energised object they were holding. Higher currents ranging from 9-25 mA can cause pain and affect the muscle control so that the energized object is hard if not impossible to release. Still higher currents between 25-75 mA can affect breathing and may cause fatality. If the current is even higher, it could result in ventricular fibrillation of the heart, which if not treated quickly, can result in

death. When currents reach 100 mA and higher, above the ventricular fibrillation level, it can cause burns, heart paralysis and inhibition of breathing.

### 4.10 Importance of high-speed fault clearing

Considering the significance of fault duration in term implicitly as an accident exposure factor, high-speed clearing of ground faults is advantageous for two reasons:

I. The probability of exposure to electric shock is greatly reduced by fast fault clearing time, in contrast to situations in which fault currents could persist for several minutes or possibly hours.
II. Tests and experience show that the chance of severe injury or death is greatly reduced if the duration of current flow through the body is very brief.

To meet above requirements, normally the earthing system comprising of an earthing mat is buried at suitable depth below the ground and is provided with ground rods at suitable points. All non-current carrying parts of the equipment in substation are connected to this grid so as to ensure that under fault conditions none of these parts are at higher potentials than the grid. Grounding rods perform the function of maintaining low values of impedance under all weather conditions which is particularly important where system earth fault currents are heavy. Under normal condition their contribution is insignificant.

Modern power sub-stations use number of sensitive electronic equipment's for instrumentation control and data processing. These equipment have to work satisfactorily in an environment with abundant sources of electrical noise. The earthing system of electronic equipment is necessary for the safety of authorized line staff and equipment.

In every sub-station, provisions for earthing of the following are necessary:

I. The neutral point of transformers of each separate system should have an independent earth, which in turn should be interconnected with station grounding mat.
II. Equipment framework and other non-current carrying parts.
III. All extraneous metallic frameworks not associated with equipment (structures, sub-stations, building etc.)
IV. Lightning arrestors should have independent earth, which should in turn be connected to station ground mat.

Earthing of sub-station fence is also equally important from view point of touch and step potentials in the area outside the fence. Normally earth mat has to be extended upto 2m beyond the fence so as to ensure that the area in the vicinity of substation fence is safe if somebody happens to touch it.

Earthing in the substation must conform to the requirements of Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010.

Earthing system has to be designed to have low overall impedance to earth and a current carrying capacity consistent with fault current. The factors which affect the design are:

I. Magnitude of fault current.
II. Duration of fault current.
III. Ground resistivity.
IV. Resistivity of surface material.
V. Shape and size of grid.
VI. Parallel impedance.
VII. Material of earth electrode.

The fault current affects the design in two ways. It determines conductor's dimensions due to its current carrying capacity and it may also influence the mesh width.

As the voltage gradients at ground surface are also dependent on ground resistivity, it can also have influence on grid configuration. The overall resistance of grounding grid is also dependent on ground resistivity.

In order to economize, currently mild steel (MS) is used in earth mat in our country. To take care of the corrosion etc. some extra margin is provided in the size of earthing strip.

### 4.11 Earthing material and method of reducing earth resistance:

1. Once the layout of sub-station and earth mat design are finalized, laying of an earth mat is taken up according to the design. 60 cm deep trenches are dug for laying the earth strip. The trenches are then filled with low resistivity material i.e Black Cotton soil free from stone. The filling should be watered and carefully rammed. The main constituents of an earth mat are:
   I. Mild Steel Strips (M.S).
   II. Cast Iron Pipes (C.I).

III. Sodium Chloride (common salt) and charcoal.

IV. RCC rings around cast iron pipes (electrodes).

2. In general, as a standard practice M.S Strip of 75x10 mm or 50x8 mm size is used. Sometimes 40 mm dia. MS rods are also used. The size is decided after considering allowance for corrosion.
3. Cast iron pipe is used as electrode. Its length is normally 3000 mm and dia is 150 mm. It has got perforations of 16 mm in a cross zone manner so as to allow seepage of water to soil around it.
4. The joints of earth mat shall be riveted, brazed, bolted or welded. For rust protection, the welds should be treated with Barium Chromate. Welded surface should be painted with red lead and aluminium paint in turn and afterwards coated with Bitumen. Joint in earthing conductor between switchgear units and cable sheath, which may be required to be opened subsequently, should be bolted and joint faces be tinned. All joints in steel earthing system should be made by welding except the points for separating the earth mat for testing purpose which should be bolted. These joints should be accessible and frequently supervised. All exposed steel conductor should be protected with bituminous paint.
5. Switchyard areas are usually covered with about 10mm thick gravel layer or crushed stone which increases safety of authorized line staff. Crushed stone or gravel has high resistivity. By spreading such material in switchyard, high touch potential area avoided on the surface and thus do not reach equipment and flashover, short circuit due to reptiles are avoided. This also avoids formation of oil pools in case of leakages from the oil filled equipment. Last but not the least, growth of weeds is controlled in switchyard areas. This entails the provision of service roads for the movement of vehicles etc. required for carrying the equipment from switchyard to service bay.
6. Material which are added to the soil to reduce the soil resistivity are as follows:
    I. Sodium Chloride (NaCl), coke and sand are the most common, popular and economical materials which are used to bring down the earth resistivity of the soil.
    II. Aluminium sulphate is another chemical equivalent to sodium chloride, but it is slightly costlier.
    III. Other effective chemicals like Magnesium Sulphate (MgSO4.7H2O), Calcium Chloride (CaCl2) and Potassium Chloride (KCl) when mixed bring down the resistivity of the soil. These chemicals are ten times costlier than aluminium

sulphate and more than ten times costlier then sodium chloride. As such, choice is preferably limited to sodium chloride or aluminium sulphate but mostly the former one.

IV. Bentonites clay, which has a property of holding moisture, is another chemical at our disposal but it is used in high resistivity soil only.

### 4.12 Earthing of Gas Insulated Sub-Stations:

General consideration of GIS Earthing:

a. All the cables should be shielded and earthed.
b. Cables with separate function should be routed in separate cable trunks.
c. Star point of CT, PT is to be formed at one point only this will avoid galvanic coupling of current from earthing to the control cable core.
d. All metallic enclosures should normally operate at ground voltage level.
e. All enclosures of GIS should be earthed at several points to the earth bus through the base frames of the GIS. All conduits and cable sheaths should be earthed to earth bus available in control cubicles and marshalling boxes.
f. Spacing of the earth mat in the GIS may be adjusted as per manufacturer recommendations. It should be bonded with floor reinforcement for better performance of transient high frequency signals. Similarly all earthing risers should be bounded to floor reinforcement.
g. Shielded cables should be earthed at one end only.
h. To avoid circulation of enclosure current beyond regular path, power cable sheath should be earthed directly without involving the enclosure in the earth path. To facilitate this isolation design of cable termination should be such that on isolating air gap as proper insulating elements are provided.
i. Proper care should be taken to ensure that CT mounted on GIS do not carry the enclosure return current.
j. Wherever there are discontinuities in enclosure/ change in the medium e.g at cable terminals at transformer connection, special care should be taken to limit very fast transient over voltages and to prevent circulating currents in circuit breakers and transformer tanks.
k. GIS cable terminations and other discontinuities in the enclosure are significant sources of transient earth potential, rise phenomenon. The isolation between the directly earthed power cable sheath and the enclosure may give rise to transient potential rise phenomenon.

## 4.13 REMOVING THE EARTH CONNECTIONS:

On completion of work, removal of the earthing devices shall be carried out in the reverse order to that adopted for placing, that is, the end of earthing device attached to the conductors of the earthed mains or apparatus shall be removed first and the other end connected to the earth shall be removed last. The conductor shall not be touched after the earthing device has been removed from it.

# CHAPTER 5:

## SAFETY DOCUMENT (PERMIT TO WORK)

CEA Regulation regarding safety requirement for construction, operation and maintenance of electrical plants and electric lines regulation 2011, Clause 4 stipulates that:

1. The owner shall make safety an integral part of the work processes to ensure safety for employees including employees of contractors, sub-contractors as well as visitors.

2. The owner shall set up a sound and scientific safety management system.

Safety is ensured by following certain well defined policies, procedures and methods during construction, operation and maintenance. The objective of safety documentation system is to ensure that written instructions and guideline are available and are to be followed.

Safety document system is an essential part of safety Management by following safety Rules/Procedures and precautions so that the safety is ensured.

These Rules/Procedures and precautions are documented and the documents are issued by the shift in charge with strict instructions to be followed up at appropriate stage (with the signature and seal).

These safety documents are also useful in investigation of an accident.

Following are the written documents to be maintained by the sub-station in charge.

1. Permit to Work book.
2. Electrical Inspector permission for charging the sub-station.
3. Authorisation chart/register.
4. Office record.
    a. Log book, Log sheet.
    b. Site test report of equipment's and lines.
    c. Factory Test Reports of equipment's.
    d. Tripping Register.
    e. Equipment maintenance Register/Maintenance schedules/Safety Audit.
    f. Inspection register/ Record.

## 5.1 BRIEF OF STATUTORY PROVISIONS

**I. As per Regulation 43 of CEA (Measures Relating to Safety and Electric Supply) Regulations 2010.**

Before making an application to the Electrical Inspector for permission to commence or recommence supply after an installation has been disconnected for six months and above at voltage exceeding 650 V to any person, the supplier shall ensure that electric supply lines or apparatus of voltage exceeding *650* V belonging to him are placed in position, properly joined and duly completed and examined and the supply of electricity shall not be commenced by the supplier for installations of voltage needing inspection under these regulations unless the provisions of regulations 12 to 29, 33 to 35, 44 to 51 and *55* to 77 have been complied with and the approval in writing of the Electrical Inspector has been obtained by him.

**II. Authorisation Chart as per Regulation 3 and 4 of CEA (Measures Relating to Safety and Electric Supply) Regulations 2010.**

The supplier or consumer, or the owner, agent or manager of a mine, or the agent of any company operating in an oil-field or the owner of a drilled well in an oilfield or a contractor referred to on sub-regulation (1) shall maintain a register where in the names of the designated persons and the purpose for which they are engaged, shall be entered. No person shall be authorised unless he possesses a certificate of competency or electrical work permit issued by Appropriate Government.

**III. As per Regulation 30 of CEA (Measures Relating to Safety and Electric Supply) Regulations 2010.**

The periodical inspection and testing of installations of voltage above 650 V belonging to the supplier, shall also be carried out at intervals not exceeding five years by the Electrical Inspector.

**IV. As per sub-regulation 1, 6 and 7 Regulation 46 of CEA (Measures Relating to Safety and Electric Supply) Regulations 2010.**

**Sub-clause 1**. Before approval is accorded by the Electrical Inspector under regulation 43 the manufacturer's test certificates shall, if required, be produced for all the routine tests as required under the relevant Indian Standards.

**Sub-clause 6**. Records of all tests, tripping, maintenance works and repairs of all equipment's cables and supply lines shall be duly kept in such a way that these records can be compared with earlier ones.

**Sub-clause 7**. It shall be the responsibility of the owner of all installations of voltage exceeding 650 V to maintain and 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.

**V. As per Regulation 13 of CEA (Measures Relating to Safety and Electric Supply) Regulations 2010.**

i. The supplier shall ensure that all electric supply lines, wires, fittings and apparatus belonging to him or under his control, Which are on a consumer's premises are in a safe condition and in all respects fit for supplying electricity and the supplier shall take precautions to avoid danger arising on such premises from such supply lines, wires, fittings and apparatus.

ii. Service lines placed by the supplier on the premises of a consumer which are underground or which are accessible shall be so insulated and protected by the supplier as to be secured under all ordinary conditions against electrical, mechanical, chemical or other injury to the insulation.

iii. The consumer shall as far as circumstances permit take precautions for the safe custody of the equipment on his premises belonging to the supplier.

iv. The consumer shall also ensure that the installation under his control is maintained in a safe condition.

**VI. As per Regulation 14 of CEA (Measures Relating to Safety and Electric Supply) Regulations 2010.**

i. The supplier shall provide a suitable switchgear in each conductor of every service line other than an earthed or earthed neutral conductor or the earthed external conductor of a concentric cable within a consumer's premises in an accessible position and such switchgear shall be contained within an adequately enclosed fireproof receptacle.

ii. Every electric supply line other than the earthed or earthed neutral conductor of any system or the earthed external conductor of a concentric cable shall be protected by suitable switchgear by its owner.

**VII. As per Regulation 17 of CEA (Measures Relating to Safety and Electric Supply) Regulations 2010.**

Where bare conductors are used in a building the owner of such conductors shall:

a. Ensure that they are inaccessible.
b. Provide in readily accessible position switches for rendering them dead whenever necessary.
c. Take such other safety measures as are specified in the relevant Indian Standards.

**VIII. As per IS 5216 Part 1 Sr No. 4**

a) All messages and instructions relating to the operation of switches and other important communication concerning the work shall be recorded in the register of Messages.
b) The issue of permit shall be entered in the log book or log sheet either in red ink or should be under lined.

## 5.2 INTRODUCTION TO PERMIT SYSTEM [9]

The "Permit to Work & Safety Tagging System (PTW & STS)" is the process to put in place standard working practice which will promote a culture of safe working among its personnel while carrying out any work in electrical equipment/ system. This in turn will ensure safety of personnel, safety of equipment and safety of society at large. It is to be emphasized that these are intended for the safety of the personnel themselves and their observance will be in their own interest.

This document defines the process of obtaining a permit to work on a certain electrical equipment of UPCL and also puts in place the usage of relevant "Tags" to designate the electrical equipment under maintenance.

### 5.2.1 PERMIT AND ISSUANCE OF PERMIT TO WORK

'Permit to work' means a form of declaration signed by and given by one authorized person to another authorized person in-charge of work to be carried out on or adjacent to any electrical apparatus, mains or service lines, for the purpose of making known to such latter person exactly what apparatus, mains or service lines are made dead and earthed and safe for working.

No employee of the company shall climb any pole, tower or apparatus or work in proximity of an open conductor or work on the distribution lines and equipment's unless the person or in charge of the work has necessary permit to work.

### 5.2.2 AUTHORISATION

1. An Authorised person shall be:
    a) A permit issuing person not below the rank of a Junior Engineers/SSO.
    b) A competent employee authorized in writing by a responsible Officer not below the rank of an Executive Engineer, to carry out specific duties incidental to the position held by him in accordance with clause 7 mentioned below.
2. No person shall be deemed to be authorized unless the same has been entered in the list maintained at the Office of the authorizing Officer and the entry has been attested by the person so authorized.
3. A list of authorized persons shall be maintained at the Office of the respective Executive Engineers and at each centre of activity i.e. 33/11 KV substations by the respective Assistant Engineers. The list shall clearly define the extent of all such authorization. Such list shall be furnished to the respective Electrical Inspector on demand.
4. As per clause 7 Chapter- II of CEA Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010:
    a) Engineers or supervisors in operation and maintenance of the distribution system shall hold diploma in Electrical, Mechanical, Electronics and Instrument Engineering.
    b) The technicians to assist Engineers and supervisors shall possess a certificate in appropriate trade.
    c) Engineers, supervisors and Technicians engaged for operation and maintenance of distribution systems, electric plants should have successfully undergone the type of training as specified in Schedule-ll.
    d) UPCL shall arrange for training of their personnel engaged in the operation and maintenance of distribution system in his own institute or any other institute recognized by the Central Government or State Government.

5. Authorised person for taking shutdown for LT and 11 KV lines will be JE/Line man level and for 33 KV and above will be AE/JE.
6. Duties to be performed only by an Authorized person are:-
    a) Issue and receipt of permits for working on transmission lines, distribution lines, service lines, underground cable, and all equipment installed in the Generating Stations, Receiving Stations, Sub-stations, Distribution System etc.
    b) Discharging permits issued under (a) above.
    c) Operating air break switches/ACB/MCCB/VCB/SF6 CB/TPMO/Isolators when alive.
    d) Replacement of fuses on H.T. sides of transformers.
    e) Work on live equipment's, or live lines, where the voltage to earth does not exceed 250 volts AC or DC like renewal of street bulb, renewal of aerial fuse, cut-outs, fuses and consumer fuses, renewal of L.T. fuses of transformer and L.T. feeders.
    f) Testing consumer's installations and effecting service of L.V. installations.
    g) Repairing or connecting L.T. equipment such as meters, time switches, etc.
    h) Possession of keys / switches / kiosks /RMUs / Isolators and equipment.
    i) Inspection, testing and maintenance work.

### 5.2.3 ISSUE OF PERMIT TO WORK

1. Before any work or testing is carried out on live mains and apparatus connected to distribution system, a 'Permit-to-work' in the prescribed form covering the apparatus and mains to be worked on or tested must be issued, except in exceptional circumstances such as for the purpose of saving life or plant in the event of any emergency. In such cases, the action taken is reported to the concerned Executive Engineer without the least delay.
2. The issue of the 'Permit-to-work' form by the Permit Issuing person to the authorized person gives the line clear and authority for the JE/ line man to proceed with the work. The Permit Issuing person shall issue the safety tools along with the work permit (if required) where working on electric lines and equipment's is envisaged and shall also ensure that the materials issued are

returned back along with the 'Permit-to-work'. The JE/ Line man shall keep in his possession the 'Permit-to-work' form throughout the duration of the work.

3. If for any reasons, the pre-arranged shutdown work cannot be completed within the period applied for, intimation will be given to the Permit Issuing person and duration of permit, extended suitably on the permit Form. For pre-arranged shutdowns publication of shutdown in the newspaper is must.
4. In the case of work on consumer's installations, the consumers should be advised of such extensions, sufficiently in advance to avoid inconvenience.
5. When written permits cannot be given, line clear should be given and taken over the Phone. In such cases substances thereof shall be repeated by the person who receives the line clear message and shall be confirmed by the sender to ensure that both parties are quite clear as to its purpose. Such instructions shall be recorded only in the line clear permit books/log books at both sending and receiving ends with a code under intimation to next higher officer properly recorded.
6. Duplicate copies of the line clear shall be shared as soon as possible for record.

### 5.2.4 SPECIAL INSTRUCTIONS TO PERMIT ISSUING PERSONS

The Permit Issuing Person shall not issue the permit before:-

a) The switch/circuit breakers (all types) /Isolators (and also OCB where provided) or switches have been opened and are completely isolated on both sides, links and fuses opened, apparatus and mains discharged and earthed, and all adjacent live parts adequately protected. Where possible the switches/Isolators shall be locked out and keys kept in safe custody. Isolators/switch at control panels shall also be fixed with ‘HOLD’, ‘LINE CLEAR ISSUED’ boards.

Where the OCB mentioned above are controlled remotely, additional danger boards shall be hung at control switch handles also. Control circuit fuses of the control panels shall also be removed and kept in the custody of the issuer of permit.

The transformer shall be effectively discharged both on the LT and HT terminals by means of discharge grounding rods, which shall be left in position till the permit is returned.

b) "HOLD BOARDS", "MEN WORKING", "DO NOT CLOSE" and 'MEN ON LINE' boards should be attached to apparatus.

c) An entry is made in the log sheet or Register to the effect that the apparatus and mains under the permit have been made dead, on no account shall the apparatus and mains again be made alive until the return by the JE/Supervisor of the 'Permit-to-Work'.

d) The Permit Issuing Person shall take necessary steps in the circumstances to ensure that while energizing and in the event of any tripping of automatic switch / circuit breaker, such switch / circuit breaker shall not be re-closed until the section/apparatus is thoroughly checked.

e) When different permits are issued to work on same lines, the Permit Issuing person shall make cross referencing of the permit to work issued in each permit to work. In no case the switch/circuit breakers/Isolators be put back in service till all the permit to work issued for same line are returned.

### 5.2.5 SPECIAL INSTRUCTIONS TO SUPERVISORS (JE/ Line man)

1. No employee shall be ordered or permitted to carry out any work, other than that for which he is specially, authorized in writing by the Executive Engineer/ Designated persons as per Chapter II, clause 3 of CEA (measures relating to safety and Electricity Supply) Regulation, 2010.
2. The authorized person termed the Supervisor in charge of a working party (employees) shall keep with him a complete list of all persons who are detailed to work on the particular job. All other persons shall be warned to keep away from the area and no one shall be allowed to enter the area unless under a permit. This list shall be kept on record for any further reference.
3. The Supervisor, before allowing any Workmen to commence work on the lines, mains or apparatus shall:
    a) Explain to the workmen the nature of work and the precautions taken by the Permit Issuing Person, to ensure the safety of the workmen and also the precautions to be taken by them during the whole time, when the work is in progress.
    b) Satisfy himself that the switch or switches Isolators controlling the mains and apparatus have been isolated, discharged, properly earthed and

tested with a discharge rod and that caution or Danger Notice have been placed at conspicuous places.

c) Warn the workmen and the public of the danger that exist in the vicinity of the area covered by the 'Permit-to-work'.

d) Create a safety zone by short circuiting together all the conductors and adequately earthing on either sides of the place of work.

### 5.2.6 TRANSFER OF PERMIT TO WORK FORM

1. Transfer of permit-to-work from one Supervisor to another, is strictly prohibited except in special circumstances. If there is more than one working party, separate permits should be issued to the Supervisor in charge of each working party and a written record should be kept of the number of such permits issued for each work. In such cases a cross-reference of shut down issued earlier may be mentioned in the work permit form.
2. If work is of such a nature and duration and in special circumstances only, that it has to be carried out continuously, but under the supervision of more than one Supervisor on shift duty, the 'Permit to-work' form shall be endorsed by the Permit Issuing Person, cancelling the name of the Supervisor to whom it was originally issued and substituting the name of the second or subsequent Supervisor to whom the permit will now become valid. The time of each endorsement should be noted on the 'Permit-to' Work' form and it's duplicate.

