HINDUSTAN ZINC
Zinc & Silver of India

Sustainability Framework

SAFETY STANDARD

General Electrical Safe Management Standard

Hindustan Zinc Limited

SAFE SMART SUSTAINABLE

Document Control Details

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Abbreviations

- CSRP – CORPORATE STANDARDS RULES AND PROCEDURES SUBCOMMITTEE
- CSC – CORPORATE SAFETY COUNCIL
- CPR – CARDIOPULMONARY RESUSCITATION
- CEA – CENTRAL ELECTRICITY AUTHORITY
- DINS - DISTRIBUTION INCIDENTS
- EOHS – ENVIRONMENT OCCUPATIONAL HEALTH & SAFETY
- FAI - FIRST AID INJURY
- GESMS – GENERAL ELECTRICAL SAFETY MANAGEMENT STANDARD
- HZL – HINDUSTAN ZINC LIMITED
- HSE – HEALTH, SAFETY AND ENVIRONMENT
- HR - HUMAN RESOURCES
- HIRA – HAZARD IDENTIFICATION AND RISK ASSESSMENT
- IE – INDIAN ELECTRICITY RULES
- IMS – INTEGRATED MANAGEMENT SYSTEM
- LOTO – LOCKOUT TAGOUT
- LTI - LOST TIME INJURY
- MCC/PCC – MOTOR CONTROL CENTERS/POWER CONTROL CENTERS
- MTI - MEDICAL TREATMENT INJURY
- NFPA – NATIONAL FIRE PROTECTION ASSOCIATION
- NEC – NATIONAL ELECTRIC CODE
- OTJ - OFF THE JOB
- OSHA – OCCUPATIONAL SAFETY & HEALTH ASSOCIATION
- PPE - PERSONAL PROTECTIVE EQUIPMENT
- PTW – PERMIT TO WORK (ALSO KNOWN AS WORK PERMIT)
- RWI - RESTRICTED WORKDAY INJURY

- RCD – RESIDUAL CURRENT DEVICE
- SPI - SERIOUS PROCESS INCIDENT
- S&FS – SAFETY & FIRE SERVICES
- SOP – STANDARD OPERATING PROCEDURE
- SRPSC – STANDARDS, RULES & PROCEDURE SUBCOMMITTEE
- UIC – UNIT IMPLEMENTATION COMMITTEE
- WI – WORK INSTRUCTION
- ZSC – ZONE SAFETY COMMITTEE

1. Introduction

This standard provides requirements and guidance for establishing, sustaining, and improving the procedures and practices used to manage interaction with electrical equipment and energized systems to prevent injury, disruption to capital project, interruptions to operations, and impact on equipment that is critical to process safety. The implementation responsibilities are with Unit/Plant relevant Electrical maintenance / Project team.

1.1 Intent and Purpose

This standard has been developed by cross functional teams from all Zones of HZL. The requirements which have been identified here are equally applicable across all Zones/ sites of HZL. This will also help in bringing about a consistency in the process used across all locations.

The Standard will help to provide a new impetus towards achieving the best in class safety standards. This standard is formulated based on best practices.

2. Scope

This standard applies to all Hindustan Zinc Limited (HZL) business units and incorporates all of the requirements of the Vedanta Electrical Standard. It is applicable to all HZL operations, including admin/corporate offices and research facilities located off site; during exploration, through all development phases and construction, operation to closure and, where applicable, for post closure management. National regulations shall be used in conjunction with this standard.

2.1 Field of Application:

The highest risk group exposed to electrical hazards includes personnel (employees and contractors) who construct, operate, maintain, and dismantle electrical equipment and systems in facilities (e.g., manufacturing plants, utilities, laboratories, office complexes, and warehouses). The requirements and guidance in this standard also apply to lower risk groups in all work locations, including personnel who use portable electrical-powered tools, appliances, and equipment.

Unit / Plants shall be aware that local regulations may impose requirements not reflected in this standard.

The most stringent requirement shall apply. Unit / Plants may also want to consider other Local standards and guidelines and nationally recognized industry standards when developing and implementing Unit / Plant procedures and practices.

Mandatory requirements in this standard are noted in italics.

3. References

3.1 Corporate Policy

3.1.1 HZL HSE Policy

3.1.2 HZL Safety Principles

3.2 Corporate Standards

3.2.1 Process Safety Management Standard
3.2.2 Process hazard Analysis
3.2.3 GN 8 : Energy & Carbon Policy
3.2.4 GN 20: Lock-Out & Tag-Out
3.2.5 Vedanta Electrical Standard
3.2.6 Permit to Work Standard
3.2.7 IS Standards
3.2.8 IE Rules/CEA Regulations
3.2.9 Local/National Regulations on Electrical Procedures

3.3 Others

3.3.1 International Electro-technical Commission (IEC) 60529 – Degrees of Protection Provided by Enclosures (IP Code)

3.3.2 IEC 61010 – Safety Requirements for Electrical equipment for Measurement, Control, and Laboratory Use

3.3.3 National Fire Protection Association (NFPA) 70E 2024 – Standard for Electrical Safety in the Work place

4. Electrical Safety Overview

4.1 Electrical shock:

Shock occurs when the body becomes part of the electric circuit. The current must enter the body at one point and leave at another. Shock may occur in one of the three ways:

1. With both wires of the electric circuit.
2. With one wire of an energized circuit and the ground.
3. With a metallic part that has become live by itself in contact with an energized wire.

The severity of the shock depends on the following factors:

a. The rate of flow of current through the body measured in amperes.
b. The path of the current through the body.
c. The length of time the body is in the circuit.

4.1.2 Effects of Electric Current on Human Body

mA	Effect on Person
0.5 - 3 mA	Tingling sensations
3 - 10 mA	Muscle contractions and pain
10 - 40 mA	"Let-go" threshold
30 - 75 mA	Respiratory paralysis
100 - 200 mA	Ventricular fibrillation
200 - 500 mA	Heart clamps tight
1500 + mA	Tissue and Organs start to burn

4.1.3 Human Resistance to Electrical Current

Body area	Resistance in ohms
Dry skin	1,00,000 to 6,00,000
Wet skin	1000
Internal Body	hand to foot 400 to 600
Ear to Ear	(about) 100

4.1.4 Comparison between AC and DC

Even 18 V of AC has been known to be fatal. DC even more than 140 V have not caused death. Three times DC is equal to AC in effect. Currents between frequencies of 20-100 HZ are very dangerous. A shock at 50 HZ may start ventricular fibrillation.

4.2 ARC-BLAST

Arc-blasts occur from high-amperage currents arcing through air. This abnormal current flow (arc-blast) is initiated by contact between two energized points. This contact can be caused by persons who have an accident while working on energized components, or by equipment failure due to fatigue or abuse. Temperatures as high as 35,000$_{o}$F have been recorded in arc-blast research. The three primary hazards associated with an arc-blast are:

1.) Thermal Radiation

2.) Pressure wave

3.) Projectiles

4.3 EXPLOSIONS

Explosions occur when electricity provides a source of ignition for an explosive mixture in the atmosphere. Ignition can be due to overheated conductors or equipment, or normal arcing (sparking) at switch contacts. OSHA standards, the National Electrical Code and related safety standards have precise requirements for electrical systems and equipment when applied in such areas.

4.4 FIRES

Electricity is one of the most common causes of fire both in the home and workplace. Defective or misused electrical equipment is a major cause, with high resistance connections being one of the primary sources of ignition. High resistance connections occur where wires are improperly spliced or connected to other components such as receptacle outlets and switches.

5. Management Leadership Responsibilities

Line management has the responsibility to implement this standard.

5.1 Management, Leadership and Commitment

Effective General electrical safety management system should include the following related to the unique hazards of electrical energy.

- Establishing electrical management resources and procedures that focus on providing each Unit / Plant with an effective general electrical safety management process.
- Committing resources to implement a general electrical safety management program and to sustain continuous improvement of electrical safety.
- Establishing accountability for performance against specific safety goals and/or objectives.
- Ensure that all Electrical Inspectorate and DGMS – Electrical Safety requirements are fulfilled.
- Ensure that all electrical Elevators and Lifts are as per the guidelines given by State Authorities as applicable.
- Verifying (through internal audits) the degree of compliance with established electrical safety standards and practices and implementing appropriate corrective actions.
- Participating in activities that visibly demonstrate a commitment to electrical safety.

5.2 Unit Operations and Engineering Services Department

The unit operations group should lead and manage electrical safety activities. The Engineering Services Department function should provide adequate resources to support the electrical safety improvement process.

5.2.1 Operations Leadership (SBU's & Plant)

Operations leadership shall help and ensure that proper resources are committed to supporting a sustainable electrical safety improvement process. This shall include designating a Unit / Plant electrical safety leader. In addition, the operations leadership's responsibilities should include, but not be limited to,

- Demonstrating overall management leadership and commitment.
- Auditing Unit / Plant electrical safety programs.
- Making electrical safety expertise available to all Unit / Plants.
- Promoting information exchange among Unit / Plants.
- Confirming that electrical hazards are periodically assessed, and the information is used to prioritize improvement of Unit / Plant electrical safety programs.
- Paying adequate attention to electrical safety when forming joint ventures, making acquisitions, deactivating facilities, and dismantling facilities.

Corporate Electrical Safety Leader: This person shall be responsible to co-ordinate all electrical activities with respect to safety within the organization irrespective of the SBU. He/ She shall co-ordinate with in electrical network the members of whom shall be the unit/Plant/Mine Electrical Lead.

5.2.2 Information sharing through HZL Electrical Network

Each Unit / Plant Unit / Plant Electrical Safety lead should share electrical safety information with the network members co-ordinated by Corporate electrical safety leader. Unit / Plant. Information that should be shared includes electrical incident reports and summaries, electrical equipment failures, and any other information about unusual electrical events that may be of interest and have valuable lesson- learning potential.

5.3 Unit / Plant Management

5.3.1 Employee Involvement

Unit / Plants should, on an ongoing basis, to seek participation and input from employees regarding ideas for improving and strengthening Unit / Plant electrical safety programs and procedures.

Effective electrical safety programs should involve everyone in individual and collective efforts to manage electrical safety. *Recognizing that all employees are exposed to potential electrical hazards, Unit / Plant line management shall provide for and encourage a broad spectrum of employee involvement in the design, implementation, and ongoing operation of the Unit / Plant's electrical safety program.*

Some examples of involving employees include, but may not be limited to,

- Being a member of Unit / Plant electrical safety teams or committees
- Participating in Electrical Safety Month
- Serving as part of incident investigation teams
- Participating in prestart up reviews
- Conducting equipment tests and inspections
- Writing and/or reviewing operating and maintenance procedures
- Participating in the development of training procedures and programs
- Participating in electrical safety audits
- Electrical safety training program for contract employees

5.3.2 Electrical Safety Improvement Process

Unit / Plants shall establish an electrical safety improvement process as part of their overall safety and occupational health management process. The electrical safety improvement process shall include, but not be limited to the following activities:

- *Developing, documenting, and issuing Unit / Plant electrical safety procedures and Practices.*
- *Providing training in safe electrical work practices appropriate for job responsibilities for all Unit / Plant personnel.*
- *Developing and implementing improvement plans based on both on-Unit / Plant and off-Unit/Plant electrical incident findings and recommendations.*
- *Identifying and promoting electrical facility improvement opportunities through the use of Inherently safer electrical technology.*
- *Conducting internal audits for compliance with Unit / Plant electrical safety procedures and practices, analyzing audit results and preparing reports for Unit / Plant management, acknowledging strengths, and recommending upgrades and corrective actions.*
- *Conducting audits to check compliance relevant to statutory requirements.*
- *Providing Unit / Plant coordination for electrical safety, particularly where different business sectors are present*
- *Networking with other Unit / Plants as appropriate*
- *Identification of power supply sources at the final distribution ckt. where RCBO OR, RCCB + MCB (30mA I-sensitivity) is not available and upgradation of such sources with the same shall be done at the earliest.*

A proven practice for managing these requirements is establishing and empowering a Unit / Plant electrical safety team (or, for small Unit / Plants, a single person) with management sponsorship and appropriate responsibility and accountability to Unit / Plant leadership for overseeing this improvement process.