### 5.2.7 ISSUE AND RECEIPT OF 'PERMIT-TO-WORK' BY THE SAME PERSON

In cases where the same person who has to issue the permit, has also to carry out the work covered by the permit, a 'Permit-to-Work' form shall be issued on himself before he undertakes the work and the form should be subsequently cancelled after the work is completed.

### 5.2.8 CANCELLATION OF 'PERMIT-TO-WORK' FORMS

1. 'Permit-to-work' form issued to the Supervisor shall be returned to Permit Issuing Person only after all the works are complete and earth removed so that the apparatus, mains and overhead lines are safe in all respects for charging and after all the workmen are withdrawn from the working area and are suitably

warned that it is no longer safe to touch or approach the apparatus within the said area.

2. Under no circumstances shall any work be attempted after the return of the 'Permit-to-work' form duly discharged. A fresh permit shall be obtained for completing the balance of work subsequently.
3. The return of the 'Permit-to-work' form duly discharged will authorize the permit issuing officer, to resume normal operation.
4. The Supervisor will not allow his staffs to disperse before the permit issuing person has tested the apparatus and advice the Supervisor that he has found the apparatus/ line is satisfactory for commissioning, so as to avoid any unforeseen difficulties in re-commissioning the apparatus and lines.

### 5.2.9 MAINTENANCE OF 'PERMIT-TO-WORK' AND APPLICATION FORPREARRANGED SHUT DOWN BOOKS

1. A duplicate of every 'Permit-to-work' and application for 'Pre-arranged Shutdown' shall be retained in the Office of the permit issuing person for at least 4 months after issue.
2. The books should be treated as important record. The sheet and the books themselves should be serially numbered. No page should be detached or used for any but bona fide work.
3. If any paper is inadvertently detached or found to be missing, a detailed and initiated statement must be then and there recorded in the book by the Permit Issuing Person.

### 5.2.10 REGISTER OF MESSAGE

1. All messages and instructions to issue of permit to work, the operation of switches, and other important communication shall be recorded in the strict sequence in the log sheet and Register of messages maintained by the person responsible for the operation of power supply i.e distribution system.
2. The JE/SSO responsible for the issue of permit to work shall record all messages and instructions relating to the operation of switches / circuit break / isolator and other important communication concerning the work, in a register of message maintained by him for the purpose.
3. The final issue or return of permit shall be logged in the book in ink underlined when change of shift occur during the pendency of permit, the outgoing permit issuing person shall inform his reliever about the existence of all permits, and

show him the relevant entries. The incoming Permit Issuing Person shall also sign in the log book while taking over charge to acknowledge that he has noted the pendency of the permits.

## 5.3 GENERAL SAFETY PRECAUTIONS:

All voltages shall be considered dangerous even though it may not be high enough to produce serious shock.

1. All electrical circuits are to be treated as live and no work (maintenance, repairs, cleaning) is to be carried out on any part of electrical apparatus or circuit unless such parts are:

   (a) Dead

   (b) Isolated and all practicable steps taken to lock off from live conductors.

   (c) Efficiently connected to earth between such points and points of work.

   (d) Released for work by issue of permit.

   (e) By checking that equipment for its de-energised condition.

2. On some hazardous work it is not desirable for one man to work alone. The JE/Lineman shall determine when additional men are needed to protect workmen against accidents or to render assistance in case of unforeseen circumstances.

3. On especially hazardous jobs where close clearance or difficult working conditions are encountered, an observer may be required. On any job which in the opinion of the JE/ Lineman requires an observer, the JE / Lineman or a man appointed by him will act as an observer. The observer should not engage in any activity that the JE / Lineman consider will interfere with the duty of the observer.

4. Under no circumstances shall an employee hurry or take un-necessary chances when working under hazardous conditions; neither shall he attempt to perform hazardous work when extremely tired or exhausted.

5. Employees must use the Standard protective equipment intended for each job.

6. Only experienced persons shall be permitted to go behind guardrails or to clean around energized or moving equipment.

7. Employees working in an elevated position should use a suitable safety belt or other adequate means to guard against falling.

8. Telephone conductors and ground wires of lightning arresters, though they may be at or near ground potential are liable to develop high-induced voltage under fault conditions. Suitable precautions should be taken when working on or near such circuits.
9. Do not depend upon insulation of cables for safe working.

### 5.3.1 SAFETY PRECAUTION FOR WORK IN SUB STATION

#### 5.3.1.1 Substation layout diagram and equipment numbering:

1. A list should be prepared and put at a prominent place in the sub-station Control Room showing all essential safety equipment to be maintained.
2. The numbering and identification of sub-station equipment and bus arrangement should be standardized and used consistently. All equipment's shall have number and identification according to the scheme only. The numbering in the switchyard and in the control panels should be same to avoid possibility of any misunderstanding. The single line diagram in the control room shall have same numbering arrangement and should be as per SCADA nomenclature.
3. Single line schematic diagram (SLD) of the sub-station shall be put up in the control room at prominent position. The SLD should indicate the bus and feeder arrangements with all associated equipment in the Sub-station. The single line diagram shall be updated for any change/ addition in the sub-station.

### 5.3.2 SAFETY MEASURES FOR MAJOR EQUIPMENTS

#### 5.3.2.1Safety measures for Power Transformers of more than 1 MVA [9]

A. All transformer installations shall comply with the provisions of IS 1646: 1982 in addition to the following:
   1. As a protection against excessive damage due to occurrence of faults, transformers fitted with conservators shall be protected with Buchholz Relay.
   2. All transformers shall be equipped with oil temperature alarms or excess current relay protection.
   3. The bushings, insulators, and contacts of taps changing gears shall be kept scrupulously clean at all times.
4. The level and dielectric strength of the transformer oil shall be checked at periodic intervals, and in the event of presence of a large quantity of sludge the oil shall be renewed.

B. In addition to the usual cable clamps above floor level, cables shall also be clamped immediately below floor level. Each cable or group shall, where possible, be protected by a pipe or cover of heat resisting material rising to a height of at least 45 cm above floor level or terminating just below cable gland, sealed at the bottom and filled with sand or small pebbles.
C. Whenever possible, all jute shavings shall be removed from cables in switch rooms, basements and tunnels.
D. Where cables rest on the floor of tunnel or basements, they shall be separated into groups by vertical barriers of tile brick, or concrete and the trenches so formed shall be filled with small pebbles. Alternatively, the cables may be separately clamped and each cable run shall be separated by a minimum clear space of 75 mm.
E. The cable shall not be routed near hot steam pipe, turbine, pulverised coal pipe and near hot gas ducts. Wherever it is unavoidable fire resistant cables shall be used.
F. Power cables and control cables shall run in separate trenches, wherever possible.

**5.3.2.2 Fire Protection of Transformers:**

1. No fixed fire protection equipment (such as high velocity spray) is required on transformers below 10 MVA or in the case of oil filled transformers with oil capacity of2000 litres and below. For all other transformers high velocity water spray system, shall be provided. This system shall be separately mounted and designed to take into account the possibility of a transformer explosion. The water spray deluge valve house shall be located outside the transformer fire zones and protected from radiant heat and other fire effects. The actuation of this system shall be automatic but manual operating valves shall also be provided.

2. The high velocity spray system for the transformers should be well designed to have adequate coverage of the entire transformer unit including the conservation tanks, the bushings and the bottom area. The positioning of the nozzles should be such to protect all surfaces of the transformer and to give discharge rate for the system to be protected. The automatic high velocity water spray shall be of pre-active with quartzite bulbs.

3. Fire barriers walls shall be provided between transformers where they are less than 15 m apart or where the oil capacity exceeds 2000 litres.

4. The transformer shall be so designed as to permit the safe testing of the fire protection system, with discharge of water, while on load.

5. There shall be arrangements for containment of the spilled oil. For generator transformers and other large transformers the drainage system as well as storage, pit shall be sufficient to accommodate at least the total volume of the oil and an allowable volume of fire fighting water. The drain pipes shall be provided with standard type of flame arresters.
6. The fire protection systems covering the generator transformers, associated oil conservator tank and cooler batteries shall be designed to meet the single risk concept so that simultaneous deluge over all the three risk zones is possible.

**5.3.2.3 Maintenance work on transformers:**

1. When work is to be carried out on a transformer, both the low and high tension (primary and secondary side) breakers and isolators shall be opened. Similarly when isolating transformers to which potential transformers are connected, such potential transformers shall be isolated and secondary P.T fuses removed to prevent any possibility of transformer being made alive through synchronizing or voltmeter plug.
2. Before commencing any work on the transformer, the transformer winding should be discharged to ground. In case the transformer is isolated from the supply by single point of disconnection e.g. fuse, the transformer shall be safeguarded by shorting the phase terminals together and connecting them to ground, before commencing any work. The neutral ground of a transformer should never be treated as the grounding of phase terminals, as required above.

**5.3.2.4 Work on Circuit Breaker**

The following precautions shall be taken before commencing the maintenance work in the circuit breakers:

1. Breaker must be open before any disconnections.
2. It is to be ensured that line and bus isolators are open and there is no back feed from potential transformers and interlocking should be ensured.
3. Main fuses at the switchboard/panel should be removed and DC voltage must be disconnected from breaker mechanism.
4. Working tools and equipment should be in safe working condition.
5. In outdoor HV breakers work must be done from ladders or platforms alongside the breaker. Energized overhead conductors are dangerous for workmen to stand on these breakers. Essential work may be done from the top of the breaker only if protective barriers have been installed.

6. When working on the mechanism with the breaker closed wire the trip latch or block the breaker closed so that it cannot be tripped accidently. Be sure that auto-enclosure feature has been by-passed during the maintenance work.
7. After maintenance work is over the breaker should be operated by relay operation as test check. This ensures safety of the system for future faults.

**5.3.2.5 Isolator Operation and Earth Switch Operation:**

1. The circuit breaker shall be open/off.
2. The isolators should not operate (open or close) on load in any case.
3. The isolators should not be operated (open or close) on charged line/ transformer in any case.
4. After opening isolator be sure that there is no pole stuck and all three poles of the isolators have been opened fully.
5. After closing isolator be sure that all three poles of the isolators have been closed.
6. The isolator should be locked with pad lock and key after issuance of PTW and should be closed when PTW is returned properly.
7. When PTW is given for work on line the Earthing switch is closed after opening the isolator and both should be locked in position till returned of PTW properly.

**5.3.2.6 Instrument Transformers Operation:**

1. The instrument transformers should be grounded.

2. One lead of the secondary circuit of the current transformers should be connected to ground at all times when the C.T is in service.

3. Potential transformer secondary should never be shorted to ground except at star point.

4. The low voltage winding of potential transformers should always have one side permanently and effectively grounded.

**5.3.2.7 Capacitors:**

1. Every capacitor shall be treated as 'hot' until proved otherwise. Capacitors store energy and are not necessarily dead when disconnected from the lines. Once charged, a capacitor may retain this charge for several hours even after it has been disconnected.
2. Before commencing work on the capacitors first open all cut-outs or disconnecting devices to the capacitors, then wait for at least five minutes for the

internal resistor to reduce the voltage. Next use a hot stick, short circuit and ground all terminals of the capacitor. The short circuit grounding jumpers should be left attached while work is being done on the capacitor.

3. To place the capacitor bank in service, first remove the jumpers with hot sticks and then close the cut-outs.

**5.3.2.8 Battery:**

1. While preparing electrolyte for initial filling up in the new battery always remember that the acid should be poured into water slowly and not the water into acid as it may splash acid on face or eyes.
2. Water should not be poured in concentrated acid as this will lead to chemical explosion.
3. If the acid is splashed in the eyes, immediately flush eyes with water, followed by olive oil. If irritation does not subside bath eyes with zinc and rose water lotion in eye glass.
4. If the acid is drunk by mistake, take a drink of soap suds and baking soda in a glass of water and get medical advice as soon as possible.
5. Don't open flame near the battery especially while it is being charged.

**5.3.2.9 DC Distribution System**

1. DC Distribution Board (DCDB)/ Battery charger must be cleaned regularly. Connections must be tight.
2. Only H.R.C fuses of adequate and correct rating shall be used. Maintain the stock in the site store.
3. On DCDB every DC feeder DC cable provided for bay shall be named separately.
4. As far as possible separate room shall be provided for DC distribution system in the substation.
5. AC power cables and DC control cables shall be run separately in cable trench as soon as possible.
6. Do not pull out the control cables with force and jerk.

**5.3.3 Substation shall maintain following T&P (minimum) for safe working:**

1. Ten sets of discharge rods.
2. Good Quality Torch (4 Nos) with fresh cells.
3. First Aid Box.

4. Tool Box (2 Nos) containing insulation tape, all size ring and flat spanners, Allen key set, pliers (big, small size), insulation cutter etc.
5. Ladder (4 Nos).
6. Ropes.
7. A/C Distribution Board with adequate wiring set.
8. Tong Tester.
9. Megger (1/5 KV).
10. Multi meter with cords.
11. Danger Boards
12. Good quality rubber hand gloves.

### 5.3.4 SAFETY PRECAUTION FOR WORK ON OVERHEAD MAINS, SERVICE LINES

1. No person shall work on line supports or conductors unless they are discharged and earthed

2. The circuit or conductor to be worked on shall be made dead by switching off or opening the isolator links or fuses and by locking isolator/links in the off position. A danger notice board with the words "DO NOT CLOSE', 'MEN ON LINE' should be fixed securely, below the switch or links/isolator.

3. After switching off the supply, before touching the lines, every one of the conductors shall be tested for pressure (voltage) by a discharge rod. The discharge wires should be kept at least two feet away from the body. The procedure is necessary in order to make sure that the line to be worked on is actually the line that has been isolated. Rubber gloves or preferably gauntlets should be used on both hands.

4. All the conductors shall then be short circuited together and adequately earthed; this shall be done at the points on each side of the place thereby creating a safety zone where the work is carried out. Rubber gloves or gauntlets shall be used while doing this work. Poles on which work is actually to be carried out should also be earthed.

5. A working section at either end of which the conductors are earthed shall not exceed 1.5 km in length. In the case of lines meeting or crossing at any pole which forms the site of work, all the lines crossing or ending at that pole shall be earthed as stated above unless work on the one line with any or all the remaining lines alive is otherwise permissible and so specified in the permit-to-work.

6. Ensure that there is no possibility of back feed.
7. All phases shall be earthed even if work is to be carried out on one phase only.
8. When work is to be carried out on lines of all insulated conductors where grounding points are not provided at point of work, temporary grounds shall be connected at point of work through an efficient portable earth straight driven into the ground. The line shall also be grounded at the nearest line grounding point on either side of the point of work.
9. Where two or more crew are working independently on the same line or equipment, each crew shall properly protect them by placing their own temporary grounds.

### 5.3.5 WORKING ON LINES AND EQUIPMENT ADJACENT TO LIVE EQUIPMENT OR LINES

1. When working near live lines or apparatus, each man should plan his moves and take extreme care in moving from one position to another.
2. Where impractical to erect barriers between men at work and live parts within reach of their hands and objects being handled, continuous watch shall be kept by the JE/ Lineman or someone specifically designated by him for that purpose.
3. When a truck is used near live parts, all workmen except the driver should stay away from the truck. Driver should see that truck is clear from live lines before leaving and entering the truck.

### 5.3.6 WORK ON DOUBLE CIRCUIT OVERHEAD LINES WITH ONE CIRCUIT ALIVE SHALL NOT BE CARRIED OUT

#### 5.3.6.1 REPAIR WORK ON H.T.LINES AND EQUIPMENT

1. Handling and working on live electric circuits are hazardous occupations and shall be done only by workmen who are qualified by training and experience to do the work safely and only after authorization.
2. Repair work on H.T. lines on poles where L.T is also running under H.T. should be carried out only after switching off the L.T. effectively. Work on the L.T. lines should not be carried out unless there is an efficient earth screen between H.T. and L.T. lines or in the absence of such a screen, unless the H.T. line is switched off or in the opinion of the Supervisor, the work is otherwise safe.

3. Any line wherein the pressure does not exceed 250 V to earth may be worked on live line by an authorized person only provided the person:

a) Uses a safety belt.

b) Wears rubber gloves or gauntlets

c) Has not to push any part of the body, except that portion of the arms protected by the gauntlets or gloves through any conductor other than that worked upon.

d) Is accompanied by an assistant with an effective torch light if working at night.

e) Before a lineman undertakes any work on a pole or any other line support, he should first make a complete inspection from the ground of the position of all live wires, in order to determine the amount of precautions to be adopted and should inspect his insulating equipment and operating tools and tackles for their good condition before he attempts to do the actual work.

**5.3.6.2 WORK ON POLES AND TOWERS**

1. Before climbing an elevated structure every employee shall first assure himself that the structure is strong enough to sustain his weight safely.
2. If poles or cross arms are apparently unsafe because of decay or unbalanced tensions of wires on them, they shall be properly braced or guyed before they are climbed.
3. In choosing the climbing side, the side of the pole where the ground wire is attached should not be used.
4. The workman should avoid using conductors, insulators, pins and so forth as hand holds and should not rest on street light fixtures or other apparatus on the poles or structures.
5. Linemen shall wear their safety belts while working on the poles and towers.
6. Wire hooks shall not be attached to linemen's belts or safety straps.
7. Safety straps should be placed above the top cross arm when it is at the top of the pole.
8. When two or more men are ascending a pole the second man should not start climbing until the first man is in a safe position or when descending until the first man is on the ground.
9. Linemen's tools should be so secured that they will not fall out of the tool belts. A lineman should carry only the minimum number of tools in his belt. All other tools should be kept on the ground until they are required and then raised by

means of a material bag attached to a hand line.

10. Ordinarily no lineman should work vertically below another lineman on the same pole except under emergencies. When this condition is necessary, extreme care should be taken to prevent tools or other objects being dropped upon the man below.
11. Before a Lineman cuts an overhead conductor he should make sure that it will fall clear. Where there is a possibility of the falling line coming in contact with another wire or doing other damage, it should be lowered with a rope.
12. All light equipment and tools to be used aloft should be raised and lowered by means of a hand line and canvas bucket, or other suitable container. Men on the ground should stand clear of overhead work to prevent being struck by falling objects.
13. Broken insulators or other sharp edged material shall not be left in vacant lots, along the right of way or in the location where the hazard of cutting feet could be caused for men or animals.
14. When stringing wires across streets and highways, avoid interfering with traffic or causing injury to workmen or pedestrians. Danger signs should be erected on both sides of the work location and where conditions warrant, flag-men should be stationed.
15. All the line materials, tools or equipment must not be scattered around streets, sidewalks, highways, etc., but must be kept in a neat and orderly manner where they will not be liable to cause accident.
16. A leather belt should be used when working on overhead locations. In its absence, belts of flexible hemp or manila rope may be permitted round the waist of the workman and tied to cross arm or pole as an alternative to the use of leather belt, under exceptional circumstances. The ropes should be kept in good condition and scrapped when not safe. It is necessary that the rope is twisted round the pole once or twice in order that release of tension on the pole may not cause it to slip down the pole.
17. Use ladders of suitable lengths to go up the poles to renew fuses or to carry out other minor works on feeders and wherever possible or necessary, dry hickory rod should also be used.

## 5.4 CONSTRUCTION WORKS ON LINES

### 5.4.1 Hauling of Poles

a) Poles must be securely held on trucks to assure that the binders will not be released in rough going.

b) The speed of trucks hauling poles must be restricted to a point assuring safety to the operators of trucks and the travelling public.

c) A red flag by day and a red light by night must be attached to the end of poles being hauled. The red light must be visible in any direction.

### 5.4.2 Pole Storage

a) When poles are stored on pole racks they shall be properly blocked, to keep them intact on the rack. Poles of different sizes should not be mixed but stored separately.

b) When poles are stacked temporarily near a road, they should be placed as close as possible to the edge of road. They should not be stored at points in the road where there are short turns. Poles stored on the high- ways should not have cross arms attached.

### 5.4.3 Excavation of Pole Pits

a) The pole pits should not be excavated much in advance of erection as the pits cannot be left without being back-filled immediately.

b) Within town and village limits the pits excavated should be covered with planks so that no one accidentally falls into it. Danger lamps should also be put up during night time.

c) In distribution as far as possible, the pit is to be excavated without resorting to blasting as it is dangerous to the adjacent buildings and roads where there is traffic. If blasting is un- avoidable, special precautions should be taken by covering the pit with bamboo's and planks carrying out blasting at a time when there is no traffic on the road.

### 5.4.4 Erection of Poles

a) This should be done under direct supervision of Supervisor.

b) Care should be taken to see that the ropes used are in sound condition and they are tied securely to the pole and tackle.

c) When side guys are used in the setting of poles or structures, they shall be attached to crow bars driven into the ground.

d) The Supervisor shall not assist in the setting of poles, but must give his entire attention to the Supervision to assure that the work is being safely performed.

e) In obstructing a highway during the erection of poles, suitable signs or warnings shall be used on each side of the work to advise approaching traffic of the obstruction. Where traffic is heavy flag-men should be used for this purpose. Signs or signals must be moved along as the work progresses.