The electrical safety improvement process shall incorporate a full range of control measures to Safeguard personal from electrical hazards. The control measure shall include the following, which are listed in hierarchy of effectiveness and preferred order of application:

- *Elimination of unnecessary or avoidable exposures*
- *Substitution with less hazardous systems or equipment (e.g., < 30 volt [V] or optical control systems and fault current limiting or reduction technologies) in place of more*

hazardous systems or equipment.

- *Engineering controls, such as equipment designs, which reduce the possibility of inadvertent contact or reduce the need for direct interaction with exposed circuits*
- *Visual warnings (i.e., signs, barriers, and labels) as per* **IS: 2551-1982**
- *Administrative controls (e.g., permits for mobile equipment, excavations, and working near energized equipment)*
- Specific work permit system issued by one step higher authority for carrying out any work near / close vicinity of energized equipment /line (outdoor switch yards, bus coupler, two overhead lines running parallel or crossing each other, passing of any over dimension equipments/ machinery below the HT lines etc.)
- *Personal protective equipment (PPE)*

5.3.3 Electrical Safety Resource

Unit / Plant electrical safety lead shall be the electrical safety resource for implementing the Unit / Plant electrical safety improvement process identified in Section 3.3.2. The electrical safety resource's knowledge and qualifications shall include, but not be limited to:

- *Understanding the hazards associated with electrical energy and the association of electrical safety and process safety, fire safety, and asset productivity.*
- *Having experience in one or more areas of design, maintenance, operation and construction of electrical power distribution systems.*
- *Having knowledge of local electrical safety regulations, SHE Standard and other related standards.*
- *Having the ability to develop engineering solutions to eliminate, reduce, and guard against personnel exposure to electrical hazards.*
- *Being an electrician, electrical technician, or electrical engineer with knowledge of electrical power systems.*
- *One designated Electrical safety officer shall be appointed for the Unit as per the CEA 2023 regulation*

The Unit / Plant electrical safety resource should regularly participate in electrical safety network activities with electrical safety resources from other Unit / Plants to leverage and share information related to electrical safety.

For facilities where such a resource is not available at that location, the Unit / Plant shall designate one Unit / Plant person to be responsible for coordinating the Unit / Plant electrical safety activities and identifying a resource from another Unit / Plant to perform or assist in the

Unit / Plant electrical resource role.

5.4 Unit / Plant Engineering

Engineering design and construction management decisions affect electrical safety over the full life cycle of an installation, including construction, commissioning, operations, maintenance, and dismantling, Unit / Plant engineering teams shall be responsible for helping to ensure that capital project managing systems evaluate and compare design options and choices that facilitate engineering design and evaluation and construction management decisions that serve to

- *Eliminate risk.*
- *Reduce frequency of exposure.*
- *Reduce magnitude or severity of exposure.*
- *Enable the ability to achieve an electrically safe work condition.*
- *Enhance the effectiveness of other electrical hazard control measures included in this standard.*

Unit / Plant engineering teams should establish and document Unit / Plant-specific electrical safety design and installation requirements.

6. Definitions

These definitions are provided to describe the intent of this standard; the terms may be defined differently in other contexts.

Hazard: A source of possible injury or damage to health

Hazardous: Involving exposure to at least one hazard

Risk: A combination of the likelihood of occurrence of injury or damage to health and the severity of injury or damage to health that results from a hazard.

Authorized—being determined by management to be qualified and given permission and support to perform and/or direct specific tasks or functions.

Electrical event—an unusual occurrence that did not, but had the potential to, lead to an electrical incident.

Electrical incident—one of the following types of incidents:

• Any incident (as defined in HZL Standard) having an error or failure in electrical systems as a contributing cause.

• An incident that involves, or has the potential to cause, an electrical injury as defined in this standard, or other injury that may result from direct exposure to electrical energy (e.g., a fall injury that might result from reaction to electric shock).

Electrical injury—an injury that results from electrical, thermal, acoustic, or radiation energy released at the moment of an electrical incident.

Lethal shock hazard—any voltage greater than 30 V to any reference point.

Boundary, Limited Approach- An Approach Limit at a distance from an exposed energized electrical conductor or circuit part within which an electric shock hazard exists.

Practice—an accepted and recognized work method that is aligned with applicable national regulations and standards and is also aligned with policies, standards, and guidelines.

Procedure—a documented method or process of carrying out a work activity that is aligned with applicable national regulations and standards and is also aligned with policies, standards, and guidelines.

Qualified—Person one who has demonstrated the skills and knowledge to perform the job safely and able to identify and avoids the hazard in working areas.
Any person working on Electrical systems must have valid Wireman or Electrician or Supervisory license to be deemed as Competent. No person shall work on electrical systems without having valid wireman/supervisory license issued from State Electrical Inspectorate Office.

A qualified individual has the following characteristics that help to plan, audit, and perform a task safely

- Knows the construction and principle of operation of the equipment to be worked on
- Knows, and is skilled in the use of, the work methods and safe work practices for performing the task
- Understands the hazards associated with the equipment
- Is able to recognize the hazards
- Is able to avoid the hazards
- Is able to recognize and manage changing conditions of equipment or operation
- Knows the local legal requirements
- Shall be certified by relevant state electrical inspectorate Office

Residual current device (RCD)—an electrical safety device that functions to protect people from electric-shock injury by sensing leakage of current to ground associated with electric shock and de-energizing the circuit before a serious injury is likely to occur. National standards and regulations determine the performance parameters of RCDs.

Boundary, Restricted Approach- An Approach Limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc over combined with inadvertent movement.

Risk assessment: A process that identifies the hazards, estimates the potential severity of injury or damage to health, estimates the likelihood of the injury occurrence or damage to health, and determines if protective measures are required, including procedures and practices are put in place to reduce risks to acceptable levels.

Working On (energized electrical conductors or circuit parts). Intentionally coming in contact with energized electrical conductors or circuit parts with the hands, feet or other body parts, with tools, probes, or with test equipment, regardless of the personal protective equipment (PPE) a person is wearing.

Bonded (Bonding): Connected to establish electrical continuity and conductivity

Grounding or Earthing: Grounding or earthing of an object is the surest way of preventing accumulation of static charge on the object. It is for this reason that the bodies of electrical apparatus, panels, and any object likely to accumulate static charge are earthed preferably with bare conducting metal wires or strips.

7. Standard / Guidelines

7.1 Basic Electrical Safety Rules

- Only qualified, Competent & Authorized person should do electrical work
- Use protective equipment's / buddy system for work on live circuits
- Take electrical circuits as live unless proved otherwise
- Verify a circuit is open either from terminal box or switch box
- Enclose uninsulated conductors
- Use rubber mats in front of electrical panel as per IS: **15652:2006**
- In underground mine, as per CEA (Measures related to safety and electricity supply) Regulations 2010, Regulation 19, sub-regulation (2) and (5), rubber mats provision at remote panel installations like Gate end boxes, Multi feeder pillars, Single feeder pillars, fans panels etc., is not suitable in UG mining due to wet surfaces and mud. But same regulation will be met by Di-electric gumboots of 20KV to all electrical persons working in underground.
- Do not touch / operate switches in wet hand / wet condition

- Protect overhead live lines against crane boom movement
- Remove metal chain, bangle, watch ring etc. from body before working on Electrical system
- Ensure proper grounding / earthing of equipment's
- Use Industrial plugs & Sockets for portable tools and should be certified by Electrical Deptt.
- Never try to test circuit by touching use tester / test lamp
- Ensure Tag Out / Lock Out procedure before taking up electrical maintenance work
- Ensure use of Work Permit System on electrical maintenance work
- Message should be written down
- Comply with Indian Electricity Act; CEA regulations & guidelines from DGMS for Mining works.
- Do not use umbrella in substation / receiving station
- Know the voltage of circuit
- Check suitability of fuses and circuit breakers
- Inspect chords of portable tools

7.2 Electrical Technology

Technologies that eliminate exposure to electrical hazards are the first line of defense in avoiding electrical incidents. Technologies that reduce the frequency and/or severity of potential exposures, used in conjunction with safe work practices, should be considered a second line of defense. PPE technologies and requirements outlined in Section 5.2.6 should be considered the last line of defense.

Unit / Plants shall have practices and procedures in place for managing capital projects to help ensure that the following solutions are considered in the project design and selection of new equipment:

- *Personnel exposure to electrical hazards shall be reduced to acceptable levels based on a risk analysis through the use of the best available equipment design, installation details, and maintenance and operating practices for electrical equipment and systems. Examples of equipment designs to be considered include Power systems (where allowed by local regulations), ground fault protection for personnel safety, Arc-proof equipment, current-limiting fuses and circuit breakers, reduced substation and/or transformer size, and smart motor control centers.*

- *For equipment where access for maintenance, adjustment, or servicing may be required while the equipment is energized, the energized exposed parts operating at > 30V shall be provided within enclosures to prevent inadvertent contact.*

- Specifying electrical devices with shrouded terminals and conductors that provide the finger-safe (IP2X of IEC 60529, features is a highly engineered and sustainable method of reducing the possibility of inadvertent contact with energized parts.

Annexure - 1 may be used to communicate to suppliers / installations agency about design capability requirement for electrical equipments/installation and precautions / validity to be done during commissioning.

7.3 Electrical Safety Procedures and Safe Work Practices

Unit / Plants shall have electrical safety procedures that are easily accessible and up-to-date. These procedures shall be developed using a risk-assessment process and shall contain the safe practices necessary to identify and manage the electrical hazard exposure. In addition to internal operations, these procedures should cover normal and emergency operations associated with the electrical supply utility.

Note: Permission for usage of submersible pumps, temporary connections should be integrated with PTW and work can't be initiated without PTW to ensure mentioned recommendations.

Electrical safety procedures shall be reviewed and reauthorized at intervals not to exceed two years and shall be consistent with local regulations and the requirements of this standard. The review shall include individuals involved in the execution of the specific task to which the procedure pertains.

As per CEA regulations, all sub-stations should have minimum two exits with self-glowing signage. Shutters cannot be used as an emergency exit point. However, a door may be introduced by modifying the shutter to ensure hassle free and exit in case of emergency. Salient Features of Procedure: Annexure 1.1

Comparisons of work performance with standard electrical safety procedures shall be included as part of the Unit / Plant internal audit process

7.3.1 Working on or near energized electrical equipment

The goal when working on or near energized electrical equipment is that no work should be performed within the Restricted approach boundary as defined in Table 1. Risk controls that help achieve this goal shall include equipment and hazard assessment, limitation of work activities based on levels of risk, and the need for a higher level of formal authorization and work permits for work with higher levels of risk. Unit / Plants should demonstrate a commitment to minimizing exposure of working on or near uninsulated or unguarded electrical circuits and conductors energized > 30 V, including the contact of tools or any part of the body, regardless of the PPE used.

Though ARC flash protection boundary, as indicated in Annexure 1 Item 1.4, are calculated in worst case (Open Door Condition). Assessment of the boundary should be available in the sub-station to guide the man movement. In case ARC protection boundary cannot be complied, necessary deviation should be obtained and person entering the room must wear ARC flash suit.

Work within the Restricted approach boundary shall only be performed when all of the following requirements are met:

- *Only authorized personnel trained on the specific task and the hazards involved are permitted to perform work on energized conductors.*
- *Line management has participated in the decision to authorize work on energized Conductors. Each Unit / Plant shall establish the level of management approval for this authorization.*
- *A specific job plan is written for the task.*

Although voltage testing and diagnostic testing are performed within the prohibited approach boundary, it is recognized that these tasks are performed regularly and should be managed by practices, procedures, and authorization in lieu of specific written job plans.

Voltage testing shall only be performed when all of the following requirements are met:

- *Proper test instruments are selected and used in accordance with Section 7.3.5.*
- *The person performing the test is qualified and authorized to perform voltage testing as part of his or her job responsibility.*
- *Appropriate PPE is used while performing the task.*

The preferred method for performing diagnostic testing and troubleshooting is on de-energized circuits. If this is not possible, diagnostic testing and troubleshooting shall only be permitted on energized circuits when performed in compliance with the requirements above and Section 7.3.7 for guidance on de-energized troubleshooting techniques.

7.3.2 A) Energy Isolation

In addition to the requirements of LOTO standard, Unit / Plant procedures for isolating electrical energy shall include

- *The application of temporary safety grounding and/or earthing as determined by risk assessment.*
- ***Test Before Touch** (see Section 7.3.5), including verification of the test instrument before and after the test.*
- *Practices to help ensure identification, communication, and understanding of the limits of the safe work boundary.*

Note: Personnel should know the safe work boundary to avoid electrical hazards. In complex electrical equipment, the safe work boundary may not be obvious. A section of switchgear, a single starter in a motor control center, or other equipment may be isolated for safe work; however, adjacent compartments or cubicles may remain energized. There may also be multiple sources of energy.

- Techniques to enhance communication and understanding of the safe work boundary should include, but not be limited to, temporary signs, locking doors and covers on adjacent compartments, barricades, job walk-throughs, a description of the safe work boundary in job plans, and additional emphasis on Test Before Touch.
- *Identification of ownership and control of hazardous energy during construction, Commissioning, handover to operations, maintenance, and other situations in which control responsibility may change.*
- *Sites shall help ensure that all instruments that test for the absence of voltage are designed and certified to meet the requirements of IE Rules & relevant standards. Salient Features of Procedure: Annexure 1.2*

B) Safety Interlocks

Following safety interlocks are essential for the safe operation of the switchgears:

- Isolators and controlling circuit breaker shall be interlocked so that isolators cannot be operated unless the corresponding breaker is in open position

- Isolator and corresponding earthing switches shall be interlocked so that no earthing switch can be closed until the corresponding, isolator is in open condition.

- Where two or more supplies are not intended to be operated in parallel, the respective circuit breakers of linked switches controlling the supplies shall be interlocked prevent possibility or any inadvertent paralleling or back feed.

- When two or more transformers are operated in parallel, the system shall be arranged as to trip the secondary breaker of transformer in case the primary breaker of that transformer trips.
- Where two or more generators are operated in parallel and neural switching adopted, interlock shall be provided to ensure that generator breaker cannot be closed unless one of the neutrals disconnected to the earthing system.

- Access control at UG substation with lock and key is not be advised, in view of installations are scattered and unmanned. In case of fire or other emergencies, it is difficult to attend and initiate emergency response in locked condition. Prohibition of unauthorized entry will be met by providing sufficient signage boards, panels doors' effective locking etc.

- All HT Incomers & Bus Couplers must have back door Interlock system to avoid any contact with Energized system.

7.3.2 Job Plans and Permits

Careful planning is fundamental to understanding, assessing, and managing potential exposure to hazards. Unit / Plants may find it beneficial to break jobs into individual tasks to assist in identifying the hazards and safe work practices for each task. Surrounding environment and natural conditions should also be considered during job planning.

Procedures and practices shall be implemented to help ensure that recognized hazards are addressed in job plans and permits. Unit / Plants shall have a process for determining documentation requirements. The review and authorization process for job plans and permits must be consistent with the level of hazards involved and must include management oversight of the process and input from the electrical competency. Unit / Plants shall specify the levels of management and technical personnel involvement in the approval process.

If the job cannot be completed as planned or if conditions change, work shall be stopped and re-planned. Unit / Plant leadership shall effectively communicate job plans to everyone involved with, and affected by, the work, including operations and emergency response personnel, where appropriate.

A proven and effective planning aid is the My Electrical Safety Principles (Refer Section 7.1). These principles represent safe practices that everyone working around electricity should know and follow. They may be used in facilitating improvements in all aspects of electrical work activity (e.g., design, construction, operation, maintenance, deactivation, and dismantling or renewal)

Salient Features of Procedure: Annexure 1.3

7.3.3 Standby Person

Unit / Plants shall have a risk-assessment process for determining the need for and the responsibilities of, a standby person and qualifications/skills required for the specific task. All standby persons shall be trained, qualified and have skills to perform their responsibilities. The responsibilities of the standby person shall include, but not be limited to,

- *Being aware of the hazards involved in the task.*
- *Being qualified to switch off the power to the equipment being worked on.*

Note: For some equipment, specific training and authorization may be required to operate it, and the standby person should be selected accordingly.

- *Being able to isolate the supply through appropriate means. This shall be specifically done through providing awareness prior to commencing the task at the location where work is planned.*

- *Being able to initiate the alarm at the work location. This shall be specifically reviewed prior to commencing the task at the location where the work takes place.*
- *Being trained in the administration of appropriate first aid (e.g., cardiopulmonary resuscitation [CPR] where there is a recognized risk of electric shock and treatment of burns where there is a recognized risk of electric burns).*
- *Preventing personnel from removing covers not in the job plan or crossing the safe work boundary.*
- *Preventing personnel not involved in the task from crossing the safe work boundary.*
- *Refraining from doing work that interferes with his or her ability to perform any of the above duties.*
- *Communicating critical information to the first responders to the emergency.*

The standby person shall wear the same PPE as the person Performing the task if he/she may have to cross the safe work boundary (e.g., to switch off the power or initiate the first-aid process). If all of the standby person duties can be safely carried out without entering the safe work boundary, then only the PPE required to perform these standby person duties shall be worn.

Due to the differences in equipment, tasks, hazards, and risks, it is difficult to be specific about the qualification of the standby person. However, due to the responsibilities noted above, it is preferable that the standby person should be electrically qualified. *As the hazard and risk severity increases, the requirement for qualified electrical standby persons shall also increase.*

Before beginning a task, the person(s) performing the task shall be responsible for helping ensure that the standby person is sufficiently qualified to perform all of their duties associated with the task.

7.3.4 Testing for the absence of voltage

Unit / Plants shall have procedures and practices in place to test for the absence of voltage before touching bare conductors or parts (i.e., Test Before Touch). The procedures and practices shall include verifying test instruments on a known energized source before and after the test to check for absence of voltage and complying with the PPE requirements of Sections 7.3.6 and 7.3.15. Personnel should test every circuit and every conductor, every time, to verify the absence of voltage before touching. While in some cases this may seem to be redundant or repetitive testing, the practice of Test Before Touch is a critical step that minimizes risk of contacting an energized conductor due to unexpected and unplanned situations.

All personnel performing testing for the absence of voltage shall be trained in the Unit / Plant procedures and practices for voltage testing. Training and qualification shall be specific to each voltage test instrument.

Unit / Plants shall help ensure that all instruments that test for the absence of voltage are designed and certified to meet the requirements of **IEC 61010 and be rated for the appropriate category for the task.**

7.3.5 Personal Protective Equipment

Unit / Plants shall have procedures and practices in place to manage selection, approval, application, provision, inspection, testing, storage, use, and maintenance of all electrical PPE. To help ensure that proper PPE is selected and complies with requirements, refer to Section 7.3.15.

Salient Features of Procedure: Annexure 1.4

7.3.6 Troubleshooting

As outlined in Section 7.3.1, Unit / Plants shall define the safe work practices for troubleshooting. Unit / Plant practices should emphasize de-energized troubleshooting techniques and other practices that reduce exposure to energized circuits and conductors.

Unit shall have a process in place to help ensure that a risk assessment is conducted and procedures and practices are developed for every activity related to installation / operation / modification / maintenance to minimize the risk of injury to people and minimize the disruption of operations.

Unit / Plants shall help ensure that all test instruments used for troubleshooting circuits or equipment are designed and certified to meet the requirements of IEC 61010 and be rated for the appropriate category for the task. For guidance on how to select an appropriate test instrument. See Section 7.3.15 for PPE requirements when troubleshooting energized electrical equipment.

Salient Features of Procedure: Annexure 1.5

7.3.7 Dismantle and Remove and/or Rearrange Work for Cables

The identification, cutting, and removal of electrical cable tray and cable often involve a high level of risk in determining that the correct cable is removed. The risks involve exposure of personnel performing the work to electrical hazards and disruption to operations if a critical energy or control circuit is damaged.

Unit / Plants shall have a process in place to help ensure that a risk assessment is conducted and *procedures and practices are developed to minimize the risk of injury to personnel and minimize the disruption of operations. Unit / Plants shall have procedures and practices in place that*

- *Test for the absence of voltage at the source and destination ends of each cable.*
- *Positively identify each cable before it is cut. The preferred method for tracing a cable along its length from a known isolated source is to use a loop of cord or a cable tie loosely secured around the cable at the source end and sliding along the length of the cable. A cable shall not be picked up in a tray and traced by moving one's hands (hand-over-hand) along the length of the cable.*
- *Positively identify a cable at both sides of a barrier (e.g., a wall or duct) for each individual circumstance and have a qualified person approve the procedure and/or practice. A cable shall not be traced using a hand-over-hand method.*
- *Base the practice and location of cutting a cable on the level of possible risk associated with damage to other cables. Suitably grounded pneumatic cutters or cable-spiking tools and the use of correct PPE can minimize the risk to personnel. To minimize the risk of damaging adjacent cables and possible electrical exposure, a cable within a tray shall not be cut.*
- *Secure and label cable ends that remain exposed during, and on completion of, the cable removal activity.*
- *Separate Cable cutter device shall be used for cutting of cable.*
- *For underground cable, cable locator device shall be used and removal of process shall include all excavation standard procedure.*
- *For the Underground mines, all the HT cables shall have different color (Preferably Red). It is also preferred to have Red reflective sticker on every 3 mtr. interval & at every turn for HT/LT/Control cables.*

7.3.8 Documentation and Equipment Labeling

Drawings, panel directories, and other documentation provide critical reference information for planning and safely and reliably executing isolation, operation, maintenance, and construction of electrical equipment and systems. Examples of critical reference information include, but are not limited to :-

- Single line drawings.
- Schematic diagrams.
- Maps of underground electrical services.
- Area classification drawings.
- Cable schedules
- Test reports / calibration reports

- Emergency alarm / annunciation systems
- Electrical system studies (e.g., short circuit, protective device coordination, and arc flash hazards-analysis studies).