### 5.4.5 Installation of Guy Wires

a) When insulators are used they should be connected into the guy wire line before the guy wire is set in place. Rubber gloves should be worn while installing guy wires through live circuits.

b) In new work, guys should generally be installed before line wires are strung. In reconstruction work guys should be installed before any changes are made in the line wires and care must be taken not to place excessive pulls on the pole and wires already in a position.

c) Guys should be so installed as not to interfere any more than necessary with the climbing space and should clear all high tension wires as far as practicable.

d) Guy strain insulators should be provided wherever necessary to secure the required amount of insulation.

e) Guys should be carefully installed on poles to prevent them from becoming loose. Where necessary a guy hook may be used to prevent the guy from slipping down the pole. These hooks should not interfere with climbing and should be so placed that they will not be used as steps. Where guys are liable to cut into the surface of a pole, the pole should be protected at the point where the guy is attached by a guy plate. The guy plate must be well secured to the pole to prevent the possibility of injury to a lineman climbing up or down the pole.

f) All guys who are anchored should be installed so that the guy does not interfere with street or highway traffic. Where these guys are located near street or highway, they should be equipped with traffic guards (traffic guards are sometimes called anchor shields).

g) Guy wire should be so installed that it will not rub against any messenger or signal cable carried under supply lines.

h) Guy wire, containing snarls or kinks should not be used for line work. Guy wires should not contain any more splices than absolutely necessary. Standard guy

clamps or other positive clamping device should be used in making all stiff steel guy wire splices.

### 5.4.6 Removal of Guys

Before wires and guys are removed, the condition of the pole must be determined. If the pole is found to be weak, it should be securely braced before any changes in pole strain are made.

### 5.4.7 Back Filling

Side guys, etc., should not be removed until sufficient stamping has been done to prevent the falling of the pole**.**

### 5.4.8 Dismantling Poles

All poles must be guyed at least three ways by means of guy ropes before any other work proceeds on the pole. This can be done by:

a) Make two turns around the pole with a sling and tie securely.
b) Tie three guy lines around the sling at the proper angles.
c) Insert a pike pole under two sides of the sling and work the sling well up the pole.
d) Snub off securely by means of crow bars driven into solid ground on any other substantial snub.
e) Lineman may then climb up the pole safely and release all conductors and to the equipment and the pole may then be slowly brought down.

### 5.4.9 Stringing Wires

a) In stringing of wires, care must be taken not to put kinks into any part. Kinks reduce the strength of the wire and may result in snapping of wire later on.
b) In handling and stringing of weather proof covered wires, care must be takennot to injure the weather proof covering.
c) A lineman must not change the strains on a pole by adding wires until he is satisfied that the poles will safely stand the altered strain.

### 5.4.10 Tree Trimming

a) The public shall be protected against hazards of tree trimming along public streets and highways by placing danger signals and signs.
b) Before climbing, the limbs or branches should be carefully inspected to make sure that they will hold the trimmers weight. Dead or decayed limbs are not safe to support any weight.

### 5.4.11 Right of Way Clearing and Trimming

a) When walking through slush, use ankle high canvas boots to prevent injury to feet from broken insulators thorny undergrowth, shells, etc.,
b) Trees should be carefully felled to prevent them falling on transmission lines or adjacent buildings.

### 5.4.12 Patrolling Lines

a) Emergency line patrol, trouble shooting on transmission lines and similar work should always be done with the greatest caution. Patrol men should beparticularly alert at night to avoid walking into the fallen wires or metal fences which may be energized by fallen conductors.
b) Be careful with lighted cigarettes and matches, which may cause a fire along transmission line right of way. Break matches and crush cigarettes butts into earth on discarding.
c) PATROLMEN should be alert from stumbling hazards and from poisonous plants and snakes.

### 5.4.13 Line Work under Adverse Weather Conditions

In the event of the near approach of lightning storm all work on overhead lines shall cease immediately.

## 5.5 SAFETY PRECAUTIONS FOR WORK ON UNDERGROUND MAIN / CABLES

### 5.5.1 Work on Live Low Voltage Cables

Only competent, experienced and authorized persons may work on live low voltage mains and testing apparatus.

Unless an employee is authorized to work on live low voltage mains and testing apparatus, all low voltage mains testing apparatus to be worked upon, shall be isolated from all sources of supply, proved dead, and measures shall be taken against the inadvertent energizing of the mains and apparatus.

### 5.5.2 Testing Low Voltage

An employee shall not apply low voltage, for test purpose, to any mains, unless he has received a permit to work from and warned all persons working on the mains of the proposed application of low voltage for test. Where any part of the mains which

will then become live is posed, the Supervisor in charge of the test shall arrange for an employee to stand by at the exposed part during the whole period of the tests.

**5.5.3 Work on High Voltage Mains**

While working on High Voltage underground mains, the following shall be complied with:

a) The dead cable should first be identified by approved means.

b) Before working on underground cable, all its conductors shall be effectively discharged and earthed at both ends and the earthing switches wherever installed shall be locked up.

c) The neighbouring cables, if any, should be adequately protected.

d) Before cutting the dead cable, a steel wedge shall be carefully driven through it at the point where it is to be cut.

## 5.6 Minimum Working Distance

5.6.1 No employee shall work within the minimum working distance, which is normally as under:

| System Voltage (KV) | Safe Working Clearance (metres) |
|---|---|
| 12 | 2.6 |
| 36 | 2.8 |
| 72.5 | 3.1 |
| 145 | 3.7 |
| 245 | 4.3 |
| 420 | 6.4 |
| 800 | 10.3 |

5.6.2 Under certain conditions, for special work and in an emergency, an employee may work within the minimum safe working distance where the work is directly and specifically sanctioned by the Supervisor responsible for the work and employee is fully experienced and aware of the dangers that exist.

5.6.3 In all such cases, the employee shall be accompanied by another employee who is also aware of the dangers which exist and who is capable of rendering First Aid and Artificial Respiration.

## 5.7 Safety Precaution for WELDING, BURNING, CUTTING

1. The primary hazards encountered during welding are Electric shock, burns, radiant energy, toxic fumes, fire and explosions.
2. Avoid burns from electric arcs, gas welding flames, hot slag or touching welded parts before they become cool by the following precautions:
   a. Suitable goggles or welding helmets shall be worn for protection while welding. Barriers should be erected to protect other authorised line staff from rays of electric arcs or welding flames. Ultraviolet, infra-red and excessively bright visible light rays are injurious to eye.
   b. Clean goggles should be worn while chipping the slag.
   c. Adequate ventilation shall be provided while welding zinc, brass, bronze, galvanized or lead coated material. Poisonous fumes may be generated during the welding process by metallic oxides, coatings on the materials being cut or welded or by the electrode or flux rod.
   d. While welding or cutting in elevated position, precautions should be taken to prevent sparks or hot metal falling on to people or inflammable materials.
   e. No welding or cutting should be attempted in dusty or gaseous areas where there is a danger of causing explosion.
   f. Before welding or cutting a pipe, tank or container that has held flammable materials, drain it thoroughly out and fill the container with water or thoroughly wash the container with a caustic solution and spray sufficient carbon-tetrachloride into the container to fill it with non-explosive vapour.
3. Authorized line staff should avoid contact with the electrode or other live parts of electric welding equipment's. Alternating currents (AC) are dangerous even at low voltage.
4. In acetylene burning and welding, never allow oil and grease to come in contact with any cylinder, regulator, connection of gas welding equipment. Oil and grease in the presence of oxygen may cause violent explosion.
5. Never use matches to light a blow pipe. Use a friction lighter, stationary pilot flame or other suitable source of ignition.

## 5.8 Safety precaution for HANDLING AND STORING COMPRESSED GASES

1. Cylinders containing acetylene, oxygen, chlorine, hydrogen, nitrogen, carbon dioxide etc. should be stored upright in approved safe places where they cannot be knocked over and well separated from radiators, furnaces and combustible material.
2. Oxygen cylinders should be isolated from acetylene cylinders and gas filled cylinders separated from empty ones.
3. Gas cylinder should be protected from direct rays of sun.
4. Empty cylinders should be plainly marked EMPTY and the valves closed.
5. Gases like carbon dioxide, chlorine have a tendency to settle down when released in air. They also diffuse very slowly. Therefore when working in manholes and basements, care must be taken to see that an accidental leak will not lead to suffocation. In such locations the gas cylinders should be placed away from the manhole openings or entrances to basements.

## 5.9 HOUSEKEEPING:

Workmen are frequently injured by tripping, stumbling, stepping on or bumping into tools, material and other object, left Eying around or by carelessly placed object falling from above.

To ensure good housekeeping the following instruction shall be followed:

i. The place of work within the building and around the work area in switch yard, should be kept neat and clean.
ii. Handling and usage of flammable liquids, oils, cleaning solvents should be carried out as per the prescribed manner so that they will not become the potential source of fire hazard.
iii. The storage area should be neatly maintained and the materials should be stored systematically and in an orderly manner to prevent their falling or spreading and to eliminate tripping and stumbling hazards.
iv. Clothing or any other types of material should never be hanged behind the space of the neighbourhood of substations, pole yards, buildings, oil tanks, or other structures.
v. Pathways, stairways, fire escapes surrounding area near the distribution boards, control panel etc. anti all other passage ways shall be kept clear from all obstructions.

vi. Tools and materials should not be placed where they may cause tripping or stumbling hazards or where they may fall and strike anyone below.

vii. Line materials, tools or equipment must not be scattered around street sidewalks highways etc. but must be kept in a neat orderly-manner, where they will not be liable to cause accident.

viii. Broken insulators or other sharp edged material shall not be left in vacant lots, along the right of way or in the location where the hazard of cutting feet could be caused to men and animals.

ix. Broken light bulbs, glass, metal scrap and other sharp objects should be dumped in a specified place or containers provided specially for them.

## 5.10 Lifting, Carrying & Hoisting heavy object:

i. Any person should not attempt to lift beyond his capacity.

ii. Person should avoid twisting or excessive bending when lifting or setting down load.

iii. Pushing should be resorted to when moving a load horizontally, rather than pulling it.

iv. Gripping, Grasping and Lifting with just the thumb or index fingers should be avoided & whole hand and all devices should be used.

v. Authorized line staff working at site should wear helmets.

vi. Manila or sisal rope sling should not be used over sharp metal corners and edges, wire ropes with padding over sharp corners and edges may be preferred.

vii. No one shall stand or pass under any suspended load being handled by a crane.

viii. Several work men should not climb at the same time.

ix. Most lifting accidents are due to improper lifting methods rather than lifting too heavy loads. When lifting heavy objects the back should be kept close to vertical and the lifting done with leg and arm muscles rather than with back muscles.

x. Pipe, conduit, reinforcing rods and other conducting material should not be carried on shoulder near exposed live electrical equipment or conductors.

## 5.11 Important telephone numbers to be maintained at substation:

For fast and effective communication (in case of accident) the following phone numbers shall be readily available.

1. Police Station of concerned area.
2. Ambulance service.
3. Government Hospitals.
4. Fire Brigade Station.
5. Electrical Inspector

# CHAPTER 6:

## SAFETY DEVICES AND EQUIPMENTS

6.1 The minimum requirements of safety devices and special tools are as under:

a) Rubber Gloves, Gauntlets.

b) Safety Belts.

c) Leather Protective Gloves.

d) Hand lines.

e) Helmets.

f) Rubber Mats.

g) Goggles.

h) Ladders.

i) Telescope earthing rods.

j) Ropes.

k) Hand Tools

1. Insulated cutting pliers.
2. Insulated screw drivers.
3. LT line tester.
4. Adjustable spanner.
5. Rain coat.
6. Chargeable Hand Torch.

**SAFETY DEVICES**

## 6.2 WORKMEN'S SAFETY DEVICES

a) Rubber gauntlets, gloves, mats, boots and galoshes, insulated platforms and stools, safety belts, hand lines, tower wagons and other special insulated devices shall be used as required by employees working on electrical apparatus, underground mains and overhead lines as precaution against accidental electric shock.

b) Pliers and other tools insulated with brittle materials or otherwise liable to have the insulation damaged when in use, shall not be used.

c) The Supervisor in charge of the work will be responsible to test and ensure proper use of the safety equipment, supplied to the gang of workmen under him and see that it is maintained at all times in efficient condition and must immediately bring to the notice of his superior officer any equipment which is liable to be broken in use, when arrangements will be made immediately for their replacement.

### 6.2.1 LINEMAN'S, FITTER'S OR CABLE JOINTER'S CLOTHING

Lineman while working on lines shall avoid wearing loose clothing, rings, metal chains, etc., which may contact a live portion and cause hazard. They shall use rubber gloves, safety shoes, head gear, goggles wherever available.

### 6.2.2 INSPECTION OF SAFETY EQUIPMENTS

All safety equipment shall be thoroughly inspected:

a) Monthly, by the T&P holder

b) Quarterly, by the Assistant Engineer,

c) Once in six months, by the Division Officer for its being in good condition.

### 6.2.3 RESPONSIBILITY IN USING SAFETY DEVICES

It is the responsibility of the employee to make use of safety devices properly.

### 6.2.4 RUBBER GLOVES AND GAUNTLETS

Rubber gloves should not be rough handled as to be damaged. After the work they should be cleaned, and powdered with French chalk and stored in a safe place.

### 6.2.5 EYE AND FACE PROTECTION

Necessary eye protection should be used while operating the switches on load to avoid injury to the eyes due to sparking. The eye protection should be used during handling molten solder, handling the acids and electrolyte in the battery room.

The eye and face protection should be inspected by supervisor at frequent intervals and should be replaced immediately when the first sign of damage is observed.

### 6.2.6 HEAD PROTECTION

Safety head gear shall be worn by the authorised line staff whenever there is a hazard of falling object or electrical contact or any other cause which may lead to head injury. Hair should not pose any obstruction to work and also should not lead to any accident during the work.

Head protective gear should also be subjected for inspection level very frequently and should be replaced immediately when the sign of damage or deterioration is noticed.

### 6.2.7 TESTING RUBBER GLOVES AND GAUNTLETS

Before using, the gloves should be checked for cuts, weak spots, pin holes, by an "Air Test". This is done by rolling the gloves tightly from the gauntlet end, and noticing if any air escapes. If air leaks the gloves should be discarded. If the right hand glove is found to be unserviceable the pair itself should be discarded. A left hand glove should not be used on right hand.

### 6.2.8 CARE OF RUBBER EQUIPMENT

a) Rubber equipment should be kept clean and free from oil. They should not be stored near a source of heat, or exposed unnecessarily to sun's heat. They are best stored in protective containers, and should not be tied by cords or threads which may cut it.

b) Use of Rubber gloves should be insisted on

   i. When inspecting the Transformer or its H.T. & L.T. leads
   ii. When connecting wire near a live conductor or equipment.
   iii. While removing or replacing fuses of H.T. installations.
   iv. A combination of gloves and hickory rod or fuse pole rods should be used where the voltage exceeds 5,000 volts.
   v. While opening and closing isolators.

### 6.2.9 CARE OF SAFETY BELTS

Safety belt should be properly handled, and periodically treated with oil to prevent its becoming hard. Care should be taken to see that sharp tools or edges do not cut dents and holes in it. Extra holes should not be punched as it weakens the belt. It is best preserved in a separate case.

### 6.2.10 LEATHER PROTECTING GLOVES

Protective leather gloves may be worn over rubber gauntlets when wires are being spliced or when solder or hot compound are being handled when it is necessary for the person to move about a lot during working, or when line wires are being tied on to

insulators or when any other work is being done which might render the gauntlet liable to tear and consequent danger to the wearer.

### 6.2.11 LADDERS

a) Ladders must be of strength to carry double the strain of the heaviest load that would be placed upon them.
b) Defective ladders must never be used.
c) A clearance space of not less than 12" must be provided between ladder rungs. A minimum clearance space of 36"/90 cms must be provided in front of ladders where space permits.
d) When straight, portable ladders are used on hard surfaces, they must be held or firmly locked in addition, anti-slip shoes must be used where provided.
e) Ladders must be kept free from dirt, grease, and paint-spots.
f) Ladders must not be placed in front of doors opening towards the ladder, or against window sashes.
g) Step-ladders must be fully opened before being used.
h) Two ladders must not be spliced together.
i) Employees must face ladders when ascending or descending over them, and must have both hands free.
j) Ladders must be periodically inspected; when found defective; they must be repaired or disposed off.
k) Straight, portable ladders must be placed at safe angle about 75 degrees with the horizontal. In other words, place the foot of a 12'/4 Mt's ladder 3'/1 Mts. From the object it leans against.

### 6.2.12 ROPES

a) Fibre ropes are made principally of manila fibre, sisal fibre and hemp. Frequent inspections are required in the use of rope as the interior fibres may be broken or ground to powder, while the exterior fibres may indicate that the rope is little worn.
b) Pure manila rope is the strongest and most reliable of fibres ropes. It is of a yellowish colour with silvery or pearlish luster and has a silky feel when drawn through the hand. Rope with brown or black fibre is of inferior grade. Sisal rope has about 6.7% of the strength of manila rope. It is yellowish white, sometimes with a greenish tint. The Fibres are hard and stiff, with a tendency to splinter. Hemp rope is nearly as strong as manila and is slightly more resistant to atmospheric deterioration. It is of a dark grey colour and is much softer than manila rope.

c) Rope must be so uncoiled as to avoid kinking, since even a moderate strain on a rope in which there is a kink may over-stress the fibres at the kink Wet rope deteriorates rapidly unless dried properly. It should be hung up in loose coils so that dry air can be circulated through them. Heat should never be applied as it dries out the oil and thus shortens the life of the rope. Wet rope has a tendency to form kinks. No load should be applied until all kinks are removed. All ropes are easily damaged by acids and alkalis. Any rope known to have been exposed to acids or alkalis (sometimes indicated by discoloration or strains) should be used with caution.

d) In making a rope fast, an object with a smooth round surface should be selected. When rope is running over a sheave or pulley internal wear is caused by friction. The life of the rope is greatly prolonged by using blocks with sheaves of large diameter.

e) Fibre rope should always be cleaned before being placed in storage and shall be stored in a dry, airy place. It should never be stored in the same room with acid or caustics.

### 6.2.13 SLINGS

Sling is the most commonly used piece of rigging equipment. Following precautions need to be observe with slings.

a) Never use damaged slings. Inspect slings regularly to ensure their safety. Check wire rope slings for kinking, wear, abrasion, broken wires, worn or cracked fittings, loose seizing's and splices, crushing, flattening, and rust or corrosion. Pay special attention to the areas around thimbles and other fittings.

b) Never allow wire rope slings to lie on the ground for long periods of time or on damp or wet surfaces, rusty steel, or near corrosive substances.

c) Keep wire rope slings away from flame cutting and electric welding.

d) Never wrap a wire sling completely around a hook. The sharp radius will damage the sling.

e) Before making a lift, check to see that the sling is properly attached to the load.

f) When using two or more slings on a load, ensure that they are all made from the same material.

### 6.2.14 HAND TOOLS

a) Using hand tools improperly, neglecting to keep them in safe working condition and carelessly leaving them around where they may endanger persons are frequent causes of accidents. Proper tools should always be used for the work.

b) All tools shall be maintained in good working conditions. Burred heads shall be promptly redressed. Broken, cracked or otherwise damaged handles shall be replaced. All tools with sharp edges should be kept in sheaths, shields, tool chests or other containers, when not in actual use.

c) A screw driver should never be used as a chisel. Screw drivers with full length metal tong or shank through handle must not be used for electrical work. Other tools such as pliers, wrenches, etc., whether insulated or not insulated shall not be used without rubber gloves while working near live parts of any voltage.

d) All files shall be fitted with substantial handle; workmen should keep files cleaned as this reduces the slipping hazard and prevents skinned hands.

e) Never use metal tapes, rulers, or cloth tapes with metal strands or wood rulers with metal ferrules or joints near energized equipment.

# CHAPTER: 7

## CONSTRUCTION AND TRANSPORTATION

### CONSTRUCTION

Only good quality materials as per BIS/IS specifications, having more than adequate mechanical strength and the desired factor of safety for the supports and conductors as mentioned in the Safety Regulations, for construction of distribution lines and substations should be used. Using these practices would automatically avoid danger to the public and ensure Safety in the Construction.

**7.1 Central Electricity Authority regulations for safety requirement for construction, operation and maintenance of electrical plant and lines, Regulation 2011.**

**a) Regulation 4**

**Safety provisions relating to Owner:**

1. The Owner shall make safety an integral part of work processes to ensure safety for employees including employees of contractor, sub-contractor as well as visitors.
2. The Owner shall obtain accreditation of electric plants and electric lines with IS-18001 certification.
3. The Owner shall set up a sound and scientific safety management system.

**b) Regulation 6**

**Safety officer and safety committee:**

1. The Owner shall appoint one qualified safety officer where the number of employees, including contract workers, exceeds five hundred and where the number of employees is less than five hundred, a suitable officer shall be designated as safety officer. Provided that where number of employees exceeds one thousand one more safety officer shall be appointed for every additional one thousand employees. A person shall not be eligible for appointment as a safety officer unless he is qualified as below:-
   i. Under section 40-B of the Factories Act, 1948 (63 of 1948) and rules made there under or
   ii. Under sub-section (2) of section 38 of the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 (27 of 1996) and rules made there under.

iii. Where the number of employees including contract workers exceeds two hundred and fifty the Owner shall constitute a safety committee comprising of equal number of representatives of the management and the employees and during construction the safety committee shall also include representatives of contractors and their employees with equal representation and the representatives of the management shall include the safety officer and medical officer. Provided that where number of employees including contract workers is two hundred and fifty or less, the safety committee shall be constituted by the Owner for a group of electrical plants or electric lines as the case may be.

**7.2 Regulation 12 of Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulation 2010: General Safety Requirements pertaining to construction, installation, protection, operation and maintenance of electric supply lines and apparatus stipulates that:**

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

b. The relevant code of practice of the Bureau of Indian Standards or National Electrical Code may be followed for ensuring safety if the corresponding provisions are not available in CEA regulations.

c. 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.

d. All electrical equipment shall be installed above the Mean Sea Level (MSL) as declared by local Municipal Authorities and where such equipment is to be installed in the basement, consumer shall ensure that the design of the basement should be such that there is no seepage or leakage or logging of water in the basement.

**7.3 OVER-HEAD HT/LT LINES, UNDERGROUND CABLES & SUB-STATIONS/ CEA REGULATIONS PROVISION:**

### 7.3.1 CEA (MEASURES RELATING TO SAFETY AND ELECTRICITY SUPPLY) REGULATION, 2010

**a. Clause 55**

**Material and Strength:**

I. All conductors of overhead lines other than those specified in regulation 68 shall have a breaking strength of not less than 350 kg.

II. Where the voltage does not exceed 250 V and the span is of less than fifteen metre and is drawn through the owner's or consumer's premises, a conductor having an actual breaking strength of not less than 150 kg may be used.

**b. Clause 56**

**Joints:**

I. No conductor of an overhead line shall have more than one joint in a span and joints between conductors of overhead lines shall be mechanically and electrically secure under the conditions of operation.

II. The ultimate strength and the electrical conductivity of the joint shall be as per relevant Indian Standards.

**c. Clause 57**

**Maximum Stresses, factors of safety:**

I. The load and permissible stresses on the structural members, conductors and ground wire of self-supporting steel lattice towers for overhead transmission lines shall be in accordance with the specifications laid down, from time to time, by the Bureau of Indian Standards.

II. Overhead lines not covered in sub-regulation (I) shall have the following minimum factors of safety, namely:-

i. for metal supports - 1.5

ii. for mechanically processed concrete supports - 2.0

iii. for hand-moulded concrete supports - 2.5

iv. for wood supports - 3.0

III. The minimum factor of safety for stay-wires, guard-wires or bearer-wires shall be 2.5 based on the ultimate tensile strength of the wire.

IV. The minimum factor of safety for conductors shall be two, based on their ultimate tensile strength, in addition, the conductor's tension at

32° C, without external load, shall not exceed as mentioned in relevant standards.

**d. Clause 58**

**Clearance above ground of the lowest conductor of overhead lines:**

1. No conductor of an overhead line including service lines, erected across a street shall at any part thereof be at a height of less than:
   i. For lines of voltage not exceeding 650 Volts - 5.8 metres.
   ii. for lines of voltage exceeding 650 Volts but- 6.1 metres not exceeding 33 kV.
2. No conductor of an overhead line including service lines, erected along any street shall at any part thereof be at a height less than:
   i. For lines of voltage not exceeding 650 Volts- 5.5 metres.
   ii. for lines of voltage exceeding 650 Volts but- 5.8 metres not exceeding 33 kV.
3. No conductor of an overhead line including service lines, erected elsewhere than along or across any street shall be at a height less than:
   i. For lines of voltage upto and including 11000 Volts, if bare - 4.6 metres
   ii. For lines of voltage upto and including 11000 Volts, if insulated - 4.0 metres
   iii. For lines of voltage exceeding 11,000 Volts But not exceeding 33 kV. - 5.2 metres
4. For lines of voltage exceeding 33 kV the clearance above ground shall not be less than 5.2 metres plus 0.3 metre for every 33,000 Volts or part thereof by which the voltage of the line exceeds 33,000 Volts.

   Provided that the minimum clearance along or across any street shall not be less than 6.1 metres.

**e. Clause 59**

**Clearance between the conductors and trolley wires:**

I. No conductor of an overhead line crossing a tramway or trolley bus route using trolley wires shall have less than the following clearances above any trolley wire-

(i) Lines of voltage not exceeding 650 Volts: 1.2 metres

Provided that where an insulated conductor suspended from a bearer wire crosses over trolley wire the minimum clearance for such insulated conductor shall be 0.6 metre.

(ii) Lines of voltage exceeding 650 Volts: 1.8 metres
Up to and including 11,000 Volts.

(iii) Lines of voltage exceeding 11,000 Volts: 2.5 metres
But not exceeding 33, 000 Volts.

(iv) Lines of voltage exceeding 33 kV: 3.0 metres.

II. In any case of a crossing specified in sub-regulation (1), whoever plays his line later in time, shall provide the clearance between his own line and the line which will be crossed in accordance with the provisions of the said sub-regulation:

Provided that if the later entrant is the owner of the lower line and is notable to provide adequate clearance, he shall bear the cost for modification of the upper line so as to comply with this sub-regulation.

**f. Clause 62**

**Conductors at different voltages on same support:**

Where conductors forming parts of systems at different voltages are erected on the same supports, the owner shall make adequate provision to guard against danger to linemen and others, from the lower voltage system being charged above its normal working voltage, by leakage from or contact with the higher voltage system and the methods of construction and the applicable minimum clearances between the conductors of the two systems shall be as specified in regulation 69 for lines crossing each other.

**g. Clause 63**

**Erection or alteration of buildings, structures, flood banks and elevation of Roads:**

I. If at any time subsequent to the erection of an overhead line whether covered with insulating material or not any person proposes to erect a new building or structure or flood bank or to raise any road level or to carry out any other type of work whether permanent or temporary or to make in or upon any building or structure or flood bank or road any permanent or temporary addition or

alteration he and the contractor whom he employs to carry out the erection addition or alteration, shall give intimation in writing of his intention to do so to the supplier or owner and to the Electrical Inspector and shall furnish therewith a scale drawing showing the proposed building, structure, flood bank, road or any addition or alteration and scaffolding thereof required during the construction.

II. No work upon such building, structure, flood bank, road and addition or alteration thereto shall be commenced or continued until the Electrical Inspector has certified that the provisions of regulation 58, 60 and 61 should not be contravened either during or after the aforesaid construction.

Provided that the Electrical Inspector may if he is satisfied that the overhead line has been so guarded as to secure the protection of persons or property from injury certify that the work may be executed prior to the alteration of the overhead line or in the case of temporary addition or alteration without alteration of the overhead line.

**h. Clause 66**

**Routes-proximity to aerodromes:**

Overhead lines shall not be erected in the vicinity of aerodromes unless the Airport Authorities have approved in writing the route of the proposed lines as-per relevant Indian Standards

**i. Clause 67**

**Maximum Interval between supports:**

All conductors shall be attached to supports at intervals not exceeding the safe limits based on the ultimate tensile strength of the conductor and the factor of safety specified under regulations 57.

Provided that in the case of overhead lines carrying conductors of voltage not exceeding 650 V when erected in, over, along or across any street, the interval shall not, without the consent in writing of the Electrical Inspector, exceed 65metres.

**j. Clause 69**

**Lines crossing or approaching each other and lines crossing street and road:**

Where an overhead line crosses or is in proximity to any telecommunication line the owner of either the overhead line or the telecommunication line, whoever

plays his line later, shall arrange to provide for protective devices or guarding ,arrangement and shall observe the following provisions namely:-

I. When it is intended to erect a telecommunication line or an overhead line which will cross or be in proximity to an overhead line or a telecommunication line, as the case may be, the person proposing to erect such line shall give one month's notice ofhis intention to do so along with the relevant details of protection and drawings to the owner of the existing line.

II. Guarding shall be provided where lines of voltage not exceeding 33kV cross a road or street.

III. Where an overhead line crosses or is in proximity to another overhead line, guarding arrangements shall be provided so to guard against the possibility of their coming into contact with each other.

IV. Where an overhead line crosses another overhead line, clearances shall be as under:

(Minimum clearances in metres between lines crossing each other)

| **S.No** | **Nominal System Voltage AC** | **11-66 (AC) KV** | **110-132 (AC) KV** | **220 (AC) KV** | **400( AC) KV** | **800 (AC) KV** |
|---|---|---|---|---|---|---|
| 1 | Low and medium | 2.44 | 3.05 | 4.58 | 5.49 | 7.94 |
| 2 | 11-66 kV | 2.44 | 3.05 | 4.58 | 5.49 | 7.94 |
| 3 | 110-132kV | 3.05 | 3.05 | 4.58 | 5.49 | 7.94 |
| 4 | 220kV | 4.58 | 4.58 | 4.58 | 5.49 | 7.94 |
| 5 | 400kV | 5.49 | 5.49 | 5.49 | 5.49 | 7.94 |
| 6 | 800kV | 7.94 | 7.94 | 7.94 | 7.94 | 7.94 |

Provided that no guar ding's are required when line of voltage exceeding 33 kV crosses over another line of250 V and above voltage or road or a tram subject to the condition that adequate clearances are provided between the lowest conductor of the line of voltage exceeding 33kV and the top most conductor of the overhead line crossing under neat the line of voltage exceeding 33 kV and the clearances as stipulated in regulation 58 from the topmost surface of the road maintained.

**k. Clause70**

**Guarding:**

1. Where guarding is required under these regulations the following shall be observed namely:
   i. Every guard-wire shall be connected with earth at each point at which its electrical continuity is broken.
   ii. Every guard-wire shall have an actual breaking strength of not less than 635 kg and if made of iron or steel shall be galvanised.
   iii. Every guard-Wire or cross-connected systems of guard-wires shall have sufficient current-carrying capacity to ensure them rendering dead, without risk of fusing of the guard-wire or wires, till the contact of any livewire has been removed.
2. In the case of a line crossing over a trolley wire the guarding shall be subjected to clause 70 of the regulation.

**l. Clause 71**

**Service lines from overhead lines:**

No service-line or tapping shall be taken off an overhead line except at a point of support.

Provided that the number of tapings per conductor shall not be more than four in case of connections at voltage not exceeding 650 V.

**m. Clause 73**

**Safety and protective devices:**

1. Every overhead line which is not being suspended from a dead bearer wire, not being covered with insulating material and not being a trolley-wire, is erected over any part of a street or other public place or in any factory or mine or on any consumer's premises shall be protected with earth guarding for rendering the line electrically harmless in case it breaks.
2. An Electrical Inspector may by notice in writing require the owner of any such overhead line, wherever it may be erected, to protect it in the manner specified in sub-regulation (1).
3. The owner of every overhead line of voltage exceeding 650 V shall make adequate arrangements as per relevant Indian Standards to prevent undesignated persons from ascending any of the supports of such overhead lines

which can be easily climbed upon without the help of a ladder or special appliances.

**n. Clause 74**

**Protection against lightning:**

1. The owner of 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 subject to the avoidance of bends wherever practicable.

**o. Clause 75**

**Unused overhead lines:**

Where an overhead line ceases to be used as an electric supply line:

1. The owner shall maintain it in a safe mechanical condition in accordance with regulation 57 or remove it.
2. The Electrical Inspector shall by a notice in writing served on the owner, require him to maintain it in a safe mechanical condition or to remove it within thirty days of the receipt of the notice.

## 7.4 EXCAVATIONS

1. Proper and adequate timber sorting and bracing shall be provided to prevent sliding or slipping of loose or unstable earth, rock or other material or caving in of excavation.
2. Undercutting of banks of trenches and other excavations shall be avoided.
3. Excavated material shall be dumped away from the edge of the excavated trench to avoid the slipping of excavation material into the trench.
4. Excavation shall be properly fenced to protect men and animals from falling in.

5. Warning sign shall be placed near the excavation to warn the approaching traffic and men. At night, red danger light shall be displayed at a conspicuous point near the excavation.

## 7.5 CONCRETING AND CEMENTING

1. If working at a height, the workers should use life lines or safety belts.
2. Workers handling cement or concrete shall protect themselves by wearing rubber boots and rubber gloves as required.
3. Proper guards and covers shall be provided on mixer gears, chains and rollers.

## 7.6 EQUIPMENT CONTAINING SULPHUR HEXAFLURIOE (SF6) GAS

1. **Purpose: -**To control inherent dangers involved in Equipment containing SF6.
2. **Scope**: This utility safety instruction applies the principle established by the Safety Rules to achieve Safety from the System for person working on equipment which contains or has contained Sulphur Hexafluoride gas (SF6).
3. Equipment identification:
    i. Equipment on which work is to be carried out must be readily identifiable. Where necessary, a means of identification must be fixed to it that will remain effective throughout the course of the work.
    ii. Gas zones must be identified as per the layout of equipment.
    iii. Cover plates giving access to portable maintenance earthing positions must be identified. Each position must also be uniquely identified on the enclosure adjacent to its access cover.
4. Dangers

    The main dangers to authorized line staff from equipment containing SF6 Gas:-

    - Asphyxiation or suffocation.
    - Electric shock.
    - Burns.
    - The release of stored mechanical energy or pressure.

- Toxic break down products which can be formed within the Equipment.
- Damage to ozone layer.

5. Preparation for work

i. Gas Pressure:

Where the integrity of an EHV/HV Point of Isolation is dependent on the presence of SF6 gas, the gas density must be monitored throughout the period of work. This function may be performed by an automatic alarm system. Care must be taken that if such a system is used it is in service and that it has been regularly tested to prove its operation at low density immediately prior to establishment of an EHV/HV Point of Isolation. Any loss of gas density must be reported immediately to the Maintenance Engineer/Testing Engineer and Shift In-charge.

ii. Demarcation of work area-

The boundaries of the Equipment on which it is safe to work must be clearly identified.

iii. When depressurization is required: when de-pressurization is required, the following precautions must be taken to achieve Safety from the System.

a) The equipment must be drained of SF6. This must be carried out in accordance with the approved Procedure relating to Sulphur Hexafluoride gas.

b) A point of Access notice must be displayed at each initial entry point. These notices must be fixed or moved by maintenance authorized line staff under the Supervision of maintenance/testing engineer.

c) A Permit to Work or Sanction for Test must be issued for the work to proceed and where appropriate, the recommendations for General Safety Report must specify the further precautions to be taken to deal with any arc products which may be present. The removal and disposal of any product must be in accordance with the approved procedure relating to Sulphur Hexafluoride gas.

## 7.7 TRANSPORTATION

### A. GENERAL PRECAUTIONS

1. Equipment should be kept in good operating condition and the vehicle should be driven in a safe manner so as to prevent injury to the authorized line staff and others.
2. Authorized line staff shall not operate a car or truck, unless has the proper license in his possession.
3. Every driver of the car or truck shall be thoroughly familiar and comply with the State and city traffic laws covering the territory where he operates.
4. Confirm that the RTO passing is done for the vehicle.
5. Labour carrier certificate (5 yearly) approved by RTO should be available.
6. Test the brakes, clutch, horn and lights.
7. See that tyres are in good condition and properly inflated.
8. Check emergency equipment's such as first aid kits, jacks and tools. Any equipment found missing or defective should be reported immediately.
9. Every driver shall report the vehicle's defect if any is detected.
10. Before filling the fuel tank, the motor should always be shut off. The hose nozzle should be kept in contact with the tank to avoid static sparks. While filling the petrol tank, smoking or using an open flame near the vehicle should be avoided.

### B. DRIVING

1. Most traffic accident can be prevented by faithful observation of three things:
    I. 'Control speed', speeding is dangerous. A few minutes saved at the cost of an accident is no bargain.
    II. Avoid distraction. Give your undivided attention to the job of driving. Keep your eyes on the road.
    III. Drive defensively. Don't insist on your right of way. Try to anticipate the intention of other drivers and pedestrians. Their failure to observe traffic regulations does not justify your running into them.
2. Keep safe distance from the vehicle in front.

3. Do not attempt to pass another vehicle going in the same direction unless you can plainly see far enough ahead to be sure you can pass safely. Proper horn signal should be given before passing.
4. Do not drive to the right of the road centre when approaching the crest of a hill, an intersection, rail road crossing or curve where full view of the roadway ahead is obstructed.
5. Before starting a parked vehicle, observe front and rear to make sure that authorized line staff and objects are out of the way.

**C. OPERATION OF TRUCKS AND TRAILERS**

1. Before starting a truck, the man in charge of the party should carefully inspect the loading of material and see that wherever necessary, the material is secured safely and that all men are safely aboard.
2. Loadings of vehicles should not exceed their rated capacity and objects should not be permitted to be extended beyond the sides unless the necessary permit has been obtained from the Authorities.
3. The passengers carried in trucks should not exceed the legally permitted number.

**D. PROCEDURE IN TRAFFIC ACCIDENT**

1. Do not get involved in an argument as to who was responsible for the accident, but endeavour to get all facts in the case. Remember that accidents which may appear trivial often result in claims for authorized line staff injury or property damage.
2. Do not lose your temper, try to be courteous and helpful.
3. Following instructions should be observed in the order given, if possible, when you are involved in a traffic accident:

a. STOP-Pull over to the curb or out of traffic, if possible. Never leave the scene of an accident with stopping to identify yourself and render such assistance as possible.

b. Assist injured authorized line staff in so far as you are able, giving immediate attention to severe bleeding. Do not move seriously injured authorized line staff unless necessary for their protection against further injury. Send for doctor and ambulance, if necessary.

c. When requested give your name, address, company affiliation and show driver's license to the other party.

d. Secure name, address and license number of the other driver, car license number and names and addresses of car owner and insurance company.

e. Record names and address of witnesses.

f. Unless some policeman is present at the scene of the accident, notify police having jurisdiction in the territory.

g. Sketch the location showing position of vehicles or pedestrians involved and any special conditions such as obstructions, parked cars, skid marks, show date, time of day, weather and road conditions and any other information which you may consider useful.

h. Notify your supervisor and also submit written report with all useful information which you possess.

**E. TRANSPORTING AND STORING OF MATERIAL NEAR OVERHEAD LINES**

1. No rods, pipes or similar materials shall be taken below or in the vicinity of any bare overhead conductors or lines if they are likely to infringe the provisions for clearance under regulation 60 and 61 of CEA (measures relating to safety and Electricity Supply) Regulation, 2010 unless such materials are transported under the direct supervision of a competent authorized line staff authorized in this behalf by the owner of such overhead conductors or lines.
2. Under no circumstances rods, pipes or other similar materials shall be brought within the flash over distance of the bare live conductors or lines.

# Chapter 8

## SAFETY BINDING ON CONTRACTORS

### 8.1Regulation 7 of Central Electricity Authority (Safety requirements for construction, Operation and Maintenance of Electrical plants and Electric Lines), Regulations 2011.

**Safety provisions relating to contractor:-**

1. The Owner shall incorporate the safety provisions in the contract document which are required to be complied by the contractor's employee during execution of the contract to facilitate safe working during execution of the work.
2. The Contractor shall observe the safety requirements as laid down in the contract and in case of sub- contract, it shall be responsibility of main contractor that all the safety requirements are followed by the employees and staff of the sub-contractor.
3. The contractor employing two hundred employees or more, including contract workers, shall have a safety coordinator in order to ensure the implementation of safety requirements of the contract and a contractor with lesser number of employees, including contract workers, shall nominate one of his employees to act as safety coordinator who shall liaise with the safety officer on matters relating to safety and his name shall be displayed on the notice board at a prominent place at the work site.
4. The Contractor shall be responsible for non-compliance of the safety measures, implication, injuries, fatalities and compensation arising out of such situations or incidents.
5. In case of any accident, the contractor shall immediately submit a statement of the same to the owner and the safety officer, containing the details of the accident, any injury or causalities, extent of property damage and remedial action taken to prevent recurrence and in addition, the contractor shall submit a monthly statement of the accidents to the Owner at the end of each month.

### 8.2 Safety aspects during Civil Work

1. The plan layout of the sub-station for method of construction and route of line must be got approved from Electrical Inspector.

2. After approval of Electrical plan layout of switchyard, a civil foundation plan layout is to be prepared and got approved from competent authority the only the civil work is taken in hand.
3. Land Leveling:
    i. The leveling of the land is done to make available a plain land for switchyard development.
    ii. There shall not be water logging during the rainy season/ rain water must drain away.
    iii. The level of the cable trench should be maintained so that water will be drained away immediately.
4. Construction quality has long term effect on Safety, hence ensure excellent quality of work during every stage of the project construction.
5. The record of the civil quality test taken at all stages of construction must be documented/ preserved.
6. Seasonal and trained young workers must be engaged for civil work, preferably with knowledge of site.
7. Workers protective equipment's like helmet, safety belts, boots etc. must invariably be used while working.
8. The contractor will maintain a first aid box, get the safety, first aid and disaster management training carried out for his staff.
9. Child Labor- It is criminal to employ the child labor.