Procedures and practices shall be in place to help ensure that

- *Electrical documentation and labeling necessary to identify and isolate electrical hazards is accurate, up-to-date, and readily accessible.*
- *Labels and equipment identification are designed, specified, provided, and maintained to communicate warnings, cautions, and circuit information critical to safe operation and maintenance of electrical equipment and systems, including abandoned-in-place wiring and equipment.*

Unit / Plants may find it beneficial to have only one labeling convention across each Unit / Plant.

It is recommended that labeling on electrical DB/Panel can be done in black colour with yellow background & black border.

7.3.9 Excavations and Penetrations

Unit / Plants shall have procedures and practices in place to help ensure that the electrical lines, conduits, and cables in the area of work activity are identified before performing excavations and/or penetrations of floors, roofs, and walls. The procedures should include boundary limits for approaching underground lines (energized or de-energized) with mechanized and hand-held tool excavation methods.

All excavation and penetration work should be performed on a permit basis, and permit approval forms should specifically address the hazards of buried electrical lines.

Practices should include, but may not be limited to, using up-to-date Unit/ Plant maps showing underground cables and using electronic tracer systems for locating cables before excavation or penetration commences.

All underground Power & Control cables must be marked with suitable cable route markers and voltage signages to avoid accidental exposure to supply while excavation / penetration.

Salient Features of Procedure: Annexure 1.6

7.3.10 Cranes and Mobile Equipment

Unit / Plants that have overhead electric lines shall have procedures and practices in place for helping ensure that cranes and mobile equipment do not come closer to these lines than the approach distance defined in Table 1.

Salient Features of Procedure: Annexure 1.7

7.3.11 Water and/or Steam Cleaning

Unit / Plants that use water and/or steam cleaning shall have procedures and practices in place to prevent hazards associated with moisture ingress to nearby electrical conductors and equipment. Portable electric-powered cleaning equipment should be protected with or residual current device (RCD) protection (see Section 7.3.15).

Salient Features of Procedure: Annexure 1.8

7.3.12 Power Distribution Operations

Unit / Plant electric power systems operations, including switching, maintenance, and construction activity, involve risk of serious personal injury, widespread and prolonged disruption to Unit / Plant operations, and impact on process safety.

Only personnel authorized by Unit / Plant management shall manage and execute power system operations activities. Unit / Plants shall develop and implement procedures and practices to eliminate hazards where feasible and minimize risk of personal injury and disruption of power to operations.

Unit / Plant procedures and practices shall address the following, where appropriate:

- *Switching sequences to minimize risk of, and exposure, to arc flash hazards*
- *Techniques to effectively identify and communicate safe work zones in switchgear*
- *Training, renewal, and succession planning for key job functions*
- *System studies updates (e.g., arc flash hazard analysis, protection coordination, and others deemed appropriate by each Unit / Plant)*
- *Operational plan for the electrical power system in the event of severe weather*
- *Management plan for the installation of temporary generators*

Unit / Plants may find it beneficial to have a dedicated power distribution team.

7.3.13 Management of Change—Technology

Unit / Plants shall have procedures in place to help ensure that design changes and field modifications in electrical systems are reviewed, approved, documented, and communicated to personnel who may be affected by the changes.

Unit / Plants shall have a practice for involving a qualified electrical person in the approval of new electrical technology and equipment, and in assessing the impact of the changes in general electrical safety management.

7.3.14 Management of Electrical Hazards

7.3.14.1 Electrical Distribution System Hazard Analysis

Unit / Plants shall perform an electrical hazard analysis for the Unit / Plant electrical distribution system. The analysis shall be validated at a ***frequency not to exceed two years.***

A process hazard analysis methodology is one tool Unit / Plants can use to identify unsafe conditions and situations in electrical system facility operation and maintenance that may lead to electrical incidents. This methodology helps Unit / Plants evaluate situations where electrical hazards may be present through evaluating the effectiveness of control measures (e.g., the operation of protection system devices to reduce arc flash energy), the guarding of energized parts, and the completeness of electrical safety procedures, training, and the potential effect of human factors. For additional information, refer to PHA standards.

7.3.14.2 Shock Hazard

Unit / Plants shall have procedures and practices in place to assess and manage shock hazards. For information on boundary limits, refer to Table 1 and Figure 2.

At a minimum, the following requirements must be followed:

- *The limited approach boundary for circuit parts and conductors without IP2X equivalent design shall be crossed only by a qualified person*
- *The restricted approach boundary shall be crossed only by a qualified person that is using shock protection techniques and equipment.*

Unit / Plants shall have practices and procedures in place that require the use of voltage-rated PPEs on circuits greater than 30 V when:

- *Using voltage testing or measuring instruments.*
- *Working within any approach boundary.*

Note: Where the equipment contains all finger-safe components (IP2X), Unit / Plants can assess the risk of unintentional contact with uninsulated energized parts for work within the restricted approach boundary and may consider relaxing the requirement for voltage-rated gloves if deemed appropriate.

- *Touching energized, insulated wires, cable cores, or components.*
- Proper design, installation, and maintenance of equipment grounding and/or earthing and bonding are critical to managing shock hazards. Requirements for managing the mechanical integrity of grounding and/or earthing and bonding are described in Section 5.4.3.

All Unit / Plants should have a program in place to expand shock-hazard protection. The program may include reducing the amount of socket-fed equipment, expanding the use of G RCDs during

retrofits and design of new facilities and evaluating the benefits of converting existing socket-fed equipment to hard-wired equipment. This technology and the regulatory requirements for preventing shock hazards are available toward protecting all socket-fed equipment (double insulated equipment)

Unit / Plants shall have a procedure in place for the application, testing, and maintenance of RCDs. With the exception of applications that are technically infeasible, all portable and transportable tools and electrical equipment, temporary wiring, and extension cords that operate at greater than 30 V to ground and are frequently subjected to rough service and/or are routinely plugged and unplugged must be protected by permanent or portable RCDs. These devices shall have a 30mA maximum current setting. Local regulations may require lower maximum current settings.

Vending machines, water fountains, and socket-fed equipment in kitchens, cafeterias, break rooms, and in wet or damp locations shall be protected by RCDs.

Unit / Plants should consider using the following technologies to complement the overall shock protection program and to minimize the risk of shock:

• Use RCBO of 30mA sensitivity or RCCB of 30mA sensitivity +MCB
• All submersible pumps should be protected with 30mA sensitivity RCBO or RCCB of 30mA sensitivity +MCB
• All the Power sockets (1 Phase/ 3 Phase) or any source of power supply within plant, colony, mines and any area where plant power supply is being used shall be through RCBO of 30mA or RCCB of 30mA sensitivity +MCB.
• Permission for usage of submersible pumps, temporary connections should be integrated with

PTW procedure so that such jobs cannot be initiated without PTW to ensure that the power supply source is protected through RCBO or RCCB+MCB.

- Battery-powered tools
- Reduced-voltage equipment
- Double earthing for equipment
- Double-insulated equipment
- Shrouding and barriers (e.g., to IEC 60529 requirements for IP2X finger-safe terminals)
- Insulated or voltage-rated tools
- Voltage-rated PPE (e.g., gloves or hats, Di-electric Gum Boots)
- Insulated mats on floors as per IS 15652-2006
- Insulated, flexible barriers for exposed equipment parts
- Display of appropriate Caution boards / signage / labeling
- It is recommended to use PVC / FRP Junction Boxes for control voltage, 100 V or below. However individual site needs to asses associated hazards and finalize/ eliminate their use.
- Non-Conductive Gumboot usage shall be mandatory for the employees and contract workmen while working in wet area such as dewatering of the pits, cable cellars / trenches etc.

Where multiple voltage sources exist in equipment, Unit / Plants shall have procedures in place to manage shock hazard exposure. The procedures and practices should include, but not be limited to, the following supplemental elements:

- Identification of multiple voltage sources inside cabinets
- Segregated voltages to prevent accidental contact where multiple voltage sources exist in one unit
- IEC 60529 requirements for IP2X (or equivalent) finger-safe terminals to prevent finger contact
- Barriers
- Insulated, voltage-rated tools to minimize the hazards of accidental contact
- Labeled back-feeds, temporary feeds, and dual feeds

When mechanically connected, common or borrowed neutrals have zero potential relative to earth or ground. When disconnected, one or more of the separated neutral wires may have lethal voltage. Unit / Plants shall have practices and procedures in place to prevent the use of common or borrowed neutrals on any new installation or retrofit. For existing installation, the use of common or borrowed neutrals shall be identified.

7.3.14.3 Arc Hazards

Arcing faults in electrical equipment are multi-energy events (i.e., involving heat, blast, light, and sound) that generally produce short-duration burn and explosive blast hazards.

Unit / Plants shall have procedures and practices in place to reduce potential exposure to electric arc hazards. Unit / Plants shall have a process in place to help ensure that an arc flash hazard analysis of Unit / Plant electrical systems is performed and the results are documented to determine the level of arc flash energy and the consequences of an arcing fault. The analysis shall be updated when the electrical system is modified and at least every five years using the latest available and appropriate arc-flash energy calculation equations.

Where the incident energy is greater than 1.2 cal/cm2 (5.0 Joule/cm2), Unit / Plants shall have a process in place to perform and document an arc flash risk assessment for determining how the work can be done safely. At a minimum, the following items shall be assessed:

- *Incident energy at the working distance*
- *Arc-flash boundary*
- *Activity*
- *Equipment*
- *Body positioning*
- *Tools*

In some cases, the level of risk may lead to the conclusion that the work is too hazardous to perform under energized conditions. In these situations, line management and functional experts should be involved to reduce the risk to an acceptable level.

Arcing faults in oil-filled electrical equipment (e.g., oil-filled transformers and circuit breakers) have an additional component of hazard and risk. Arcing faults within an enclosure or tank can result in a burn hazard caused by hot oil being expelled from the unit. This is due to overpressure created by expanding gases from the arc energy. The overpressure can result in either a tank rupture or pressure-relief device operation leading to a hot-oil spill in the immediate area of the unit. The hot oil can ignite when it exits the unit's relief device or ruptured tank and comes into contacts with oxygen. Burn injuries or fatalities may result from the burning liquid igniting anything it comes into contact with.

Unit / Plants with liquid-filled, insulated electric power distribution equipment shall have a process (i.e., process hazard analysis or another method deemed appropriate by Unit / Plant management) in place for assessing the additional potential hazards of liquid-filled, insulated equipment that is part of the electric power distribution system.

The analysis should consider, but not be limited to, the following:

- The frequency and duration of personnel exposure due to proximity of personnel walkways and work areas

- The direction path of oil being expelled from a pressure-relief system
- For off load transformer tap changers that are rated for operation only under de-energized conditions, a control method as secure as that used for personal lockout/tagout helps ensure that these devices are operated only under de-energized conditions.
- In line with requirement under IS1646-1997, proper arrangement for safe evacuation of insulated oil in the suitable size underground RCC tank to be made for the emergency situation like fire in the transformer due to overheating / fault within the terminals. Alternatively, for single tank with lesser capacity, IS requirement (provision of baffle walls of 4 hrs. fire ratings) as applicable should be implemented.