### 8.2.1 Unsafe conditions in civil work

| S.No. | Unsafe Conditions | Prevention |
|---|---|---|
| 1 | Risk of fall of worker during installation due to:<br>i. Open pit of civil foundation.<br>ii. Open Cable Trench.<br>iii. Unguarded opening from First/Second floors in slabs. | i. The foundation pit must be barricaded by the rope and danger signs.<br>ii. Put cable trench covers.<br>iii. Put barricade around the opening and place danger/warning signs as necessary. |
| 2 | Mistake in Civil Layout<br>i. Insufficient clearances. | The plan of the layout must be got approved from competent authority |

| | | |
|---|---|---|
| | ii. Insufficient clearances for movement. | and take necessary corrective steps during construction in consultation with competent authority. |
| 3 | Uneven Foundation<br>i. Inclined superstructure<br>ii. Inclined equipment | The level of the foundation must be maintained and level to be taken by dumpy level must be taken before casting the foundation. |
| 4 | Accident during transportation/ material handling<br>i. Road not ready<br>ii. Inadequate strength width/ curvature | Good quality internal road must be ready with adequate width and curvature before actual transportation of material is started. |
| 5 | Uneven roof level | Arrangement must be made to drain out the rainy water so that the water leakage is eliminated. |
| 6 | Snakes in the cable trench | Use poisonous gas sprays at regular intervals. |
| 7 | Inadequate water arrangement and its storage | Before start of work the water arrangement must be made for<br>i. Drinking<br>ii. Civil Work<br>For the initial stage of civil work, temporary water arrangement must be done for drinking and other works. |
| 8 | Open water pipe line | The pipe must be laid underground. |
| 9 | Roof leakage during rains and water spray through window | Water proofing of roof top parapet wall above window should be done. |

### 8.2.2 Unsafe Act in Civil work

| S.No. | Unsafe Act | Prevention |
|---|---|---|
| 1 | Digging in the switchyard without knowledge of underground wiring/ cable/water pipe line. | Work must be taken under the supervision of authorized line staff with adequate knowledge of the site. |
| 2 | Putting a lot of debris and garbage in the yard. | Put the yard clean, keep out unwanted equipment/ material outside the yard as soon as the work is over. |
| 3 | Large heap of soil from excavation | Put danger signs and barrier fencing round the uncompleted work. |
| 4 | Running around in the yard with rush of work | Plan the work and be calm on the worksite. |
| 5 | Survey in the substation by Iron Ranging Rod. | Use bamboo in place of iron rod. |

## 8.3 Identification of the name of equipment and demarcation of work hazardous/ dangerous area in view of safety.

### 8.3.1 Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulation 2010.

1. **Clause 18**

   **Danger Notices:**

   The owner of every installation of voltage exceeding 250 V shall affix permanently in a conspicuous position a danger notice in Hindi or English and the local language of the District, with a sign of skull & bones of a design as per IS-2551:-

   a. Every motor, generator, transformer and other electrical plant and equipment together with apparatus used for controlling or regulating the same.
   b. All supports of overhead lines of voltage exceeding 650 V which can be easily climbed upon without the aid of ladder or special appliances.

c. Luminous tube sign requiring supply, X-ray and similar high frequency installations of voltage exceeding 650 V but not exceeding 33 kV.

Provided that where it is not possible to affix such notices on an, generator, motor. Transformer or other apparatus, they shall be affixed as near as possible thereto or the word "danger" and the voltage of the apparatus concerned shall be permanently painted on it:

Provided further that where the generator, motor, transformer or other apparatus is within an enclosure, one notice affixed to the said enclosure shall be sufficient for the purposes of this regulation.

Explanation-For the purpose of clause (b) rails, tubular poles, wooden supports, reinforced cement concrete poles without steps, I-sections and channels, shall be deemed as supports which cannot be easily climbed upon.

2. **Clause 24**

   **Distinction of different circuits:**

   The owner of every generating station, substation, junction-box or pillar in which there are any circuits or apparatus, whether intended for operation at different voltages or at the same voltage, shall ensure by means of indication of a permanent nature that the respective circuits are readily distinguishable from one another.

3. **Clause 25**

   **Distinction of the Installations having more than one feed:**

   The owner of every installation including sub-station, double pole structure, four pole structure or any other structure having more than one feed, shall ensure by means of indication of a permanent nature, that the installation is readily distinguishable from other installations.

4. **Clause 73**

   **Safety and protective devices:**

   a. Every overhead line which is not being suspended from a dead bearer wire, not being covered with insulating material and not being a trolley-wire,is erected over any part of a street or other public place or in any factory or mine or on any consumer's premises shall be protected with earth guarding for rendering the line electrically harmless in case it breaks.

b. The owner of every overhead line of voltage exceeding 650 V shall make adequate arrangements as per relevant Indian Standards to prevent undesignated persons from ascending any of the supports of such overhead lines which can be easily climbed upon without the help of a ladder or special appliances.

**8.4 WARNING BOARDS**

Warning boards shall be placed by the authorized line staff-in-charge, on all switchgear before men are permitted to work and should only be removed by the authorized line staff who has placed them. It is desirable that the authorized line staff issuing the permit shall place one warning board on the switch energizing the mains for each permit issued so that he can be sure that all the permits-to-work are returned when he has to charge the mains.

**8.5 VISITORS AND UNAUTHORIZED PERSONS**

Visitors and unauthorized persons shall not be allowed to proceed to the vicinity of live mains and apparatus, unless accompanied by an authorized line staff that will be responsible to ensure that his instructions regarding safety are strictly complied with.

**8.6 WARNING THE PUBLIC**

When, either accidently or otherwise, live mains and apparatus pose a danger to authorized line staff in a public place, an authorized line staff shall be directed to stand at such locations for authorized line staff working until the danger has been removed/ cleared.

**8.7 DANGERS**

The main Danger to authorized line staff working in substation.

- The possibility of mistaking Equipment on which it is unsafe to work.
- Inadvertently infringing safety clearances.
- Other induced voltage on the equipment from adjacent/ nearby live equipment line/ line.
- Failure to make proper use of authorized line staff protective equipment's.
    i. Where work is to be carried out near to equipment which may be live, then the limits of the work area must be defined as per the Safety clearance.

ii. Boundary mark must be clearly identifiable and easy to see. They must only be fixed or removed only by the maintenance authorized line staff under the supervision of the Maintenance Engineer/ Shift Engineer.

**8.8 BOUNDARY MARKING SHOULD:**

- Be independently supported.
- Not to be attached to any structure supporting any equipment.
- Not carry any notice.

The boundary of the work area must be identified using plastic tape or nylon rope of about 8/10 mm diameter.

Where the work is separated from adjoining areas by fixed screens, the work must be identified by green cones placed within the safe area and visible from the outside at each point of access. The fixed screens must remain in position during the course of the work.

# CHAPTER 9:

# FIRE

## 9.1 INTRODUCTION:

Fire is a great destructive natural force. It can destroy vital stores, equipment's, accommodation and amenities. Majority of Fires, which affected properties, are due to carelessness, ignorance, arson, lack of discipline and failure to observe statutory and general regulation. A little knowledge on this subject may save loss of lives and properties.

## 9.2 CEA REGULATIONS ON FIRE PREVENTION

The Central Electricity Authority (Measures relating to Safety of Electric Supply) Regulation 2010 has made following regulations:

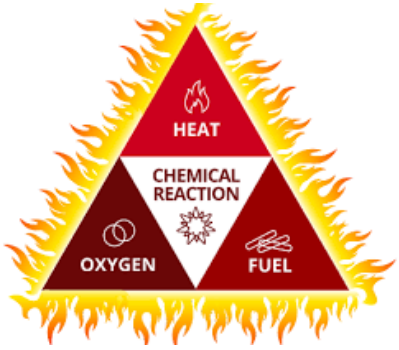
1. Fire buckets filled with clean dry sand and ready for immediate use for extinguishing fires, in addition to fire extinguishers suitable for dealing with fires, shall be conspicuously marked and kept in all generating stations, enclosed sub-stations and switching-stations in convenient location.
2. 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. No other service pipe and cables shall be taken along the ducts provided for laying power cables and all ducts provided for power cables and other services shall be provided with fire barrier at each floor crossing.
4. Where a sub-station or a switching station with apparatus having more than 2000 litres of oil is installed, whether indoors or outdoors, following measures to be taken.
    a) The baffle walls of four hours fire rating shall be provided between the apparatus where there is a single phase transformer banks in the switch-yards of generating stations and sub-stations.
    b) Provision 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 which may leak or escape from the tank, receptacle or chamber containing the same, and special precautions shall be taken to prevent the spread of any

fire resulting from the ignition of the oil from any cause and adequate provision shall be made for extinguishing any fire which may occur.

1. It is to ensure that the transformers of 10 MVA and above rating or in case of oil filled transformers with oil capacity of more than 2000 litres are to be provided with fire fighting system as per IS-3034: 1993 (FIRESAFETYOFINDUSTRIALBUILDINGS:ELECTRICALGENERATINGAND DISTRIBUTING STATIONS - CODE OFPRACTICE)or with Nitrogen Injection Fire Protection system.
2. Where it is necessary to locate the sub-station, or switching station in the basement, the following measures shall be taken:-
    a) The entrances to the room shall be provided with fire resisting doors of 2 hour fire rating and the door shall always be kept closed and a notice of this effect shall be affixed on outer side of the door.
    b) Direct access to the transformer room shall be provided from outside and the surrounding walls shall be lined with fire bricks.
    c) Fire Retardant Low Smoke (FRLS) cable of two hours rating shall be used.

## 9.3 BASIC OF FIRE:

Ordinary Fire is a chemical reaction between a fuel and oxygen in presence of heat. In other words, it may be stated that three things are essential to initiate a Fire viz. OXYGEN, FUEL & HEAT which can be represented as three arms of a triangle. The triangle is known “Fire Triangle”. A Fire cannot take place in absence of any one of these three factors.




Fuel Triangle

## 9.4 TYPES OF FIRE:

1. Class A – Wood, paper, cloth, trash, plastics, solid combustible materials that are not metals.
2. Class B – Flammable liquids: gasoline, oil, grease, acetone. Any non-metal in a liquid state, on fire.
3. Class C – Flammable Gases: Propane, Butane, Acetylene.
4. Class D – Metals: potassium, sodium, aluminium, magnesium.

## 9.5 FIRE EXTINGUISHERS:

1. For extinguishing fire on combustible materials such as paper, wood etc use ABC type fire extinguishers.
2. For extinguishing fire on electrical equipment use only carbon dioxide or dry powder.
3. The information regarding suitability of Fire extinguishers is given in form of capital letters in circle. If character 'A' is written inside the circle then it is suitable for Class-A Fires. If characters 'B'&'C' are written then it is suitable for Class-B &Class-C Fires.


CO2 Extinguisher


ABC type Extinguisher


Dry Powder Extinguisher

4. The method of operation of Fire extinguishers varies from type and capacities. It is, therefore, essential to read carefully the method of operation written on the sticker of particular Fire extinguishers. While the specifics may vary depending on the model you own, most fire extinguishers operate the same basic way. Stand six to eight feet away from the fire and remember to **PASS**:
    - **PULL** the pin on the extinguisher.
    - **AIM** the hose nozzle low toward the base of the fire.

- **SQUEEZE** the handle to release the extinguishing agent.
- **SWEEP** the nozzle from side to side at the base of the flames until extinguished.

## 9.6 PRINCIPLE OF FIRE FIGHTING:

To eliminate any one of the three factors causing fire namely

1. **Cooling Method**: The method in which heat of burning substance is removed, generally by using water is known as cooling method. Water brings the heat of substance under fire below the ignition temperature of substance. This method is normally applied in extinguishing fire of solid combustible materials.

   This method must not be adopted for fighting live electrical fire. This method is applied for extinguishing electrical originated fire only after ensuring the cut-off of power supply.
2. **Smothering Method:** The method in which Oxygen is removed from burning substances is known as smothering. In this method oxygen is restricted to Fire by using layers of foam or inert gases like CO2, Nitrogen, Chloro fluoro carbon or Dry chemical powder. Sometimes this is achieved by proper blanketing of Fire using fire blankets or asbestos blanket or other available non-combustible materials. This method is normally used for extinguishing fire in flammable liquids.
3. **Starvation Methods:** The method in which the fuel or combustible material is removed from fire is known as starvation method. This is achieved by removing burning substance from the scene of fire. Fire in pipe lines, cylinders, tankers containing flammable liquid or gas is controlled by closing the valves. By closing valves the fuel or combustible materials are isolated from fire and thus starvation is achieved. This method is best used for extinguishing fire in pipelines, cylinders containing flammable liquid or gas.

## 9.7 TO PREVENT FIRE AND EXPLOSIONS

1. Waste paper, rags and other combustible materials should not be allowed to accumulate.
2. Flammable liquids shall be kept in approved safety cans and identified by proper labels.

3. Varnish, paints, lacquers and thinners are highly inflammable and should be stored away from all open flames or possible source of ignition. Matches and open flames should not be used where varnish paint or lacquer is applied with a spray gun.
4. Open flames and smoking are prohibited in all areas where inflammable liquids or gases are stored or being used. Such areas shall be posted with appropriate warning signs.
5. All employees should be familiar with the location and proper use of fire extinguisher in their work area.
6. Power cables and control cables shall run in separate trenches, wherever possible.

# CHAPTER 10:

## ACCIDENTS REPORTS, RECORDS AND INVESTIGATION

An accident is any unplanned event that results in person injury or damage to property. The accidents result in loss of lives and/or damage to property apart from leading to loss of production hours and disruption of work and/or service. Many accidents occur almost every day for various reasons. The failure of people, equipment, supplies or surroundings to behave or react as expected causes most of the accidents. Proper investigation of the accidents reveal the cause of such accidents and thereby helps to prevent similar or perhaps most disastrous accidents. The approach for the accident investigation should be an effort of 'FACT FINDING' and not 'FAULTFINDING'.
Generally the accident require skilled investigations to arrive at the cause of accidents.

1. **Near-Miss Accidents**- These are accidents which could have caused serious damages but missed narrowly. Though there could be no damage as such, the potential for a serious incident is quite obvious and therefore calls for investigation and recommending remedial measures.

   The main purpose of a Near-Miss Accident Investigation is to determine the CHANGE OR DEVIATION that produced an ERROR that in turn resulted in an accident. By uncovering the reasons for the accident, subsequent accidents of similar or more serious in nature may be prevented by improving the mechanical system, better supervision or authorized line staff training and public awareness programs.
2. Accidents records are essential aids for prevention of accidents. They provide vital information regarding the frequency of occurrence, type of accident, place of occurrence and its relative severity. A study of these records emphasize common hazards and prompts a better understanding of the causes of accidents and most effective method of preventing them.
3. All accidents / incidents and 'near-misses' should be recorded, reported and investigated in accordance with the company's Safety Policy.
4. Each employee is responsible for reporting accidents / incidents to which they are party / witness and should liaise with their controlling officers/ supervisors in this regard. The controlling officers/ supervisors should ensure that the company accident / incident reporting form is completed in each instance.

5. All accidents to the public involving company personnel, equipment or property shall be reported promptly.
6. Every accident should be investigated to determine the cause and identify steps so as to prevent recurrence. It shall be the responsibility of the person in charge of the job to collect the detailed information about the accident at the earliest after its occurrence.
7. All accidents whether they result in personal injury or not, shall be promptly investigated by the Divisional Head or his representative.
8. A detailed accident report must be submitted to the Zonal Level, Corporate Level within 48 hours. The report should also contain employee statements actually present at the accident spot, including the diagram describing the accident.
9. Under statutory guidelines as per the Electricity Act 2003 and UERC (Distribution code) Regulations, 2018- Reporting of accidents shall be in accordance with Intimation of Accidents (Form and Time service of Notice) Rules, 2004, read with section 161 of the Electricity Act, 2003. If an accident occurs in the distribution system resulting in or likely to have resulted in loss or injury to human or animal life, the Distribution Licensee shall send a telephonic report to the Electrical Inspector within 24 hours of the knowledge of such occurrence. This shall be followed by a report in writing in the form given in **Annexure-III** (as per Form A of Intimation of Accidents (Form and Time service of Notice) Rules, 2004), within 48 hours of the knowledge of occurrence of fatal and other accidents.
10. The reporting format for accidents for immediate reporting to department is enclosed in **ANNEXURE II**.

## 10.1 INVESTIGATION: [6]&[7]

### 10.1.1 Investigation Kit:

For investigating purpose the investigating authorised line staff should have some basic equipment and facilities. The kit should contain the basic equipment required for carrying out an effective investigation. Additional equipment may be necessary based on the type and scope of the incident to be investigated. Some of the important items that are needed for successful investigation are as follows:

1. Camera.
2. Tape recorder procedure laid down by the competent agencies.

3. Telephone or any other mode of communication.
4. Codes/Standards for operation such as Indian Standards, CEA Regulations, standard engaged in such activities, International standards relevant to area of operation such as OSHA, NESC NEC and also the company safety manual.
5. Authorized line staff protection equipment (PPE). (Helmets, safety glasses, hand gloves etc.)
6. Warning Signs.
7. Caution tapes/ boards
8. Lighting (flashlight, portable lights etc.).
9. Compass
10. Thermometer (inside and outside temperature).
11. Anemometer (checking wind speed).
12. First aid kits.
13. General tools as needed.
14. Measuring tapes, protractor etc.
15. Various types of tapes like flagging tape, masking tape etc.
16. Marking paint/ chalk
17. Evidence containers (small and large zip-lock bags and/or manila envelopes).
18. Identifying tags/stickers.
19. Pens, pencils, marker pens etc.
20. Clipboards
21. Sketchpad and note pad.
22. Reporting formats.

## 10.2 INVESTIGATION STEPS:

### 10.2.1 Controlling the Scene:

Generally when an accident takes place the area is crowded by the people who are unconcerned and during investigation this not only causes the hurdles in providing necessary assistance for the injured but also destroys the necessary data that may be available at accident site which are vital for accident investigation. As such first and foremost job is to control the area and offer necessary medical aid for the suffering people. Therefore the activities can be grouped as follows:

1. First aid.
2. Transport for medical care.

3. Control/ containing existing hazards.
4. Prevent further injuries.
5. Get more help, if needed.
6. Preserve evidence.

It should be ensured that it is safe for the accident investigation team to enter the accident scene. Necessary care should be availed if need in such cases.

Next isolate the scene by whatever means as necessary (signs, barrier, caution tapes etc.) so that there is no entry of unauthorised line staff / unauthorized persons and also there is no chance of destroying of evidences. When the scene is safe and isolated, begin with the basics of accident investigation. Preserve the accident scene site.

### 10.2.2 Gathering Data:

1. Photos of accident scene.
2. Drawings, sketches and measurement.
3. Date Collection.
4. Details of the authorized line staff involved.
5. Date, time, location.
6. Activities at time of accident.
7. Equipment involved.
8. List of Witnesses.

The effects of following contributing factors also to be considered during investigation

1. Weather conditions.
2. Noise levels.
3. Lighting.
4. House Keeping.
5. Safety Equipment used.
6. Safety Equipment not used.

The statement from the victims should be recorded and wherever possible necessary information and statement from witness are also should be recorded.

Close observation should be carried out on the parts, tools or equipment's involved in the accident by looking for wear, missing pieces, misalignment or out of adjustment or any previous damage.

All safety devices like guards etc. are to be observed whether they are in place and functional or not.

All loose evidences should be gathered and tagged. Date, time and location are to be recorded.

Nothing should be thrown away and all the evidence should be kept in one location till the findings are made and concluded.

#### 10.2.2.1 Important points while taking photographs:

Photographs should be taken from various positions and angles so as to cover entire scene and without leaving anything for assumption on a later date. Photos should reveal and document the conditions. Photos of marks and debris should also be taken. If possible photos of the nearest sign/ landmark etc. should be taken to indicate location. It is better to use a ruler, next to the object to provide an accurate scale for close up photographs. An explanatory note on each photograph indicating the details and also date and time would be helpful in future dates.

#### 10.2.2.2 Sketches and Measurement:

All measurement of essential information should be indicated in a sketch. Measurement is to be taken before any evidence is moved or removed. Sketches should be made indicating the location and position of people, equipment, materials and facilities.

#### 10.2.2.3 Paper Evidence:

The following records will also give some insight in to the reasons for accidents:

1. Training records of the authorized line staff involved in the accident.
2. Maintenance of log books of the equipment where the authorized line staff was engaged in the work and caused accidents.
3. Schedule for check-up, maintenance etc.
4. Job procedures work instructions.
5. Job briefing reports like work permit etc.
6. Inspection reports of the equipment where the accident took place.

#### 10.2.2.4 Information Interviews:

This is the method of collecting the information directly from the authorized line staff who were made available at the scene at the time of accident. This information helps to pin the point of causes of deaths.

Typical questions to be asked to Supervisors would be as follow:

1. What is normal procedure for activities involved in the accident?
2. What type of training authorized line staff involved in accident have had?
3. What if anything was different today?
4. What they think caused the accident?
5. What could have prevented the accident?
6. What did you see?
7. What did you hear?
8. Where were you standing/ sitting?

Certain points should be borne in mind while conducting interviews as follows:

1. Gather just the facts. Make no judgements or statements.
2. Conduct interviews one on one.
3. Be friendly but professional.
4. Conduct interviews near the scene in private.
5. Interview all supervisors.
6. The interview with witnesses should be carried out as soon as possible while the details of the incident are fresh in their minds.

#### 10.2.2.5 Detail of Witnesses:

Name, address, phone numbers of all the witnesses should be noted down.

### 10.2.3 Analysing the Data:

The analysis of facts concerning accidents is the process of identifying the cause of an accident from the facts that have been gathered by the investigation. Analysis will then classify the accident facts (casual factors) and developed recommendations for changes of casual factors in order to prevent re-occurrence of the accident in the future.

1. Gather all photos, drawings, interview material and other information collected at the scene.
2. Determine a clear picture of what happened.
3. Formally document sequence of events.