A typical minimum arc incident energy levels for applying arc flash burn protection measures is captured in Table 2; Annexure 7.

7.3.14.4 Static Electricity Hazards

Where applicable, Unit / Plants shall have procedures and practices in place to assess and manage static electricity hazards, including lightning. Static discharges can be an ignition source, and Injuries may result from a person reacting to a static shock or from process operations that may have static electricity hazards (e.g., handling or transporting liquids, solids, or gases in portable containers or piping systems). Certain maintenance activities (e.g., steam cleaning, industrial vacuuming, and sandblasting) can produce static electricity hazards.

7.3.14.5 Explosion Hazards

The primary guidance for managing the explosion hazards in nonhazardous atmospheres from arcing faults in electrical equipment is listed in Section 5.2.15.3. The primary requirements and guidance for managing ignition sources in potentially explosive atmospheres can be found in PSM standard and associated process safety management standards.

Unit / Plants shall have procedures and practices in place to assess and manage the risk of explosion hazards associated with electrical equipment. These should include, but not be limited to,

- Provision and maintenance of drawings and documents describing the limits of the hazardous area and its classification.
- Selection and procurement of electrical equipment appropriate for the area classification.
- Installation of electrical equipment to help ensure that it does not compromise the area classification.
- Maintenance of the mechanical integrity of the installation, including grounding and bonding, wall penetrations for cabling, and electrical control rooms.
- Methods to exclude other potential ignition sources from entering the area.

- Maintenance of the mechanical integrity and calibration of explosion-meters.

7.3.14.6 Fire Hazards

Unit / Plants shall have procedures and practices in place to assess and manage fire hazard risks associated with electrical equipment and installation and fire fighting in electrical equipment and installation at the Unit / Plant. These should include, but not be limited to,

- Selection, procurement, and installation of electrical equipment and devices that minimize the possibility of igniting flammable and combustible materials.
- Elimination of any flammable and combustible material inside the electrical control room that could catch fire in the event of an arc or electrical equipment fire.
- Management of mechanical integrity, as outlined in Section 5.4.3, to eliminate or reduce the fire ignition source.
- Evaluation of toxic substances emitted from burning electrical equipment and/or materials and controlling the potential for personnel exposure.

7.3.15 Earthing for Electrical Installations:

Earthing forms a very important aspect of any electrical system. The objective of an earthing system is to provide as nearly as possible a surface under and/around an electrical installations which shall be uniform potential and at as nearly zero or absolute earth potential as possible. Earthing (or grounding) is classified as: i) System/Neutral Earthing ii) Equipment Earthing

To ensure proper earthing in an electrical system IS Code of Practice for Earthing: IS 3043-1987 & IE rule 67 shall be followed.

In the case of star-connected systems with earthed neutrals or delta-connected systems with earthed artificial neutral point : The neutral point shall be earthed by not less than two separate and distinct connections with earth each having its own electrode at the generating station and at the sub-station and may be earthed at any other point provided that no interference of any description is caused by such earthing.

For Underground Mining, Distribution Transformer's secondary Neutral point shall be earthed through High Resistance (Neutral grounding Resistance), so that max earth fault current is limited up-to 750 mA.
In Underground Mine, as per CEA regulation 2010 and DGMS circular, business partners engaged in electrical installations, maintenance, repairs must have valid *minimum* B class electrical contractor license.

In Smelter & Power Plants, Contractor must possess valid Class-A contractor license issued by Rajasthan State Electrical Inspectorate Office

It is not enough that connection with earth as required by the Rule has been made, since even after the neutral point has been earthed by two or more separate and distinct connections both at the generating station and substation, the protective devices may not function effectively.

Salient Features of Earthing System: Annexure 1.10

7.3.16 – Illumination Standard:

The right level of illumination using the right kind of light fitting is most essential in creating a safely illuminated work area, be it reading, doing precision work, sports or a process resulting in explosive or flammable vapour. Working in poorly lit area over a period of time will have an adverse effect on the visual capability of an individual.

Levels of Illumination for Different Tasks/Area as per IFC guidelines:

S.No.	Minimum Limits for Workplace Illumination Intensity	
	Location/Activity	Light Intensity
1	Emergency light	10 lux
2	Outdoor non-working areas	20 lux
3	Simple orientation and temporary visits (machine storage, garage, warehouse)	50 lux
4	Workspace with occasional visual tasks only (corridors, stairways, lobby, elevator, auditorium, etc.)	100 lux
5	Medium precision work (simple assembly, rough machine works, welding, packing, etc.)	200 lux
6	Precision work (reading, moderately difficult assembly, sorting, checking, medium bench and machine works, etc.), offices.	500 lux
7	High precision work (difficult assembly, sewing, color inspection, fine sorting etc.)	1,000 – 3,000 lux

Levels of Illumination for Different Tasks/Area as per IFC guidelines w.r.t mines/DGMS Circular whichever is high, shall be included:

Table 2. Minimum average illumination for designated mine locations and activities.[25]

Location / activity	Minimum Illumination (Lux)
Emergency lighting	5
Walkways and passages	5 -10
Dynamic locations - production and development areas.	5 - 50
Areas with occasional and simple manual tasks	50 -100
Workstations and areas with medium to high precision manual tasks	150 – 400

7.3.17 : Portable Electrical Tools & Apparatus:

Any apparatus which is capable of being taken from place to place while it is being operated is called portable, as distinct from transportable apparatus which has to be switched off and then move to a place where it is required to be operated. In case of a portable apparatus, switching off the current for the purpose of shifting is not necessary. In view of this it is necessary to take special precautions in the matter of flexible cables.

Units shall have a specific procedure to check suitability of electrically operated portable tools. It should involve checking for,

- Mechanical integrity
    - Quality and conditions of basic isolations
    - Supplementary (Protective installations)
- Verification on recommended types of tools with respect to a specific job. It should also outline class of tools to be used;
    - Class I: Tool in which accessible conductive parts cannot become live in the event of failure of basic installations and protective conductors for cables.
    - Class II: Tools with additional safety precautions like double/ re-inforced installations
    - Class II A: Tool having durable and substantially continuous in closure of insulating material covering all metal parts with exception of name plate, screws and rivets which in turn are isolated from live parts.
    - Class II B: Tool with provisions as in Class II A and is double insulated except on parts where impractical but instead re-inforced insulation is used.
- Brush gear confirming to IS: 3003 Part III with insulating covering & restricted access
- The basic insulations of internal wiring shall be at least equivalent to minimum insulation for flexible chords given in IS: 8868 (Part I) 1881 & IS: 684 (1877)

- Protection from Moisture: Tools should be so constructed that they are proof against ingress of moisture that may occur in normal use, complying to clause 20.8 of IS: 4665 (Part I) 1884.
- Moving parts of the tools should be arranged or enclosed so that they provide adequate protection against personal injury. Compliance to this requirement is checked by means of standard test fingers specified in IS : 1401-1870

CEA regulations prohibits the use flexible cables for portable and transportable apparatus, except when:

- such cables are heavily insulated
- They are adequately protected from mechanical injury and
- In case where protection to the cable is by metallic sheath or covering such covering is in metallic connection with the frame of such apparatus and earth.
- The cables shall be three core type and four-core type for portable and transportable apparatus working on single phase and three phases supply respectively and the wire meant to be used for ground connection shall be easily identifiable.
- If the cable is 2 core type only then equipment body shall be of PVC/FRP and double insulated.

RCBO or RCCB +MCB shall be used for all type of portable equipment's

Chapter X of the Indian Electricity Rules, 1956, provides for additional precautions to be taken in mines and oil fields where hazard from use of flexible cables is considerably greater, due to the presence of explosive dust or flammable vapours. Rule 123 regulates the use of flexible cables in such places, and provides for use of earthing core for earthing flexible metallic covering, use of properly constructed connectors; provision of special switch for entirely disconnecting supply from the flexible cables; provision for frequent inspection of the cables to see they have not suffered mechanical injury; for prohibiting the use of flexible cables more than 90m in length; and detaching of such cables from the apparatus when not in use, etc.

Salient Features of Procedure for temporary cable laying: Annexure 1.8

7.3.18 Selection of Electrical Apparatus

Hazardous area apparatus should be selected for use as per the following criteria:

a) Classification of area
b) Temperature classification
c) Environmental conditions

Selection According to Classification of Area:

a) Zone 0: In which an explosive gas / air mixture is continuously present, or present for long periods.
b) Zone 1: In which an explosive gas / air mixture is likely to occur in normal operation.
c) Zone 2: In which an explosive gas / air mixture is not likely to occur in normal operation and

if it occurs, it will only exist for a short time.

Selection According to Temperature Classification

T Class	Max surface temp Degree Cent
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

Selection According to Environmental Conditions

Apparatus and its component parts should be constructed so as to guard against electrical and mechanical failure in the intended conditions of use. The integrity of some electrical apparatus may be affected when required to operate under temperature or pressure conditions outside those for which the apparatus has been constructed. In such conditions further advice should be sought. Particular attention should be given to the need for protection against the weather, the ingress of liquids and particular matter, corrosion the effect of solvents and the effect of heat from adjacent plant.

7.3.19 Management of Battery Bank (Applicable for Lead Acid Battery)

Battery room should be properly ventilated to maintain the room temperature as per OEM recommendations.

- Battery room should be well kept, free from explosive and should have explosion proof lighting, exhaust fan and acid registrant floors
- Battery terminals should be protected against corrosion & insulate to avoid short circuit.
- Ensure battery charging as per OEM recommendations.
- Disposal of scrap batteries as per state pollution control board.
- Every lead acid battery rooms shall have one packet of lime (200gm) permanently kept there. The lime is used to neutralizing the leaked acid, if there is any.

However, maintenance free/dry cell battery room should also be aesthetically maintained

7.4 Personnel

In order to comply with this standard, Unit / Plants must have qualified (i.e., competent) personnel.

7.4.1 Training and performance

Personnel shall receive training and be qualified to recognize and manage the electrical hazards that they may be exposed to in their jobs. This training shall include the use of electrical PPE and electrical safety procedures and practices.

Training, validation, and refresher training shall be completed and documented at least every two years or when one or more of the following occur:

7.3.19.1 *Change in work function*
7.3.19.2 *Return to the function after more than three months out of function*
7.3.19.3 *Change in electrical installation, procedures, or organization*
7.3.19.4 *When Unit / Plant assessments and incident investigations indicate the need for refresher Training.*

Training documentation should take the form of a written test, record of verbal affirmation, documented job cycle tests, or a combination of these.

7.4.2 Contractor Administration

In the development of Unit / Plant conditions for contractors, the Unit / Plant electrical safety lead shall ensure incorporation of all applicable electrical safety requirements in the contract. These electrical safety requirements shall comply with local and national regulations and consensus standards and with this standard.

The Unit / Plant electrical safety lead can seek assistance from the corporate electrical safety leader and consult with the Unit / Plant electrical safety resource to comply with these requirements. Consideration should be given to including long-term contractors on the Unit / Plant electrical safety team.

Unit / Plants shall have a process in place to verify that contractors have received electrical safety training aligned with Unit / Plant requirements. This should include compliance with government regulations and Unit / Plant conditions.

A qualified & Skilled electrical person shall be involved in the contractor management process. Adequate no. of qualified contractor electrical personnel should be deployed at site as per risk assessment to inspect and provide assistance at working fronts.

7.4.3 Incident Investigation and Reporting

Electrical incidents shall be investigated and reported as defined. Unit / Plants shall have procedures in place to help ensure that any electrical incident with the potential for serious injury and electrical incident is investigated. The Unit / Plant electrical safety resource, or a person designated by that resource, shall participate in the investigation of electrical incidents and events. If the incident involves electrical injury, the corporate electrical safety leader shall be consulted to help ensure that appropriate resources participate in the investigation.

Unusual events occurring during electrical tasks and during work on electrical equipment provide learning opportunities. Sites should investigate and share these events with the Zone Electrical safety leaders.

7.4.4 Management of Change—Personnel

Only authorized personnel shall perform work involving electrical hazards.

Unit / Plants shall have a process in place to help ensure that personnel in functions deemed critical for sustaining electrical safety programs have the necessary skills and experience to carry out their jobs. Examples of critical job functions should include, but not be limited to,

- Electrical safety team leader.
- Electric power distribution specialist.
- Hazardous area classification coordinator.
- Responsible electrical engineer.

List of Critical job and list of qualified electrical personnel should be displayed at site.

7.4.5 Emergency Planning and Response

Unit / Plants shall demonstrate preparedness for electrical-safety emergencies (e.g., rescue and treatment for electric shock, arc-flash burns, blast injuries, or fire involving electrical equipment).

Unit / Plants shall have procedures established to help ensure prompt and immediate medical evaluation for anyone exposed to an electrical shock greater than 30 V, regardless of observable symptoms, wounds, or discomfort.

Unit / Plant preparations for response to electrical emergencies shall include, but not be limited to,

7.3.19.5 *Providing CPR training to first responders and personnel with high-risk exposure to electric shock.*

7.3.19.6 *Conducting mock drills of electrical injury emergencies.*

7.3.19.7 *Identifying energy isolation points and providing training on energy isolation requirements for emergency responders.*

7.3.19.8 *Having emergency equipment, including communications equipment, available and accessible.*

7.3.19.9 *Establishing procedures for securing the scene of an electrical incident.*

Note: These procedures should address the safety of personnel in the area and the preservation of evidence for the investigation.

7.3.19.10 *Having procedures and training in place on the appropriate use of PPE.*

7.5 Facilities

7.5.1 Quality assurance

Unit / Plants shall establish a quality assurance program, including documentation, to help ensure that electrical equipment is fabricated and installed according to the design specifications and manufacturer's recommendations.

All installations shall meet all applicable national codes and local regulations at the time of installation. When required by local codes and regulations, existing installations shall be upgraded to meet current codes and regulations.

7.5.2 Pre-Start Up Safety Reviews

Unit / Plants shall perform pre-start up safety reviews of all new and modified electrical systems and equipment. The pre-start up safety review shall confirm that:

- *Permanent circuit identification and isolation information is installed and verified as correct.*
- *Accurate documentation needed to plan energy isolation and lockout/tag out is available.*
- *Equipment construction and installation are in accordance with design specifications, local regulations, and Unit / Plant requirements.*
- *Arc flash hazard assessment, if applicable, is complete and equipment arc flash hazard labeling is installed.*

7.5.3 Mechanical Integrity

Unit / Plants shall have procedures and practices in place to manage the integrity of electrical equipment, including circuit breakers and protective relay systems; grounding and/or earthing and bonding conductors; electrical equipment auxiliary facilities; and tools and equipment critical to the safety and reliability of the electrical equipment.

Examples of auxiliary facilities, equipment, and tools include, but may not be limited to,

- Roofs and other weather protection for electrical equipment.
- Switchgear internal heaters and room-space conditioning to prevent moisture contamination of insulating materials.
- Temporary safety grounds and/or earths.
- Testing and troubleshooting instruments.
- Insulated sticks used for switching or fuse installation and/or removal.
- Thermography of electrical installation
- Transformer oil testing
- RCD checking mechanism should be available in site specific procedure, wherein scheduled maintenance should be a part.
- Integrity of earthing shall be ensured for all the power supply sources.

7.5.4 Management of subtle change—facilities

Unit / Plants shall have procedures and practices in place to manage subtle change that affects exposure to electrical hazards. Examples of subtle change include, but may not be limited to:

- Change in grade elevation that could alter the depth of underground conductors or elevation of overhead electric lines.
- Connection of temporary generators.
- Temporary connection of redundant power sources.
- Temporary electrical installations or service to temporary buildings.
- Any change that significantly affects the available fault current.
- Any change in the size, or settings of circuit protection devices.
- Abandoned electrical equipment, including cable trays, cables, and wiring. Unit / Plant practices should emphasize the removal of abandoned electrical equipment to control “creep” in increased complexity of Unit / Plant electrical systems.

- Use the existing change management procedure.

8. Management System

8.1 Management records

Records shall be retained in compliance with the company Records and Information Management Program.

8.2 Audits

Unit / Plants shall have an internal audit program that assesses compliance of Unit / Plant procedures and practices with the requirements in this standard. Internal audits shall also address local laws, regulations, and situations unique to the Unit / Plant and relative to electrical safety.

Unit / Plants may consider using the General Electrical Safety Management audit protocol as a basis for the internal audit program.

8.3 Standard Renewal Process

*This standard shall be reviewed and revised as necessary and, at a minimum, **not later than two years from the date of the last revision.***

8.4 Deviation Process

Deviations from this standard must be authorized by the corporate electrical safety lead and the plant management and documented. Deviations must be documented, and documentation must include the relevant facts supporting the deviation decision. Deviation authorization must be renewed periodically and no less frequently than every twelve month.

Emergency deviations must be authorized by the Line manager when, as a result of an unforeseen event or situation, there is inadequate time to process a formal deviation.

Emergency deviations shall be authorized only where it is not feasible to comply with a requirement in this standard. Emergency deviations shall be short in duration, not to exceed the time to perform the task at hand. Appropriate Zone/unit electrical safety leader resources shall be consulted. The deviation must be documented. The documentation must include the relevant facts supporting the deviation decision and the interim measures to be put in place to achieve acceptable levels of SHE protection.

8.5 Training and Communication

Unit / Plant electrical safety training shall be done in accordance with established Unit / Plant procedures (see Section 7.4.1).

Appendix -I

Table 1. Minimum Approach Boundaries for Applying Shock Protection Measures (Sections 7.3.1 and 7.3.15)

Local regulations that increase these minimum approach distances shall take precedence.

Δ Table 130.4(E)(b) Electric Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Direct-Current Voltage Systems

(1)	(2)	(3)	(4)[b]
	Limited Approach Boundary		Restricted Approach Boundary; Includes Inadvertent Movement Adder
Nominal Potential Difference	Exposed Movable Conductor*[a]	Exposed Fixed Circuit Part	
Less than 50 V	Not specified	Not specified	Not specified
50 V–300 V	3.1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact
301 V–1 kV	3.1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.3 m (1 ft 0 in.)
1.1 kV–5 kV	3.1 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.5 m (1 ft 5 in.)
5.1 kV–15 kV	3.1 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.7 m (2 ft 2 in.)
15.1 kV–45 kV	3.1 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.8 m (2 ft 9 in.)
45.1 kV– 75 kV	3.1 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 6 in.)
75.1 kV–150 kV	3.3 m (10 ft 8 in.)	3.1 m (10 ft 0 in.)	1.2 m (3 ft 10 in.)
150.1 kV–250 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.6 m (5 ft 3 in.)
250.1 kV–500 kV	6.0 m (20 ft 0 in.)	6.0 m (20 ft 0 in.)	3.5 m (11 ft 6 in.)
500.1 kV–800 kV	8.0 m (26 ft 0 in.)	8.0 m (26 ft 0 in.)	5.0 m (16 ft 5 in.)

Note: All dimensions are distance from exposed energized electrical conductors or circuit parts to worker.

*[a] *Exposed movable conductor* describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

[b] The restricted approach boundary in Column 4 is based on an elevation not exceeding 900 m (3000 ft). For higher elevations, adjustment of the restricted approach boundary shall be considered.

Δ Table 130.4(E)(a) Electric Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Alternating-Current Systems

(1)	(2)	(3)	(4)
	Limited Approach Boundary[b]		
Nominal System Voltage Range, Phase to Phase[a]	Exposed Movable Conductor[c]	Exposed Fixed Circuit Part	Restricted Approach Boundary[b,d]; Includes Inadvertent Movement Adder
Less than 50 V	Not specified	Not specified	Not specified
50 V–150 V[e]	3.1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact
151 V–750 V	3.1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.31 m (1 ft 0 in.)
751 V–5 kV	3.1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.63 m (2 ft 1 in.)
5.1 kV–15 kV	3.1 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.65 m (2 ft 2 in.)
15.1 kV–36 kV	3.1 m (10 ft 0 in.)	1.8 m (6 ft 0 in.)	0.77 m (2 ft 7 in.)
36.1 kV–46 kV	3.1 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.84 m (2 ft 10 in.)
46.1 kV–72.5 kV	3.1 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 4 in.)
72.6 kV–121 kV	3.3 m (10 ft 8 in.)	2.5 m (8 ft 0 in.)	1.2 m (3 ft 9 in.)
121.1 kV–145 kV	3.4 m (11 ft 0 in.)	3.1 m (10 ft 0 in.)	1.3 m (4 ft 4 in.)
145.1 kV–169 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.5 m (4 ft 10 in.)
169.1 kV–242 kV	4.0 m (13 ft 0 in.)	4.0 m (13 ft 0 in.)	2.1 m (6 ft 8 in.)
242.1 kV–362 kV	4.7 m (15 ft 4 in.)	4.7 m (15 ft 4 in.)	3.5 m (11 ft 2 in.)
362.1 kV–420 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	4.3 m (14 ft 0 in.)
420.1 kV–550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	5.1 m (16 ft 8 in.)
550.1 kV–800 kV	7.2 m (23 ft 9 in.)	7.2 m (23 ft 9 in.)	6.9 m (22 ft 7 in.)

Notes:
(1) For arc flash boundary, see 130.5(E).
(2) All dimensions are distance from exposed energized electrical conductors or circuit part to employee.
[a]For single-phase systems above 250 volts, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732.
[b]See definition in Article 100 and text in 130.4(F)(3) and Informative Annex C for elaboration.
[c]*Exposed movable conductors* describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.
[d]The restricted approach boundary in Column 4 is based on an elevation not exceeding 900 m (3000 ft). For higher elevations, adjustment of the restricted approach boundary shall be considered.
[e]This includes circuits where the exposure does not exceed 120 volts nominal.

NFPA 70E 2024 130.4 Electric shock risk assessment

(A) General. An electric shock risk assessment shall be performed:

(1) To identify electric shock hazards

(2) To estimate the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health

(3) To determine if additional protective measures are required

(B) Estimate of Likelihood and Severity. The estimate of likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health shall take into consideration all of the following:

(1) The design of the electrical equipment

(2) The electrical equipment operating condition and the condition of maintenance

(C) Additional Protective Measures. If additional protective measures are required, they shall be selected and implemented according to the hierarchy of risk control identified in 110.3 (H) (3). When the additional protective measures include the use of PPE, the following shall be determined:

(1) The voltage to which personnel will be exposed

(2) The boundary requirements

(3) The personal and other protective equipment required by this standard to protect against the electric shock hazard

(D) Documentation. The results of the electric shock risk assessment shall be documented.