#### 10.2.3.1 Classification of data of Analysis and causes:

1. Unsafe Acts what activities contributed to the accident.
2. Unsafe Conditions what material conditions, environmental conditions and equipment condition contributed to the accident.

#### 10.2.3.2 Analysis about the contribution of safety controls:

1. Engineering Controls: machine guards, safety controls, isolation of hazardous areas, monitoring devices.
2. Administrative Controls: procedures assessment inspection, records to monitor and ensure safe practices and environments are maintained.
3. Training Controls: initial new hire safety orientation, job specific safety training and periodic refresher training.

#### 10.2.3.3 Identification of the controls that have failed:

List the specific engineering, administrative and training controls that had failed and how these failures contributed to the accident.

#### 10.2.3.4Identification of the controls that have worked properly:

List any controls that prevented a more serious accident or minimized collateral damage or injuries.

#### 10.2.3.5 Determine:

1. What was not normal before the accident?
2. Where the abnormality occurred?
3. When it was first noted?
4. How it occurred?

#### 10.2.3.6 Conclude:

1. Unsafe Acts.
2. Unsafe Conditions.

#### 10.2.3.7 Final Analysis:

1. Define the Problem (what happen?)
2. Establish the norm (what should have happened?)

3. Identify, locate and describe the change than ideal one (what, where, when, to what extent)
4. Specify what was and what was not affected.
5. Identify the distinctive feature of the change.
6. List the possible causes.
7. Select the most likely causes.

**10.2.3.8 Prevention:**

What needs to change or to be improved to prevent similar accidents in the future?

1. Engineering Controls.
2. Administrative Controls.
3. Training Controls.

**10.2.4 Report Writing:**

Final report should be precise and should contain every detail without giving room for any ambiguity or contradicting interpretation. It should highlight the pre and post activities of the accidents also so that it will help to implement the preventive measures. The report should have clear recommendation for preventing the recurrence of similar accidents.

**10.2.4.1 Final Report:**

1. Background information where, when, who, how and what.
2. List of those involved and other witnesses.
3. Account of the accident-sequence of events, extent of damage, accident type and source.

**10.2.4.2 Identification of Causes:**

1. Analysis of the accident.
2. Direct Causes (energy sources, hazardous materials).
3. Indirect Causes (Unsafe acts and conditions).
4. Basic causes (management policies, authorized line staff or environmental factors).

**10.2.4.3 Remedial Actions:**

1. Basic causes.

2. Indirect causes.
3. Direct causes.

#### 10.2.4.4 Recommendations:

As a result of the finding if there is a need to make changes to:

1. Authorized line staff training.
2. Changes to be incorporated in the equipment/system/conditions.
3. Policies of procedure.

After developing a formal report, forward it for review and action by the competent authorities. Preserve the report and complete records/data/photographs/sketches pertaining to the investigation in a single file.

# CHAPTER 11:

## FIRST AID

A person/animal is electrocuted when current passes through the body. Electricity is one of the most commonly encountered hazards in any facility. Under normal conditions, safety features built into electrical equipment protect workers from shock. Shock is the flow of electrical current through any portion of the worker's body from an external source. Accidents can occur in which contact with electricity results in serious injury or death.

Most electrical systems establish a voltage reference point by connecting a portion of the system to an earth ground. Because these systems use conductors that have electrical potential (voltage) with respect to ground, a shock hazard exists for workers who are in contact with the earth and exposed to the conductors. If a person comes in contact with an energized (ungrounded) conductor, while also in contact with a grounded object, an alternate path to ground is formed in which current passes through his or her body.

The effects of electric current on the human body depend on many variables, including the:

1. Amount of current.
2. Waveform of the current.
3. Current's path through the body.
4. Duration of shock.

The amount of current passing through the body depends on:

1. Voltage driving the current through the body.
2. Frequency of the current.
3. Contact resistance and internal resistance of the body.
4. Environmental conditions affecting the body's contact resistance.

The heart and brain are the parts of the body most vulnerable to electric shock. A current of 10 mA is sufficient to paralyze a human being and a current of 30 mA may cause respiratory paralysis for the victim. If a person is electrocuted, first aid given in time can save the life of a victim. FIRST AID is the immediate and temporary care, given to the victim of an accident or sudden illness. The purpose of first aid is to preserve life,

assist recovery, prevent aggravation and minimise complication at the later dates with the help of such materials as may be available.

## 11.1 RESUSCITATION DRILL

Every employee shall qualify himself by practical study and drill in the treatment for electrical shock according to the instructions contained in this Chapter, and those given in the Resuscitation Cards hung up at all the Receiving Stations, Sub stations, Switching Stations, etc., of the Corporation.

## 11.2 REMOVAL FROM CONTACT

1. If the person is still in contact with the apparatus that has given the shock, switch off the electric circuit at once, if there is switch, fuse or circuit breaker close at hand, if not, lose no time from proceeding to remove the body from contact with the live conductor.
2. Do not touch the victim's body with bare hands, but if rubber gloves are not at hand, pull him off the live conductor by his coat, shirt, etc., if they are not wet or fold your coat, or some dry article such as a news- paper into three or more folds/ thickness, and using this as a pad, take hold of the body and pull it away from the circuit. An operating rod or a broom handle may be used to raise the body or to detach the wires from it. A good plan is to stand on a dry board or stool or on a few layers of thick newspaper or bundle of dry sacking and remove the victim away from the live apparatus.

## 11.3 PRELIMINARY STEPS

1. Extinguish any sparks if the patient's clothes are smouldering. Ascertain if he is breathing, and send for a doctor at once. If apparently not breathing, proceed as detailed hereunder:

## 11.4 IMMEDIATE ACTION TO RECOVER THE PATIENT

1. When a man has received a severe electric shock or been subjected to poisonous gases, or has been removed from the water in a drowning condition, his breathing has usually stopped. In accidents of this kind, speed may save the injured man's life, hence do not waste a second. Send for a doctor at once but do not neglect the patient in doing so.

2. The first thing to do is, to get the injured man to a suitable place where you can work on him. This may necessitate lowering from a pole, or raising him from a man-hole. This work usually involves considerable danger to the rescuer, because a man-hole may be full of poisonous gases, or the injured man may be in contact with the dangerous circuit on the pole. You must, therefore, work very carefully.
3. Avoid so placing the patient as to bring pressure on the burns he has sustained, if any. Do not expose the patient to cold. Stimulants should not be administered unless recommended by a Doctor. Cold water may be given in small quantities in cases of electric fire or asphyxiation cases and smelling salts may also be administered in moderation.
4. Continue artificial respiration without interruption (if necessary for four hours) until breathing is restored and medical help is available. Cases are on record of success after 3 + hours or more of effort. Ordinary tests for death are inconclusive in cases of electric shocks and Doctor's pointed attention must be drawn to this, when necessary.
5. Resuscitation should be carried on at the nearest possible place where the patient received his injuries. He should not be removed from this place until he is found breathing, normally and then also moved only in lying position. Should it be necessary due to extreme weather conditions, etc., to move the patient before he is breathing normally, he should be kept in a prone position, and placed on a hard surface (door or shutter) or on the floor of a conveyance, resuscitation being carried on during the time that he is being removed.
6. A brief return of spontaneous respiration is not a certain indication for terminating the treatment. Not infrequently, the patient, after a temporary recovery of respiration, stops breathing again. The patient must be watched, and if normal breathing stops, artificial respiration should be resumed at once.

## 11.5 UPON RECOVERY

When the patient revives, he should be kept lying down and not allowed to get up or be raised under any circumstances unless on the advice of a Doctor. If the Doctor has not arrived by the time the patient has revived, he should be given some stimulant, or a drink of hot ginger, tea or coffee. The patient should then

have any other injuries attended to and be kept warm, being placed in the most comfortable position.

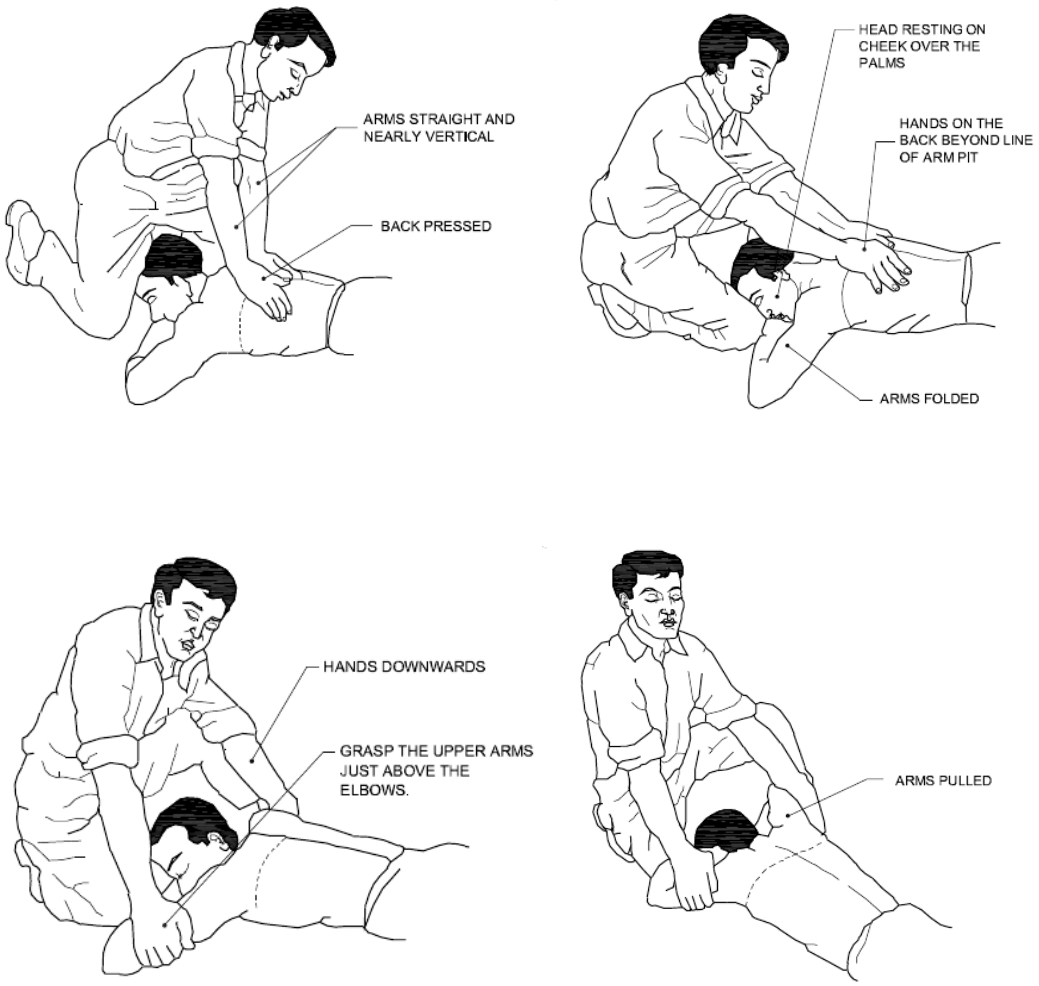
## 11.6 FIRST CARE OF BURNS

1. Burns, if serious, should be treated with a proper dressing. A raw or blistered surface should be protected from the air. If clothing sticks, do not peel it off but cut around it. The adherent cloth, or a dressing of cotton or other soft material applied to burnt surface should be saturated with picric acid (0.5%). If this is not at hand, use a solution of baking soda (one teaspoonful to a pint of water), or the wound may be coated with a paste of flour and water, or it may be protected with Vaseline, Carron oil, olive oil, castor oil or machine oil, if clean.
2. Cover the dressing with cotton gauze, linen, clean waste, handkerchief, or other soft cloth, held tightly in place by bandage. The same coverings should be tightly bandaged over a dry, charred burn, but without wetting the burnt region or by applying oil to it. Do not open blisters.

## 11.7 ARTIFICIAL RESPIRATION

### 11.7.1 Nelson's Arm lift back pressure method:

Place the victim prone face down with his arms folded with the palms one over the other and the head resting on his cheek over the palm. Kneel on one or both knees near the victim's hand. Place your hands in the victims back beyond the line of the armpits, with your fingers spread outwards thumbs just touching each other's as shown in the figure.




Gently rock forward keeping the arms straight until they are nearly vertical and thus steadily pressing the victim's back to force the air out of the victim' slung.

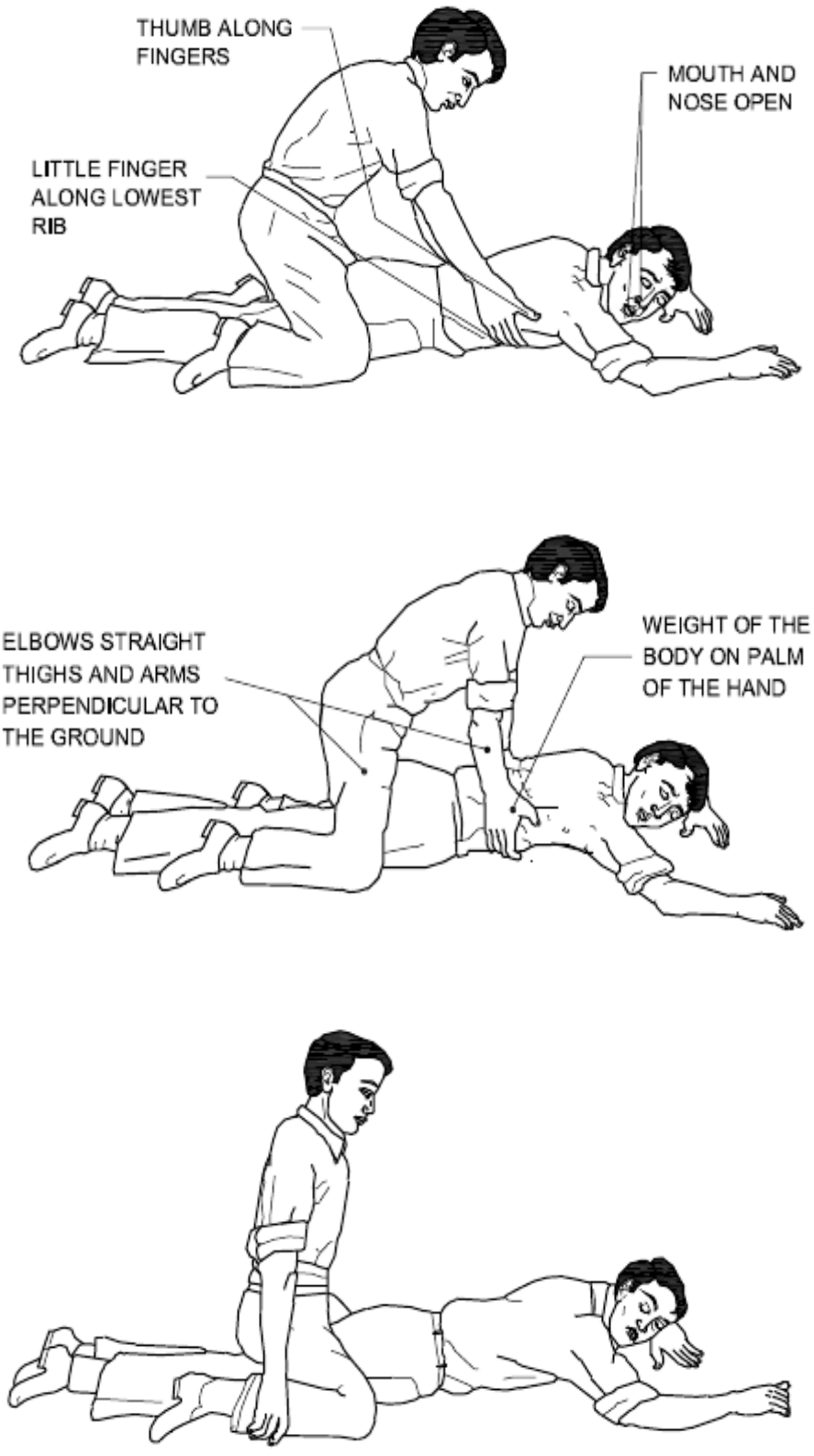
Synchronizing the above movement rock backwards, slide your hands downwards along the victim's arms and grasp his upper arm just above the elbows as shown.

As you rock back, gently raise and pull the victims arms towards you until you feel tension in his shoulders. To complete the cycle, lower the victim's arms and move your hands up to initial position. This method should not be used if there are injuries on the chest and belly of the victims.

**11.7.2 Schafer's method:**

Lay the victim on his belly, with one arm extended directly forward and the other arm bent at the elbow and with the face turned sideward and resting on the hand or fore arm.

Kneel astride the victim, so that his thighs are between your knees and with your fingers and thumbs positioned as shown in the figure.



### 11.7.3 Direct artificial Respiration

1. Direct Artificial respiration is the method whereby a person ventilates the lungs of an unconscious non-breathing victim by blowing his own breath directly into the mouth or nose of the victim.
2. Direct mouth-to-mouth breathing is by far the most effective method of artificial respiration, as proven by comparative studies conducted by research groups in the United States.

### 11.7.4 Mouth-to-Mouth Method

1. The Following needs to be ensured:
    a. Place the victim on back immediately.
    b. Clear throat of water, mucus, toys, coins, or food.
    c. Tilt head back as far as possible.
    d. Lift jaw up to keep tongue out of air passage.
    e. Pinch nostrils to prevent air leakage when you blow.
    f. Blow until you see the chest rise.
    g. Listen for snoring and gurgling signs of throat obstruction.
    h. Repeat blowing 10-20 times a minute.
2. In case of infants and small children tilt the head fully back, surround the mouth and nose completely with your mouth. Blow with only enough force to produce a visible rise in the victim's chest and no more. Repeat every 3 seconds. Continue direct artificial respiration until victim breathes for himself or until expert help is obtained. The method is fully described hereunder:

    **Step (1)** Lay the victim flat on his / her back and place a roll of clothing under the shoulders to ensure that his head is thrown well back. Tilt the victim's head back so that the chin points straight upward.

    **Step (2)** Grasp the victim's jaw as in the Figure 1 and raise it upward until the lower teeth are higher than the upper teeth or place finger on both sides of the jaw near the ear lobes and pull upward. Maintain jaw position throughout artificial respiration to prevent the tongue from blocking the air passage.

Figure 1

**Step (3)** Take a deep breath and place your mouth over the victim's mouth as in Figure 2. Making airtight contact. Pinch the victim's nose shut with thumb and forefinger. If you dislike direct contact place a porous cloth between you and the victim's mouth. For an infant place your mouth over its mouth and nose.

**Step (4)** Blow into the victim's mouth (gently in the case of an infant) until his chest rises. Remove your mouth and release the hold on his nose to let him exhale turning your head to hear the out rush of air. The first eight to ten breaths should be as rapid as the victim responds. Thereafter the rate should be slowed to about 12 times a minute (20 times for an infant).

Figure 2

**Note:**

A. If air cannot be blown in check the position of the victim's head and jaw and recheck the mouth for obstructions, then try again more forcefully. If the chest still does not rise turn the victim's face down and strike his back sharply to dislodge obstructions.

B. Sometimes air enters the victim's stomach as evidenced by a swelling stomach. Expel air by gently pressing the stomach during the exhalation period. In any case where external cardiac compression and artificial respiration are being administered Pressure-Cycling mechanical resuscitators shall not be used in lieu of mouth-to mouth

or other approval artificial respiration because they may not be effective in adequately ventilating the lungs with air (oxygen).Medical research has shown that properly administered mouth to mouth resuscitation is at least as effective as mechanical resuscitator also MMR can be performed effectively without the use of airways of any kind. The time delay in waiting for a mechanical resuscitator or an airway to be made available and place in operation could materially reduce or preclude the victim's chance of recovery.

## 11.8 TREATMENT FOR ELECTRIC BURN

If as a result of electric shock the patient is suffering from burns, the following treatment should be given without hindrance to artificial respiration:

a. Remove clothing locally to enable the burn to be treated but do not break blisters.
b. Saturate burns with warm solution of one dessert spoonful of bicarbonate of soda to a pint of warm water or a teaspoonful of salt to a pint of warm water.
c. Cover with lint soaked in a similar solution and bandage (lightly if blisters have formed).
d. If the above solutions are not available, cover with a sterile dressing.
e. Warm, weak sweet tea may be given when the patient is able to swallow.

## 11.9 CARE FOR THE UNCONSCIOUS

1. Oxygen is the element most vital for survival. Permanent brain damage or death may result within a few minutes from lack of air or oxygen. Therefore a victim's breathing requirements must receive your first attention.
2. The case of unconsciousness may be obvious, as in the case of drowning, electric shock, smoke or gas inhalation, strangulation, severe injuries, etc.
3. The cause of unconsciousness may be obscure, as in the case of poisoning, overdose of drugs, alcoholism, heart disease, brain disease, diabetes, uraemia, epilepsy etc.
4. **An unconscious person may be breathing or not breathing:** In either case an open air passage to the lungs must be maintained. The muscles of the tongue relax with loss of consciousness. In certain positions the tongue may fall back, obstructing the throat and cutting off the air passage.
   a. The unconscious person who is breathing: Many accident victims, especially those sustaining head injuries (common in home and traffic accidents), suffer temporary shock and loss of consciousness. This may lead to death by suffocation. Accidental death may be avoided in such cases by first taking a simple precaution:
      I. Place the victim on his side or abdomen with his head turned to one side, and tilted back.