(E) Electric Shock Protection Boundaries. The electric shock protection boundaries identified as limited approach boundary and restricted approach boundary shall be applicable where personnel are approaching exposed energized electrical conductors or circuit parts. Table 130.4(E) (a) shall be used for the distances associated with various ac system voltages. Table 130.4(E) (b) shall be used for the distances associated with various de system voltages.

Informational Note: In certain instances, the arc flash boundary might be a greater distance from the energized electrical conductors or circuit parts than the limited approach boundary.

The electric shock protection boundaries and the arc flash boundary are independent of each other.

(F) Limited Approach Boundary.

(1) Approach by Unqualified Persons. Unless permitted 130.4(F) (3), no unqualified person shall be permitted approach nearer than the limited approach boundary of energized conductors and circuit parts.

(2) Working at or Close to the Limited Approach Boundary.

Where one or more unqualified persons are working at or close to the limited approach boundary, the alerting methods in 130.8(o) shall be applied to warn the unqualified person (s) of the electrical hazard and to stay outside of the limited approach boundary.

(3) Entering the Limited Approach Boundary. Where there is a need for an unqualified person(s) to cross the limited approach boundary, a qualified person shall advise the unqualified person (s) of the possible hazards and continuously escort the unqualified person(s) while inside the limited approach boundary. Under no circumstance shall unqualified person (s) be permitted to cross the restricted approach boundary.

(G) Restricted Approach Boundary. No qualified person shall approach or take any conductive object closer to exposed energized electrical conductors or circuit parts than the restricted approach boundary set forth in Table 130.4(E) (a) and Table 130.4 (E) (b). unless one of the following conditions applies:

(1) The qualified person is insulated or guarded from energized electrical conductors or circuit parts operating at 50 volts or more. Insulating gloves and sleeves are considered insulation only with regard to the energized parts upon which work is performed.

(2) The energized electrical conductors or circuit parts are insulated from the qualified person and from any other conductive object at a different potential.

Appendix-II

S N	Voltage level	Task (Assumes equipment is energized and work is done in the Flash Protection Boundary	Hazard/ Risk category
1	240V and Below (25kA short circuit current & fault clearing time 0.03 sec)	Circuit breaker (CB) or Fuse switch operation with covers on.	0
		CB or fuse switches operation with covers off.	0
		Work on energized parts including voltage testing	1
		Remove install CB or fused switches	1
		Removal of bolted cover (to expose bare, energized parts).	1
		Opening hinged cover (to expose bare, energized parts).	0
2	>240V and up to 600V (25kA short circuit current & fault clearing time 0.03 sec)	Circuit breaker (CB) or Fuse switch operation with covers on.	0
		CB or fuse switch operation with covers off	1
		Work on energized part including voltage testing.	2
3	600V MCCs (65kA short circuit current & fault clearing time 0.03 sec)	CB or fused switch or starter operation with enclosure door closed.	0
		Reading a panel meter while operating a meter switch	0
		CB or fused switch or starter operation with enclosure door open.	1
		Work on energized parts including voltage testing	2
		Work on control circuits with energized parts 120V or below, exposed.	0
		Work on control circuits with energized parts >120V, exposed.	2
		Insertion or removal of individual starter —bucket‖ from MCC.	3
		Application of safety grounds after voltage test	2
		Removal of bolted cover (to expose bare, energized parts).	2
		Opening hinged cover (to expose bare, energized parts).	1
4	600V Switchgear (with Power circuit	CB or fused switch or starter operation with enclosure door closed.	0
		Reading a panel meter while operating a meter switch	0
		CB or fused switch or starter operation with enclosure door	1

	breaker Or fused switches) (65kA short	open.	
		Work on energized parts including voltage testing	2
	Circuit current & fault clearing time up to 1 sec)	Work on control circuits with energized parts 120V or below, exposed.	0
		Work on control circuits with energized parts >120V, exposed.	2
		Insertion or removal of CBs from cubicles doors open.	3
		Insertion or removal of CBs from cubicles doors closed.	2
		Application of safety grounds after voltage test	2
		Removal of bolted cover (to expose bare, energized parts).	3
		Opening hinged cover (to expose bare, energized parts).	2
5	Other 600V class (277V, through	Lighting or small power transformer(600V maximum)	-
		Removal of bolted cover (to expose bare, energized parts).	2
		Opening hinged cover (to expose bare, energized parts).	2
	600V, nominal equipment	Work on energized parts including voltage testing	2
		Application of safety grounds after voltage test	2
		Cable trough or tray cover removal or installation	1
		Miscellaneous equipment cover removal or installation	1
		Work on energized part including voltage testing	2
		Application of safety grounds, after voltage test.	2
6	NEMA E2 Motor starters, 2.3kV through 7.2kV.	Contactor operation with enclosure door closed	***3***
		Reading a panel meter while operating a meter switch	0
		Contactor operation with enclosure door open.	***3***
		Work on energized part including voltage testing	3
		Work on control circuits with energized parts 120V or below, exposed.	0
		Work on control circuits with energized parts >120V, exposed.	3
		Insertion or removal of starters from cubicles doors open.	3
		Insertion or removal of starters from cubicles doors closed.	***3***
		Application of safety grounds after voltage test	3
		Removal of bolted cover (to expose bare, energized parts).	4
		Opening hinged cover (to expose bare, energized parts).	3
7	Metal Clad switchgear,	CB or fused switch operation with enclosure door closed.	***3***
		Reading a panel meter while operating a meter switch	0
	1kV And Above	CB or fused switch or starter operation with enclosure door open.	4

		Work on energized parts including voltage testing	4
		Work on control circuits with energized parts 120V or below, exposed.	2
		Work on control circuits with energized parts >120V, exposed.	4
		Insertion or removal of CBs from cubicles doors open.	4
		Insertion or removal of CBs from cubicles doors closed.	***3***
		Application of safety grounds after voltage test	4
		Removal of bolted cover (to expose bare, energized parts).	4
		Opening hinged cover (to expose bare, energized parts).	3
		Opening voltage transformer or control power transformer compartments	4
8	Other Equipment 1kV And Above	Metal clad load interrupter switches fused or un-fused switch operation, doors closed	***3***
		Work on energized parts, including voltage testing.	4
		Removal of bolted cover (to expose bare, energized parts).	4
		Opening hinged cover (to expose bare, energized parts).	3
		Outdoor disconnect switch operation	3
		Insulated cable examination in manhole or other confined space.	4
		Insulated cable examination, in open area	2

Appendix – lII : Design Requirements

Contractor should consider use of technologies that create inherently safer design such as high resistance grounding, see-through rigid barriers, finger safe fuses/relays/terminal strips/etc, insulated buses and terminal covers, arc-resistant switchgear, and enhanced safety motor control centers. Switchgear main power bus and feeder breaker bus as well as CT shorting blocks are not required to use finger safe design.

Design option decisions should facilitate the ability to eliminate hazards or reduce risk by doing the following:

(1) Reducing the likelihood of exposure
(2) Reducing the magnitude or severity of exposure
(3) Enabling achievement of an electrically safe work condition

Incident Energy Reduction Methods. The following methods have proved to be effective in reducing incident energy:-

(1) Zone-selective interlocking. A method that allows two or more circuit breakers to communicate with each other so that a short circuit or ground fault will be cleared by the breaker closest to the fault with no intentional delay. Clearing the fault in the shortest time aids in reducing the incident energy,

(2) Differential relaying. ~he concept of this protection method is that current flowing into protected equipment must equal the current out of the equipment. If these two currents are not equal, a fault must exist within the equipment, and the relaying can be set to operate for a fast interruption. Differential relaying uses current transformers located on the line and load sides of the protected equipment and fast acting relay,

(3) Energy-reducing maintenance switching with a local status indicator. An energy-reducing maintenance switch allows a worker to set a circuit breaker trip unit to operate faster while the worker is working within an arc flash boundary, as defined in NFPA 70E, and then to set the circuit breaker back to a normal setting after the work is complete.

Other Methods :-

1 Energy-reducing active arc Hash mitigation system. This system can reduce tbe arcing duration by creating a 10\>,' impedance current path, located within a controlled compartment, to cause the arcing fault LO transfer to the new current path, while the upstream breaker clears the circuit. The system works without compromising existing selective coordination in the electrical distribution system.

2 Arc flash relay. An arc flash relay typically uses light sensors to detect the light produced by an arc flash event. Once a certain level of light is detected the relay will issue a hip signal to an upstream overcurrent device.

3 High-resistance grounding. A great majority of electrical faults are of the phase- to-ground type. High-resistance grounding will insert an impedance in the ground return path and will typically limit the fault current to 10 amperes and below (at 5 kV nominal or below), leaving insufficient fault energy and thereby helping reduce the arc flash hazard level. High-resistance grounding will not affect arc flash energy for line-to-line or line-to-line-to-line arcs.

4 Current-limiting devices. Current-limiting protective devices reduce incident energy by clearing the fault faster and by reducing the current seen at the arc source. The energy re-duction becomes effective for current above the current-limiting threshold of the current-limiting fuse or current limiting circuit breaker.

General Design Requirements :-

1. Selection/use of electrical systems should be such that energization can be scheduled without additional exposure, or minimal additional exposure, to continuing construction activities.
2. Contractor should consider providing earth fault protection for personnel safety, Arc proof equipment, current-limiting fuses and circuit breakers, reduced substations and/or transformer sizes, and smart motor control centers.
3. For equipment where access for maintenance, adjustment, or servicing may be required while the equipment is energized, the energized exposed parts operating at >50 V shall be provided within enclosures to prevent unintended contact.
4. Specifying electrical devices with shrouded terminals and conductors that provide the finger- safe features is a highly engineered and sustainable method of reducing the possibility of unintended contact with energized parts.
5. Proper RCDs (Residual Current Devices) in all areas with increased potential for personnel to sustain electrical shock should be employed.. Portable electric-powered cleaning equipment should be protected with ground-fault circuit interrupter (GFCI) or residual current device (RCD) protection.
6. Personnel exposure to electrical hazards shall be reduced to acceptable levels based on a risk analysis through the use of the best available equipment design, installation details, and maintenance and operating practices for electrical equipment and systems. Examples of equipment designs to be considered include high-resistance grounding for low-voltage power systems (where allowed by local regulations), ground fault protection for personnel safety, arc- proof equipment, current-limiting fuses and circuit breakers, reduced substation and/or transformer size, and smart motor control centers.
7. For equipment where access for installation, check-out, adjustment, or servicing may be required while the equipment is energized, the energized exposed parts operating at >50 V should be provided within enclosures to prevent inadvertent contact. Specifying electrical devices with shrouded terminals and conductors that provide finger-safe

features is desirable.