II. In this position there is less danger of obstruction by the tongue or aspiration of vomit us into the lungs.

b. **The unconscious person who is not breathing:** In such cases the unconscious victim requires immediate artificial respiration. Direct artificial respiration is the most positive and efficient means of ventilating his lungs. The indirect or manual chest compression methods of artificial respiration (Holger-Neilsen, Schafer, etc.) depend on negative pressure, and are unsatisfactory unless provision has been made to establish and maintain an open air passage to the lungs.

c. **The Unconscious person whose breathing is very slow or shallow**: The victim may be assisted by direct artificial respiration, timing the air inflation with the patient's breathing efforts.

## 11.10 SPECIAL CARE SITUATIONS

### 11.10.1 Drowning:

1. Direct artificial respiration must be started as soon as the victim's head can be kept above the water.
2. Do not waste valuable time waiting to bring the victim ashore or by attempting to drain the stomach or throat beforehand. This may be done after artificial respiration has been started.
3. If the stomach is distended, lower and turn the victim's head to the side and then apply moderate pressure with the palm of the hand over the distended stomach. Any air or water in the stomach will be then belched up.

### 11.10.2 Inhalation of Foreign bodies

If the victim is a child turn him over your knees in the "spanking position" with his head lower than his hips, slap him between shoulder blades in an attempt to dislodge the foreign body by causing him to cough it out. If the object is not dislodged and the child is in distress, quickly clean the throat with the fingers and begin direct artificial respiration.

### 11.10.3 INFANT AND CHILD VICTIMS

The technique of direct artificial respiration is essentially the same in cases involving children and adults. However in the case of infants and children:

a. Only a small volume of air is required to inflate the lungs. Over-inflation may produce damage. Short puffs of air are all that are required, sufficient to produce a noticeable rise in the infant's chest with each inflation.
b. The inflation rate should be at least every 3 seconds, twenty times per minute.
c. An over-distended stomach in infants interferes with ventilation as well as normal heart action. This may be reduced by applying pressure over the infant's abdomen, care being taken to avoid aspiration of the fluid brought up in this manner by turning the head to one side.

## 11.11 FIRSTAID BOX

i. A First Aid Box is an essential medical unit in any habitual premises. It ensures tiding over the crisis by avoiding last minute hunts. It should he kept at accessible place and bare essentials stored in it. Each item must be replaced as soon as it gets used up.
ii. The essential items to be preserved in the First Aid Box are given below:

## CONTENTS OF FIRST AID BOX

| S.No | Contents | Quantity |
|---|---|---|
| 1 | Wound dressing (sterilized) | 6Nos. |
| 2 | Burn dressing (sterilised) Large | 3 Nos. |
| 3 | Adhesive plastering ((for fastening dressing), 2 cm x 1 mtrs. | 1 No. |
| 4 | Washable Bandage | 6 Nos. |
| 5 | Triangular Bandage (for fractures) -large | 1 No. |
| 6 | Safety pins (for fastening bandages) | 1 Bunch |
| 7 | Scissors (of fastening bandages) | 1 Pair |
| 8 | Scissors (of stainless steel) 8 cm plank | 1 Pair |
| 9 | Absorbent cotton wool for cleaning wound) | 100 Grams |
| 10 | i. Potassium Permanganate B.P.<br>ii. tincture iodine B.P. (for all wound)<br>iii. Dettol or Savlon<br>iv. Hydrogen peroxide (Antiseptic and bleeding stopper | 1 Bottle<br>1 Bottle<br>1 Bottle<br>1 Bottle |
| 11 | Snake bite lancet | 1No. |
| 12 | Burn Ointment (for burns, cuts & insect bites) e.g. Burnol etc | 1 Tube |
| 13 | Tourniquet (for stopping bleeding) | 1 Set |
| 14 | i. Soda-bi-carp. BP For acid burns<br>ii. vinegar (for Alkali burns] | 1 Bottle<br>1 Bottle |
| 15 | i. Eye Drop<br>ii. sterilized eye pads (separate by seal) | 1 Bottle<br>6 Nos |
| 16 | Anti-Allergy tablet (avil or pyrigesic) | 50 Nos. |
| 17 | Analgesic tablet (crocin or pyrigesic) | 100 Nos. |
| 18 | i. Spirit of Sal volatile<br>ii. Smelling salts | 1 Bottle<br>100 Grams |
| 19 | First Aid Leaflet | 1 Copy |

# CHAPTER 12

# TRAINING

## 12.1 Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010, Clause 7, Safety measures for operation and maintenance of transmission, distribution systems stipulates that:

Sub clause3- Engineers, supervisors and Technicians engaged for operation and maintenance of transmission and distribution systems, electric plants should have successfully under gone the type of training as specified in Part IV, V and VI of Schedule-ll.

Provided that the existing employees shall have to undergo the training mentioned in sub-regulation (3) within three years from the date of coming into force of these regulations.

Owner of every transmission or distribution system shall arrange for training of their personnel engaged in the operation and maintenance of transmission and distribution system in his own institute or any other institute recognized by the Central Government or State Government.

## 12.2SYLLABUS FOR ENGINEERS, SUPERVISORS AND TECHNICIANS ENGAGED IN THE OPERATION ANDMAINTENANCE OF SUB-TRANSMISSION AND DISTRIBUTION SYSTEM

For ensuring safety during regular working, all the personnel involved in the work must have general knowledge of electric plant and specific knowledge pertaining to their field of operation and safety rules. Accordingly Central Electricity Authority has framed the syllabus with the hourly breakup as under:

### 12.2.1 ENGINEERS

| S.No | Particulars | No. of Hours |
|---|---|---|
| 1 | Overview of Power Sector Scenario | 3 |
| 2 | Regulatory Environment - Rules and Regulations | 3 |
| 3 | Distribution planning and optimization | 30 |
| 4 | Sub-transmission and Distribution Lines | 15 |
| 5 | Electric Sub-Stations (33 kV and below) | 15 |
| 6 | Metering Requirements | 6 |
| 7 | Concept of Losses and Loss Reduction Measures | 9 |
| 8 | Reliability Issues, Quality of Power Supply, Customer Awareness and Satisfaction | 6 |
| 9 | IT Intervention | 12 |
| 10 | Rural Electrification | 9 |
| 11 | Project Management: Contracts | 9 |
| 12 | Disaster Management | 3 |
| 13 | Electrical Safety Aspects | 9 |
| 14 | Field Visits and on-job training | 66 |
| | **TOTAL = 195 hours or 6-1/2 Weeks** | |

### 12.2.2 SUPERVISORS

| S.No | Particulars | No. of Hours |
|---|---|---|
| 1 | Overview of Power Sector Scenario | 3 |
| 2 | Distribution Planning and Optimisation | 6 |
| 3 | Sub-transmission and Distribution Lines | 9 |
| 4 | Electric Sub-Stations (33kV and below) | 9 |
| 5 | Metering Requirements | 3 |
| 6 | Concept of Losses and Loss. Reduction Measures | 6 |
| 7 | Reliability Issues, Quality of Power Supply; Customer Awareness and Satisfaction. | 3 |
| 8 | IT Intervention | 6 |
| 9 | Rural Electrification | 3 |
| 10 | Project Management: Contracts | 3 |
| 11 | Disaster Management | 3 |
| 12 | Electrical Safety Aspects | 6 |
| 13 | Field Visits and On-Job Training | 60 |
| | **TOTAL = 120 hours or 4 Weeks** | |

### 12.2.3 TECHNICIANS

| S.No | Particulars | No. of Hours |
|---|---|---|
| 1 | Overview of Power Sector Scenario | 3 |
| 2 | Sub-transmission and Distribution Lines | 9 |
| 3 | Electric Sub-Stations (33kV and below) | 9 |
| 4 | Metering Requirements | 3 |
| 5 | Concept of Losses and Loss. Reduction Measures | 3 |
| 6 | Reliability Issues, Quality of Power Supply; Customer Awareness and Satisfaction. | 3 |
| 7 | Electrical Safety Aspects | 12 |
| 8 | Rural Electrification | 3 |
| 9 | Disaster Management | 3 |
| 10 | Field Visits and On-Job Training | 60 |
| | **TOTAL = 108 hours or 4 Weeks** | |

An assessment of the trainees at the end of the training shall be carried out as per assessment schedule attached as:

**Annexure-VIII: Engineers and Supervisors.**

**Annexure-IX: Technicians**

**12.3 Central Electricity Authority Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines Regulations, 2011, Clause 11, Safety training and awareness stipulates that:**

I. Regular safety training programmes to be conducted for employees shall include the following:
    a. General safety awareness.
    b. First aid.
    c. Emergency procedures including shock treatment.
    d. Use of personal protective equipment.
    e. Safety precautions while handling electro-mechanical equipment.
    f. Use of different types of fire fighting equipment.
    g. Response in the event of emergencies including fire, flood, landslide, earthquake etc.
    h. Site specific hazards and the precautions as well as response in respect of the same.
    i. Ten hours training per year to each employee.

II. The Owner shall ensure that adequate safety training is provided by the contractor to his employees.

III. Safety promotional activities shall be organised periodically to create awareness and enthusiasm among the employees which shall include organising safety day, safety week, fire safety day, fire safety week, safety competitions, posters, slogans, safety calendars and displays depicting possible consequences of unsafe acts and conditions in conspicuous locations in the plant.

# Chapter 13

## DISASTER MANAGEMENT AND EMERGENCY RESPONSE PLAN

CEA Regulations, Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines Regulations, 2011, clause 9 stipulates that:

1. An on-site emergency management plan shall be formulated for thermal generating plant, hydro-electric generating plant, sub-station and group of electric lines for quickly and effectively dealing with probable emergencies like fire, explosion, gas leakages, landslides, floods, earthquakes, storms, cyclones, hurricanes, and crisis situations arising in the event of strikes, terrorist threats, attacks and sabotages, bomb threats and explosions and reducing response time.

2. The provisions to be made for the on-site emergency management plan shall conform to the Schedule- III annexed to these regulations.

3. The on-site emergency management plan shall be prepared by the Owner of electrical plants and electric lines before the commencement of trial operation except that for existing electrical plants and electric lines, the on-site emergency management plan shall be prepared within ninety days from the date of coming into force of these regulations:

Provided that in case of construction of electrical plants and electric lines, emergency action plan shall be prepared, before commencement of construction activity, to handle emergencies like fire, explosion, collapse of lifting appliances and transport equipment, collapse of building or structures, gas leakages, landslides, floods, earthquakes, storms, cyclones, hurricanes and crisis situations arising in the event of strikes, terrorist threats, attacks arid sabotages, bomb threats and explosions.

4. The Owner shall ensure that a mock drill of the on-site emergency management plan is conducted at least once every six months.

Uttarakhand is prone to many natural hazards such as Earthquake, landslides, flash floods, cloud bursting, snow storms etc. The state is also evident to the hazards which are manmade such as forest fire, road accidents, industrial and hazardous chemicals.

Earthquake is the most prominent danger in the state. Landslides are the other common disaster in the state which causes the immense loss of life and property.

The safety precautions required to be followed in the disasters are as follows:

## 13.1 EARTHQUAKE SAFETY PROCEDURES

It is not possible to prevent earthquakes or change the likelihood of an earthquake occurring. However, we can greatly increase our chances of safety and survival, by being aware and prepared. Since knowledge and preparation are keys to our survival during and after an earthquake, we should take steps to become informed. The mock drills of earthquake safety should be carried out at regular intervals.

### 13.1.1 Dangers Associated with Earthquakes

The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Most casualties result from falling objects and debris or collapsing structures. Injuries are commonly caused by:

a) Partial building collapse, such as falling masonry, collapsing walls, falling ceiling plaster etc.
b) Flying glass from broken windows.
c) Overturned bookcases, filing cabinets, fixtures, furniture, office machines and appliances.
d) Fires, broken gas lines, etc. These dangers may be aggravated by lack of water due to broken mains.
e) Fallen power lines.
f) Inappropriate actions resulting from panic.

### 13.1.2Earthquake Safety Guidelines

1. Remain Calm. Sound usually precedes earthquake motion by a split second. If you have developed the correct earthquake responses in your mind before a quake, this split second is enough time to activate your automatic reactions. If you stay calm, you will be better able to assess your situation. The rolling and roaring may terrify you, but unless something falls on you, the sensations probably won't hurt you. Try talking yourself through the violent motion phase. This will release stress and others may take courage and follow your reasoned restraint. Think through the consequences of any action you plan to take.
2. If you are indoors, stay there, stay safe by following the instructions as under:
    a) Get under a sturdy table, desk or bed.
    b) Brace yourself in an inside corner away from windows.

c) Move to an inner wall or corridor. (A door frame or the structural frame or inner core of the building are its strongest points and least likely to collapse. They will also break the impact of any falling objects).
d) In an apartment building the safest place is by the central reinforced core of the building, which is usually located by the elevator well.
e) Choose shelter which will provide an airspace if it collapses. If your furniture shelter moves, stay under it and follow it around the apartment.
f) Watch for falling objects – plaster, bricks, light fixtures, pots and pan, etc.
g) Stay away from tall shelves, china cabinets and other furniture, which might slide or topple over.
h) Stay away from windows, sliding glass doors, mirrors.
i) Grab anything handy (blanket, pillow, tablecloth, newspapers, box, etc.) to shield your head and face from failing debris and splinting glass.
j) Don't be alarmed if the fire alarm or sprinklers go off.

3. Do Not Rush Outside. Stay on the same floor that you are on. Stairways may be broken and exits jammed with people. Do not use elevators as the power for elevators may go out and leave you trapped. The greatest danger from falling debris is just outside doorways and close to outer walls. If for safety reasons you must leave the building, choose your exits as carefully as possible.
4. If you are outside, stay there. Move away from the building, garage, walls, power poles and lampposts. Electric power lines are a serious hazard - stay away from fallen lines. If possible, proceed cautiously to an open area.
5. If you are in a moving car, stop. Stop as quickly as safety permits in the best available space. Stay in your car. Don't stop where buildings can topple down on top of you. A car is an excellent shock absorber and will shake a lot on its springs during an earthquake, but it's a fairly safe shelter from which to assess your situation.
6. Avoid Fallen Power Lines. The possibility of encountering fallen live wires is great during and after an earthquake. If you are on foot, make a wide path around the wires. If you are in the car and live wires have fallen across the car, remain where you are. Your car is usually well insulated and will protect you from electric shock. Never assume that downed power lines are dead.

### 13.1.3 After An Earthquake

#### 13.1.3.1 Within the First Several Minutes:

1. Remain Calm. Don't Panic. Try to calm and reassure others. Stop and take time to think. Wait until all motion has stopped. Do not run down stairs or outdoors. Be prepared for additional shockwaves.
2. Do not light matches, cigarettes or turn on electrical switches. Flashlights are one of the best light sources after a damaging earthquake. Proceed with extreme caution.
3. Protect hands and feet from broken glass or debris. Keep head and face protected (hard-hat, blanket, tablecloth, etc.).
4. Make a quick check for injuries or trapped people. Provide emergency first aid if needed. Do not try to move seriously injured persons unless they are in immediate danger from further injury.
5. Turn off all appliances and office machines. Extinguish all open flames. Check power lines and cords. If problems exist in electrical lines or gas lines the mains should be shutoff.
6. It may be necessary to draw a moderate amount of cold water in bathtubs and sinks and other containers, in case service should be disrupted.

#### 13.1.3.2 During the Next Several Hours:

1. Do not operate electrical switches, appliances or open-flame equipment if gas leaks are suspected. Sparks or flames can ignite gas from broken lines causing an explosion.
2. Tend further to injured or trapped persons. Try to get help if necessary. If a person is trapped and you can free him without injury to yourself, remove debris piece-by-piece starting with the top of the pile.
3. Be prepared for aftershocks-they are weaker than the main shock but can cause additional damage and psychological trauma. Watch out for other possible dangers, which may follow an earthquake, such as fire, flood, landslide or TSUNAMI (tidal wave).
4. Turn on a battery radio to receive disaster instructions. Use telephones only to report extreme emergency situations.
5. Inspect your work area carefully for structural damage. Carefully open exit doors – they sometimes jam. The initial quake may damage the structure and an

aftershock could knock down weakened walls. Use extreme caution when moving around in damaged areas- they may collapse without warning. Check to see that sewage lines are intact before flushing toilets.

6. You should not try to get home until government authorities say it is safe, which will be when the worst fires are under control and the streets have been cleared. This may happen quickly or it may take longer (perhaps 72 hours or more). You should advise your family that in the event of a major earthquake you may be retained at work. When possible notify your family about your wellbeing.
7. Don't go outside sightseeing. Keep streets clear for passage of emergency vehicles. Your presence might hamper rescue and other emergency operation.

## 13.2 Landslides

The fragile nature of rocks forming the mountains, along with the climatic conditions and various anthropogenic activities has made the state vulnerable to the landslides. Beside earthquake, landslides are the other geological hazards that are common and peculiar to the state.

Landslides are the downslide movement of soil, debris or rock resulting from natural causes, vibrations, overburden of rock material removal of lateral supports, change in the water content of rock or soil bodies, block drainage etc. In Uttarakhand the mass movement varies in magnitude from soil creep to landslides.

### 13.2.1 Immediate steps for imminent Landslide:

I. Contact your local Fire, Police or Public Works Department.
II. Inform affected neighbours.
III. Leave the area quickly.

### 13.2.2 Actions to be taken before Intense Rainfall:

i. Become familiar with the land around you. Slopes, where landslides or debris flows have occurred in the past are likely to experience them in the future.
ii. Buildings should be located away from known landslides, debris flows, steep slopes, streams and rivers, intermittent-stream channels and the mouths of mountain channels.
iii. Observe the patterns of storm-water drainage on slopes near your home and watch especially the places where runoff water converges, increasing flow over soil-covered slopes. Observe the hillsides around your home for any signs of

land movement, such as small landslides or debris flows or progressively tilting trees.

iv. Contact your local authorities to learn about the disaster management response and develop your own emergency plans for your family and business.

### 13.2.3 During Intense Rainfall:

i. Be observant. Many landslide and debris flow casualties occur when people are sleeping. Listen to radio for warnings of intense rainfall. Intense short bursts of rain may be particularly dangerous, especially after longer periods of heavy rainfall and damp weather.

ii. Unusual sounds might indicate moving debris such as trees cracking or boulders knocking together. A trickle of flowing or falling mud or debris may precede larger landslides. Be alert for any sudden increase or decrease in water flow in streams or channels. Such changes may indicate landslide activity upstream, so be prepared to move quickly.

iii. If you live in areas susceptible to landslides and debris flows, consider leaving if it is safe to do so. If you remain at home, move to a part of the house farthest away from the source of the landslide or debris flows, such as an upper floor, but keep an escape route open should it become necessary to leave the house.

iv. Be alert when on the roads. Embankments along roadsides are particularly susceptible to landslides. Watch the road for collapsed pavement, mud, fallen rocks and other indications of possible landslides or debris flows. Be observant. Many landslide and debris flow casualties occur when people are sleeping. Listen to radio for warnings of intense rainfall. Intense short bursts of rain may be particularly dangerous, especially after longer periods of heavy rainfall and damp weather.

### 13.2.4 After Intense Rainfall:

Be alert for signs indicating land movement. Landslides can occur weeks or Months after intense storms.

### 13.2.5 Things to Remember:

**i.** Mudflows tend to flow in channels, but will often spread out over a floodplain. They generally occur in places where they have occurred before.

**ii.** Landslides and mudflows usually strike without much appreciable warning. The force of rocks, soil or other debris moving down a slope can devastate anything in its path. Take the following steps to be ready:-

a. Plant ground cover on slopes and build retaining walls.
b. In mudflow areas, build channels or deflection walls to direct the flow around buildings.
c. Remember: If you build walls to divert debris flow and the flow lands on a neighbour's property, you may be liable for damages.

### 13.2.6 Precautions to be taken during landslides

**If inside a building:**

i. Stay inside.
ii. Take cover under a desk, table or other piece of sturdy furniture.

**If outdoors:**

i. Try and get out of the path of the landslide or mudflow.
ii. Run to the nearest high ground in a direction away from the path.
iii. If rocks and other debris are approaching, run for the nearest shelter such as a group of trees or a building.
iv. If escape is not possible, curl into a tight ball and protect your head.

### 13.2.7 After Landslide

i. Stay away from the slide area. There may be danger of additional slides.
ii. Check for injured and trapped persons near the slide area. Give first aid if trained.
iii. Remember to help your neighbours who may require special assistance-infants, elderly people and people with disabilities.
iv. Listen to a radio or television for the latest emergency information.
v. Check for damaged utility lines. Report any damage to the utility company.
vi. Check the building foundation, chimney and surrounding area for damage.
vii. Replant damaged ground as soon as possible since erosion caused by loss of ground cover can lead to flash flooding.

### 13.2.8 Restoration of the system

Before moving yourself and your team for restoration of the power system:

i. Gather information about the area of the damage in the work place before commencing work.
ii. Take some first aid measures along with eatables before proceeding.
iii. Arrange essential manpower necessary T &P to carry out the work.

# CHAPTER 14:

# 5S PRACTICES

**PRINCIPLE OF 5S**

1. The concept of "5S" originated in Japan. It is an integral tool of TQM which lays a very strong foundation for quality movement within the organization. The 5S are pre-requisites (basics) for any improvement programme. 5S Philosophy focuses on effective work place organization, simplifying work environment, reducing waste while improving quality and safety. There is no other way for improving efficiency or quality in work place
2. The five S stands for the five first letters of these Japanese words:

| JAPANESE Term | ENGLISH Equivalent |
|---|---|
| Seiri | Sort |
| Seiton | Set In Order |
| Seiso | Shine |
| Seiketsu | Standardize |
| Shitsuke | Sustain |

**MEANINGS**

**Seiri**

1. Sorting, keep the necessary in work area, dispose or keep in a distant storage area less frequently used items, unneeded items are discarded. Seiri fights the habit to keep things because they may be useful someday. Seiri helps to keep work area tidy, improves searching and fetching efficiency, and generally clears much space. Seiri is also excellent way to gain valuable floor space and eliminate old broken tools, obsolete jigs and fixtures, scrap and excess raw material.

**Seito**

1. Systematic arrangement for the most efficient and effective retrieval. A good example of Seiton is the tool panel. Seiton means tidily putting things away after you have used them. Putting things away requires following three rules: Decide where things belong; decide how things should be put away; Follow the put-

away rules to leave things where they can be quickly and properly found next time they are needed.

2. Seiton saying would be: “A place for everything and everything on its place.”

**Seiso**

Cleaning, after the first thorough cleaning when implementing 5S, daily follow-up cleaning is necessary in order to sustain this improvement. Cleanliness is also helpful to notice damages on equipment such as leaks, breakage and misalignment. These minor damages, if left unattended, could lead to equipment failure and loss of production. Regular cleaning is a type of inspection. Seiso is an important part of basic TPM; Total Productive Maintenance and Safety matter through cleanliness is obvious.

**Seiketsu**

Standardizing- Once the first three S have been implemented, it should be set as a standard without which the situation will deteriorate right back to old habits. Have easy-to-follow standards and develop a structure to support it. Allow employees to join the development of such standards. Thus the 3 first S are often executed by order. Seiketsu helps to turn it into natural, standard behaviour.

**Shitsuke**

Finally, to keep first 4 S alive, it is necessary to keep educating people maintaining standards. By setting up a formal system; with display of results, follow-up, the complete 5S get insured to live, and be expanded beyond their initial limits, in an ongoing improvement way. The effect of continuous improvement leads to less waste, better quality and faster leads times.

**Need For Cleanliness**

1. Today electronics and other machinery demand very high levels of precision and cleanliness. Just a spot of grime can cause a computer to crash. Filings and burrs can mean that things do not fit tightly. Dropping things on an assembly line can mean that the wrong parts are put together or that the product is shipped to the wrong client. There are all kinds of major problems caused by seemingly minor “5S” lapses. It is clear that the 5S’s are prerequisite to quality, and this cannot be overemphasized.
2. Problems discovered in the cleaning process are as follows:

a. Filings in the conveyance chutes lead to scratching.
b. Scraps in the die lead to faculty pressings.
c. Things fall off the equipment and get into the products.
d. Things get dented or bent in conveyance.
e. Filings and other particles contaminate the resin.
f. Dirty coolant leads to clogging.
g. Dust and other substances ruin the paint jobs.
h. Bad connections are made because the electrical contacts are dirty.
i. Fires are caused because garbage shorted the electrical equipment.

**Equipment**

1. Although you will need a detailed and exhaustive checklist for each piece of machinery, it is possible to mention some of the main items common to most equipment.
    a. Cleaning: Grime, clogging, rust, leakage etc.
    b. Heat: Oil tanks, heaters, control planes, washing or cleaning water etc.
    c. Breakage: Breakage, meters that do not return to zero, cracked glass, handles that have come off, broken switches or buttons, cables or bundles of wires that have come unravelled, things that are misshapen etc.
    d. Electrical: Control panel covers, control panel interiors, lamps, light bulbs, switches etc.
    e. Tools and measurement devices: Tools, measurement devices, gauges etc.
    f. Equipment-specifics: transport equipment etc.

**Launching of 5S – Operative Activities**

1. Recording the present situation – Before launching into 5S activities, the very first thing to do is to take photographs around the workplace. These will be very useful for comparison purposes when 5S is in full swing.
2. Identifying abnormalities by visual control- Because it is people who control and manage things, it is essential that your people be able to tell the difference between normality and abnormality and be able to act accordingly. Yet, as seen in industrial defect rates, the possibility of abnormalities occurring is generally 1% or less, and most of the time things will be operating as normal with no problems. It is in the midst of this normality that people must identify abnormality.

3. Visual management -an answer.
4. How can you best make sure that abnormalities surface? In our everyday work, we use our minds to remember things and all five senses to do our best work. What is important here is to transform these static senses into dynamic awareness and to make them come alive for us. And it is the visual sense-the sense of sight-that is the most important. It has been estimated that 60% of all human activity starts with sight. Of course, we also learn from our sense of hearing and our sense of feel, and it is also important to make the fullest possible use of these senses as well, but it is our sense of sight that dominates. That is why visual management is sometimes referred to as the embodiment of visual awareness.
5. Points to remember in making visual control tool
    a. Make them easy to see from a distance
    b. Put the displays on the things they are for
    c. Make them so that everyone can tell what is right and what is wrong
    d. Make them so that anybody can use them easily and conveniently
    e. Make them so that anybody can follow them and make the necessary corrections easily
    f. Make them so that using them makes the workplace brighter and more orderly

**Checkpoints**

1. Clearly determine the position each picture was taken from, so that you will be able to have before and after photographs.
2. Date all photos. If possible, use a camera which prints the date on the negative

**Analysing Why and What**

1. Every piece of equipment fulfils specific functions, and understanding these functions will make you a better inspector. This understanding can be vastly enhanced if you ask yourself why for each of the problems and minor defects that you identify.

2. Ask yourself
    a. Why is this important?

   b. Why has this been overlooked or ignored?
   c. What can be expected to happen if we leave this the way it is? What impact will it have? What are the principles and mechanisms involved here?
   d. Why has this gone so long before being detected? What could have been done so that it would have been detected earlier?
   e. Why is it this way? Does anybody know about this? Does everybody know about this?
3. By constantly asking yourself the whys and what you will get to the core of the problem and will be able to involve the small-group (quality circles) as well as management in finding and implementing solutions. Inspections are all well and good, but they are not the end of the process. The purpose of an inspection is to find problems and then to solve them so that they do not show up on the next inspection.

**The Differences 5S make**

1. Although the "5S" movement obviously results in major improvements in 5S areas, it is even more important in changing the way people approach their work and what they do.
2. It is impossible to mount a "5S" campaign with just one or two people. You need to have everyone actively involved. Each of the individual things that need to be done is simple enough in itself. The difficult thing is to keep doing them. This requires determination, persistence, and cooperation. But that combination in turn creates a new sense of team identity and a better corporate climate.
3. It is important to start by doing. No matter how well you understand the theory, the theory does not produce results. Only doing does. And this doing has the power to change the way people look at things. It has the power to transform them.
4. Every part of the "5S" process is important. Every step has the potential for opening our eyes. The 5S's are the best way to eliminate waste.

**The Pledge**

- I will not get things dirty.
- I will not spill.
- I will not scatter things around.
- I will clean things right away.
- I will rewrite things that have gotten erased.
- I will tape up things that have come down.

## ANNEXURE-1

**PERMIT TO WORK**

Book No. _____ S.No. _____

### A. Requisition for PTW

| S.No | Nature of work that is required to be carried out | Name of the line/ substation wherein work will be carried out | Duration for which PTW is required | Purpose of Shutdown |
|---|---|---|---|---|
| | | | | |

Name: Mobile No. Signature

### B. Issue of PTW

PTW No. _____
Name of Sub-division_____
Name of Division _____
Name of Substation_____
Date/time of issue _____

You are allowed to work on the following Equipment/ Line

Name of the Equipment/ Line: _____

Station Name:_____

| PTW Issued To (Name) | PTW Issued By (Name) |
|---|---|
| | |

| DESCRIPTION | REMARKS | |
|---|---|---|
| Nature of work that will be carried out on the above Equipment/ Line | | |
| Above Equipment/ Line is isolated at the following location(s) | | |
| Above Equipment/ Line is connected to earth at the following location(s) | | |
| Safety tags have been placed at the following locations | | |
| Authorised person issuing PTW | Designation | Sign |
| | | |
| Authorised person receiving PTW | Designation | Sign |
| | | |
| If PTW has been issued on the above Equipment/ Line to more than one person, indicate the other PTW Nos | | |
| Time: _____AM/PM Date: | | |
| Transfer of Ownership of PTW | | |

| | | | | |
|---|---|---|---|---|
| | | | | |
| PTW held by | | | Name | Sign |
| | | | | |
| This PTW is transferred to | Name | Sign | Time | Date |
| | | | | |
| | | | | |

| | | | | |
|---|---|---|---|---|
| Extension of the above PTW needed: YES/NO If Yes, give reasons below | | | | |
| Reason for Extension: | | | | |
| New Validity of the PTW | From Date | From Time | To Date | To Time |
| | | | | |
| Authorised person requesting the Extension of PTW | Name | | Sign | |
| | | | | |
| Authorised person approving the Extension of PTW | Name | | Sign | |
| | | | | |
| Authorised person issuing the Extension of PTW | Name | | Sign | |
| Time: _____AM/PM Date: _____ | | | | |

All isolated point mentioned is ensured and checked from all concerns. Yes/No
Safety Zone is created by PTW owner. Yes/No
Safety tags are placed at various locations. Yes/No

All safety measures including earthing of lines and uses of proper tools and tackles are to be used and the PTW owner getting the work done must ensure before taking up the work on the line/ Equipment's

**C. Return of PTW**

I hereby declare that all men under my charge have been withdrawn and warned that it is no longer safe to work on the Equipment/Line specified on this PTW and those tools, temporary earth and other connections are all removed, leaving that portion of the Equipment/ Line ready for taking into service.

| Name | Designation | Signature | Date | Time |
|---|---|---|---|---|
| | | | | |

I hereby declare this PTW cancelled

| Name | Designation | Signature | Date | Time |
|---|---|---|---|---|
| | | | | |

**ANNEXUREII**

# ACCIDENT REPORT

(As per section 161 of The Electricity Act, 2003)

## TELEPHONE/FAX MESSAGE

1. Name of the Section/Sub-Section:

   ……

2. Date and time of occurrence:

   ……

3. Name of the casualty, address, sex and age:……

4. Fatal/non-fatal (if non-fatal state condition:……

5. Departmental or non-departmental (If departmental, details of designation etc., to be furnished):

   ……

6. Voltage, name of the feeder and place of accident:

   ……

7. State the occurrence in brief:……

8. Date and time of reporting: ……

9. Name:

   ……

10. Signature:

    ……

11. Designation:

    ……

**ANNEXURE III**

# FORM FOR REPORTING ELECTRICAL ACCIDENTS

(As per section 161 of The Electricity Act, 2003)

| | | |
|---|---|---|
| 1 | Date and Time of accident | |
| 2 | Place of accident (Village / Town, Tehsil / Thana, District and State) | |
| 3 | System and voltage of supply (Whether EHV/HV/LV line, sub-station/generating station/consumer's installations/service lines/other installations) | |
| 4 | Designation of the Officer-in-charge (in whose jurisdiction the accident occurred) | |
| 5 | Name of owner/user of energy in whose premises theaccident occurred. | |
| **6** | **Details of victim(s)** | |
| **(a)** | **Human** | |

| **S.No** | **Name** | **Father's Name** | **Sex of victim** | **Full Postal Address** | **Approx. Age** | **Fatal / Non-Fatal** |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **(Animal)** | | | | | | |

| **S.No** | **Description of Animals** | **Number(s)** | **Name(s) of Owner(s)** | **Address (es) of owner(s)** | **Fatal / Non-Fata** |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

| | | |
|---|---|---|
| **7** | In case the victim(s) is /are employee(s):<br>(a) Designation of such person(s)<br>(b) Brief description of the job undertaken, if any.<br>(c) Whether such person/persons was/were allowed to work on the job. | |
| **8** | In case the victim(s) is/are employee(s) of a licensed contractor<br>(a) Did the victim(s) possess any electric workman's permits(s), supervisor's certificate of competency issued under Rule 45? If yes give number and date of issue and the name of issuing authority.<br>(b) Name and designation of the person who assigned the duties of the victim(s) | |
| **9** | In case of accident in the Distribution Licensee system, was the Permit To Work (PTW) taken? | |
| **10** | Describe fully the nature and extent of injuries, e.g. fatal/disablement (permanent or temporary) of any portion of the body or burns or other injuries. In case of fatal accident, was the post mortem performed? | |
| **11** | Detailed causes leading to the accident (To be given in a separate sheet annexed to this form) | |
| **12** | Action taken regarding first-aid, medical attendance etc. immediately | |

| | | |
|---|---|---|
| | after the occurrence of the accident (give details) | |
| **13** | Whether the District Magistrate, Police Station concerned and Chief Electrical Inspector have been notified of the accident (if so, give details) | |
| **14** | Steps taken to preserve the evidence in connection with accident to the extent possible. | |
| **15** | Names and designation(s) of the person(s) assisting, supervising the person(s) killed or injured. | |
| **16** | What safety equipments were given to and used by the person(s) who met with this accident (e.g. rubber gloves, rubber mats, safety belts and ladders etc.)? | |
| **17** | Whether isolating switches and other sectionalising devices were employed to deaden the section for working on the same? Whether working section was earthed at the site of work? | |
| **18** | Whether the workmen conduced proper earthing as per prescribed guidelines on either side of the work place? | |
| **19** | Whether the work permit was undertaken by authorised person(s)? If so, the name and the designation of such person(s) may be given. | |
| **20** | Whether the artificial resuscitation treatment work on live lines was undertaken by authorised person(s)?<br>If yes, how long was it continued before its abandonment? | |
| **21** | Names and designations of persons present at and witnessed the accident. | |
| **22** | Name and designation of person held responsible for the accident as per detailed investigation report. | |
| **23** | Any recommendation regarding safety procedures pertaining to corrective and preventive actions for avoiding future accident | |
| **24** | Whether investigation report of CEI has been received and the same is attached? | |
| **25** | Any other information/remarks. | |
| **Place** | | |
| **Time** | | |
| **Date** | | |
| **Signature** | | |
| **Name** | | |
| **Designation** | | |
| **Address of the person reporting** | | |

Note: Copy of the duly filled form has to be forwarded to the following people:

1. Reporting Division office

2. Reporting Circle office

3. Reporting office of the Chief Engineer in charge

4. Director Operations/Head office

**ANNEXURE IV**

## APPLICATION FOR PRE ARRANGED SHUT DOWNS

1. Name of the applicant:……
2. Designation and address: ……
3. Section of line or feeder or equipment on which shutdown is required:

   ….……
4. Time, date and duration of shutdown:

   ……
5. Purpose of shutdown: ……
6. Consumers affected by shutdown: ……
7. Whether concurrence of competent authority obtained or not:

   ……
8. Contact No. ……

Signature of applicant

Signature of UPCL Officer recommending

Signature

Approved by Officer-in-charge of station

1. The applicant shall not be below the rank of a Junior Engineer.

The application duly approved by Officer-in-charge of Station will be forwarded to the concerned operator on duty for shutdown and this form will be retained by him as a record.

**ANNEXURE V**

## NEAR MISS INCIDENT RECORD

| S. No | Place | Location | Date | Time | Type | Root Cause Analysis | Responsibility | Target Date |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

**ANNEXURE-VI**

# TOOL BAG AUDIT FORM

Report No.

Date:

1. Name of Lineman/ Jointer/Fitter:_____
2. Emp No.: _____
3. Department: _____
4. Observations:
5.

| S. No | Observation | Remarks |
|---|---|---|
| 1 | Condition of tools and its insulation | |
| 2 | No proper tools | |
| 3 | Shortage of tools | |
| 4 | Condition of tool box/ tool | |
| 5 | Condition and availability of personal protective equipment like helmet/hand gloves/fuse/puller/safety shoes etc. | |

6. Any other remarks:_____

Electric Safety Officer

**ANNEXURE-VII**

## SAFETY AUDIT FORM

Report No.
Date:

1. Location:_____
2. Month/Year: _____

| S. No | Description | Remarks |
|---|---|---|
| 1 | TRANSFORMER (Rating) | |
| | A) EARTHING | |
| | B) STENCILLING | |
| | C)OIL LEAKAGE | |
| 2 | HT/LT SWITCHGEAR | |
| | A) EARTHING | |
| | B) STENCILLING | |
| | C)RUBBER MAT | |
| | D) OIL LEAKAGE | |
| 3 | BATTERY ROOM | |
| | A) EXHAUST FAN | |
| | B) NO SMOKING BOARD | |
| 4 | RUBBER MAT | |
| 5 | LIGHTING FIXTURES | |
| 6 | DANGER BOARD | |
| 7 | ARTIFICIAL RESPIRATION CHART | |
| 8 | FIRE EXTINGUISHERS | |
| 9 | FIRE BUCKET | |
| 10 | FIRST AID BOX | |
| 11 | DETAILS OF LAST SAFETY TRAINING/DRILL | |

3. Any unsafe conditions noticed:_____

Electric Safety Officer

**ANNEXURE-VIII**

# ASSESSMENT FORMS (TRAINING PERFORMANCE)

## (I) ASSESSMENT FORM FOR ENGINEERS AND SUPERVISORS

Name of the Trainee.....

Period: From..... to .....(Extended period).

Working in.....

Section.....

Department.....

| S.No | Particulars | Marks allotted | Marks given | Remarks |
|---|---|---|---|---|
| A | Punctuality and attendance. | 5 | | |
| B | Intelligence and grasp. | 25 | | |
| C | Temperament and behaviour. | 20 | | |
| D | Any special qualifications- capacity to execute a particular or difficult job economically intelligently, resourcefully or with special skill. | 10 | | |
| E | Judgment of the candidate by taking viva-voce test or by asking questions verbally. | 40 | | |
| | TOTAL MARKS | 100 | | |

The marks may be given as below:-

Excellent91-100%
Very good71-90%
Good 61-70%
Average51-60%
Below average Below 51%

**Section-in-charge**

(Power Plant)

Special Remarks. If any-

Station Superintendent

# (I) ASSESSMENT FORM FOR ENGINEERS AND SUPERVISORS

(For use of Training Department)

1. Name of the Trainee –
2. Date of birth/age-
3. Training period: From…… (Months)……
4. Technical qualification-
5. Specialisation if any-
6. Practical experience-
7. Mark**s** secured in periodical tests ( out of 100):

| Test | No. | Date | Written | Viva | On job | Project |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

8. Percentage of marks secured in all the tests-
9. General Remarks and Recommendations-

Director of Institute

**ANNEXURE-IX**

## ASSESSMENT FORMS (TRAINING PERFORMANCE)

## (I) ASSESSMENT FORM FOR TECHNICIANS TO ASSIST ENGINEERS AND SUPERVISORS

Name of the Trainee.....

Period: From..... to .....(Extended period).

Working in.....

Section.....

Department.....

| S.No | Particulars | Marks allotted | Marks given | Remarks |
|---|---|---|---|---|
| A | Punctuality and attendance. | 5 | | |
| B | Intelligence and grasp. | 25 | | |
| C | Temperament and behaviour. | 20 | | |
| D | Any special qualifications. | 10 | | |
| E | Judgment of the candidate by taking viva-vocetest or by asking questions verbally about power plant and equipment. | 40 | | |
| | TOTAL MARKS | 100 | | |

The marks may be given as below:-

Excellent91-100%
Very good71-90%
Good 61-70%
Average51-60%
Below average Below 51%

**Section-in-charge**

(Power Plant)

Special Remarks. If any-

Station Superintendent

# (II) ASSESSMENT FORM FOR TECHNICIANS TO ASSIST ENGINEERS AND SUPERVISORS

(For use of Training Department)

1. Name of the Trainee –

2. Date of birth/age-

3. Training period: From..... (Months).....

4. Highest technical qualification-

5. Specialisation if any-

6. Practical experience-

7. Mark**s** secured in periodical tests ( out of 100):

| Test | No. | Date | Written | Viva | On job |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

8. Percentage of marks secured in all the tests-

9. General Remarks and Recommendations-

Director of Institute

**ANNEXURE-X**

## Sample First Aid charts to be displayed at various places

# ANNEXURE-XI

## BIBLIOGRAPHY/ REFERENCES


| S.No | References |
|---|---|
| 1 | The Electricity Act, 2003. |
| 2 | Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations, 2010. |
| 3 | Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines) Regulations, 2011. |
| 4 | Indian Standard Code of practice for earthing, IS: 3043-1987, Bureau of Indian Standards. |
| 5 | Electrical Safety Manual and General Safety Instructions Himachal Pradesh State Electricity Board Ltd. |
| 6 | Uttar Haryana Bijli Vitran Nigam Limited, Safety Manual. |
| 7 | Safety Manual, Bangalore Electricity Supply Company Limited. |
| 8 | Safety Manual, Maharashtra State Electricity Transmission Corporation Ltd. |
| 9 | Fire Safety of Industrial Building, Electric Generating and Distribution Station-Code of Practice (Second Revision), IS 3034:1993, Bureau of Indian Standards. |
| 10 | IS 5216 Part 1 and Part2, 1982 Recommendation on safety procedures and practise in electrical works and life saving techniques. |
| 11 | UPSEB RESPO Manual |
| 12 | National Electrical Code 2011. |