8. Contractor shall establish a quality assurance program, including all relevant documentation, to help ensure that electrical equipment and distribution systems are fabricated and installed according to the design specifications and manufacturer's recommendations.
9. Separate ground wire from the motor to the motor starter shall be installed in cable raceways of all types (cable tray, conduit, wire way, etc.).
10. Copper conductors shall be used for grounding motor frames unless otherwise specified.
11. Voltage for lighting circuits needs to be given serious consideration. Use of phase to neutral voltage from a distribution power substation is not recommended for lighting circuits due to hazards of high arc flash energy levels.
12. Segregation of lighting circuits to dedicated panel boards is recommended. Instrumentation and other non-lighting circuits should be powered from separate panel boards.
13. Lighting circuits should not use a common neutral in multi-branch circuits.
14. Lighting panels should be specified with junction boxes mounted directly above the panel with all circuits pre-wired to touch-proof terminal strips to reduce risk of electric shock.
15. Lighting panels must provide mechanisms to independently lock out each individual circuit breaker.
16. Structures subject to vibration should give special consideration to alleviate lighting fixture fatigue failure of metal parts and to extend lamp filament life. Additional bracing designs may be required for wind loading or longer fixture stems.
17. MCC should have an integral bus, be completely metal-enclosed, free-standing, sectionalized, and suitable for extending laterally and installing back to back. (i.e, two independent MCCs with integral horizontal and vertical buses, mounted with backs together). Bus compartments, load wiring compartment, and each starter or switch unit shall be enclosed and essentially isolated from one another. Repair or replacement of all electrical parts (including buses and bus supports) shall be possible when MCCs are installed against walls or in back to back configuration. Wireway top covering shall be separate from the enclosure to facilitate the cover's removal for conduit drilling and other access.
18. Maximum ambient temperature of the space where the equipment is installed is 50°C, exclusive of sun loading (where applicable). Louvers are allowed for ventilation only for transformer units without disconnect or adjustable speed drive units. Supplier shall certify that maximum temperatures attained will not exceed maximum ratings or equipment or 80°C, whichever is lower. Wire insulation thickness should take into account proximity to equipment operating at elevated temperatures, e.g., fuses, contactor coils, or frame.
19. Fastenings in all parts of the equipment shall be adequate for carrying the maximum stated fault current of the line-side protective device without undue distress. Fastening

approach should employ means to negate the effect of temperature cycling and bus material cold flow or creep.Sticky-back‖ wire holders will only be permissible where mechanical fasteners are impractical.

20. Doors with mounted electrical devices with voltage >120V must be grounded to the section frame or ground bus with a flexible braided copper wire or strap of at least 14 AWG, arranged so the connection cannot be pinched as the door is opened or closed.
21. Terminals accessible from within the wire-way must be covered to prevent accidental contact while altering wiring to other starters. All metal edges in wireways must be treated to prevent damage to wires.
22. Each phase of the vertical bus shall be isolated from the other phases to reduce the risk of fault. The connection of the vertical bus to the horizontal bus will be accessible for thermal inspection. This may be achieved by a removable cover, a small swinging cover, or by infrared viewports.
23. A copper vertical ground bus shall be provided in each vertical section that is equipped for plug- in units. This bus shall be connected to the horizontal ground bus in each section.
24. Each plug-in unit shall be equipped with a mechanical safety interlock such that 1) a unit can only be inserted into the vertical structure and make contact with the vertical bus when the operating handle is in the OFF (open) position; and 2) a unit in the fully inserted position can only be withdrawn with the operating handle in the OFF (open) position. A positive and reliable method shall be provided to lock the operating handle in the OFF (open) position only. It should be possible to lock the handle only after the disconnect mechanism has been positively operated.
25. Select Arc Resistant Equipment (Type 1 or Type 2 as stipulated by IEEEC37.20.7). Incorporation of AFCI (Arc Flash Circuit Interrupter) to be explored in all old HT panels. For all new/upcoming projects, this specific feature should be in-built or, Arc rated panels to be used only.
26. Contractors should consider having a thermal rated switchgear main bus vs. current density rated bus. Both can meet IEEE/ANSI standards, but the thermal rated design typically uses much smaller cross-section.
27. For protective relays, special consideration needs to be given to the station battery charger dc output filtering quality to prevent undesirable/inadvertent operation of high speed sensitive relays.
28. All exterior doors of switchgear enclosures should be provided with a mechanical latch to hold doors in fully open position.
29. Exterior ventilation louvers on outdoor switchgears should be weatherproof, include insect screens, and be fitted with non-metallic dust filters that slide out and can be removed/replaced from outside without exposing maintenance personnel to energized equipment.
30. All batteries room shall be provided by acid proof tiling, eye wash facility and exhaust system connected with alarm system.

31. The electrical equipment's / installations must have adequately designed earthing system – both system and equipment as per need.

32. Automated clean agent system in control rooms and substation cable cellars to be ensured.
33. Usage of insulated coated flooring as per the respective voltage grade in front and rear side of electrical panels and balance of floor area of substations.
34. All substation doors shall be min. 2hrs fire rated. The emergency door of the substation should be of "postman red color" and should have panic bar from inside.
35. All substations should be adequately provided with CCTV cameras.
36. All substations should have controlled access by means of biometric based access control system.
37. All MCCs/PMCCs should be SMART /INTELLIGENT type.
38. SMART health monitoring system of critical motors can be adopted.
39. Automated rack in rack out of MV/HV breakers from local (through pendant with sufficient length of cable as well as from remote).
40. Omission of TNC switch from MV/HV panels and to be done through pendant with sufficient length cable to operate from certain distance.
41. The transformers or reactors of 10 MVA and higher rating or oil filled transformers or reactors with oil capacity of more than 2000 litres shall be provided with automatic high velocity water spray system as per relevant IS or Nitrogen injection based fire protection system. The transformers or reactors of 220kV or higher voltage may be provided with Nitrogen injection based fire protection system in addition to automatic high velocity water spray system (Ref.: CEA 2010)
42. Passive fire protection measures such as fire/ barriers for cable galleries and shafts etc., fire retardant coatings, fire resistant penetration sealing for all openings in floors, ceilings, walls etc., fire proof doors etc .. shall be provided to prevent spreading and for containment of fire (Ref.: CEA 2010).
43. HT Panel rear cover electrical interlocking to be done for all new upcoming as well as existing panels, Scheme of which will be as follows:
    1. Incomers/Bus-couplers/Tie Feeders:
    (a) Shall have protection primarily through Solenoid based Lock system to prevent opening of rear cover during live/energized condition of Bus/Terminals
    (b) Energization/De-Energization of Solenoid coil shall be through VDI insulator based Relaying system, Circuit Breaker-Auxiliary contact & Test-Service Limit Switch (i.e., cover opening will be permitted only when the relevant circuit breaker(s) are in TEST position with OFF condition)
    (c) Shall have back-up protection to Trip the upstream breaker/relevant breaker(s) if rear cover is opened in live / energized condition (through limit/micro-switches which are fitted onto the rear cover).
    2. Outgoing Feeders:

(a) Shall have protection primarily through Solenoid based Lock system to prevent opening of rear cover during live/energized condition of Bus/Terminals

(b) Energization/De-Energization of Solenoid coil shall be through Circuit Breaker-Auxiliary contact & Test-Service Limit Switch (i.e., cover opening will be permitted only when the relevant circuit breaker is in TEST position with OFF condition)

(c) Shall have back-up protection to Trip the relevant outgoing breaker if the rear cover is opened in live/energized condition (through limit/micro-switches which are fitted onto the rear cover).

Annexure – 1

1.0 Electrical Safety Procedures and Safe Practices

1.1 Salient Features of Procedure working on / near energized electrical equipment

Follow HZL LOTO standard

- Ensure that Earthing clamp / rod is properly fixed.
- Check whether proper platform, ladder, and Rubber mat is in place.
- Check whether Risk assessment has been done & all measures taken.
- List out all required PPE'S & ensure all people are using it.
- Safety instruction is given to all concerned before start up the job.
- Check whether adequate illumination is available at site.
- Check whether appropriate tools, tackles and measuring devices are available at site.
- Ensure that nearby charged source is properly barricaded / shrouded.
- Use insulated Tools where ever applicable.
- Ensure that safe working distance from nearby charged equipment is maintained.
- The basic policy for this is that working on unguarded energized equipment is not permissible. However, situations may arise that require energized work. In such cases, specific approval must be obtained and the following four hazards addressed:

  Shock and burn due to contact.
  Electric arc burns caused by high energy electrical faults (Arc Flash)
  Damage to equipment due to arcing or short-circuited conductors.
  Upset or shutdown of an operating unit.
- The preferred method for performing diagnostic testing and troubleshooting is on deenergized circuits. If this is not possible, diagnostic testing and troubleshooting shall only be permitted on energized circuits when performed in compliance with the requirements above and Section 6.2.6/1.5 for guidance on de-energized troubleshooting techniques.

1.2 Salient Features of Procedure - Electrical Energy Isolation

- Use HZL LOTO STD
- Obtain permission from CCR / concerned department.
- Ensure that Drive (Motor) is in OFF Condition.
- Ensure that all connected outgoing loads are in OFF Condition.

- Ensure that equipment connected with multi source has been isolated from coupling points.
- Ensure that manual isolator has been switched OFF / disconnected and earth switch engaged.
- In case of MCB / MCCB / etc. after isolation, verify Zero voltage at the outgoing terminals.
- In case of capacitor / reactor connected with equipment, ensure those have been discharged after isolation.
- Check whether earth rod has been provided on overhead line.

1.3 Salient Features of Procedure - Jobs, Plans and Permits

- Ensure that Job Risk Assessment has been done which includes the Electrical Safety aspect. Follow HZL HIRA standard

  General Hazard-Risk Category classification with respect to different electrical job are indicated in Appendix-II
- Ensure that safety instructions are given to all concerned before starting the job.
- Ensure that PTW has been taken with power isolation. Follow HZL PTW standard.
- Permission for usage of submersible pumps, temporary connections should be integrated with PTW and work can't be initiated without PTW to ensure mentioned recommendations
- Check whether proper tools and tackles have been arranged with their test certificates before commencing the job.
- Check whether required PPEs are available with workmen. Ensure that SWP of job has been discussed with concern
- Ensure proper lighting at site is in place & is in working condition.
- Check whether the Working agency has proper authorization for executing the job.
- Ensure that all man & material and earthing has been removed before surrendering the PTW.

Refer Annexure - 4 Job Planning and Briefing format Sample

1.4 Salient Features of Procedure - Electrical Personal Protective Equipment

- Select the PPEs based on Electrical Hazard assessment.
- Impart proper training to the workmen on utilization of PPEs.
- Ensure that job specific PPEs are available at site.
- Check whether appropriate insulated hand gloves are being used.
- Check whether PPEs being used are tested and found in good condition.
- Check whether all PPEs are stored in proper place.
- Safety glasses with side shields or goggles must be worn for all electrical work.
- Make usage of "**non-conductive gum-boot**" mandatory by those employees and contract workmen who are part of "dewatering" activities , engaged in and manages cable cellar/ trenches, pits etc.
- Voltage-rated gloves must be worn when working on or near exposed energized

electrical equipment over 50 volts. The gloves must be rated for any voltage which may be encountered. Inspect rubber glove liners and leather outers before each use. Remove worn or damaged gloves from service. Voltage-rated gloves which are used for shock protection must be electrically tested, and the test date marked on the glove. *As per OSHA 1910.137 (b) (2) Table I-6, Voltage rated gloves should be tested every six months during use. If testing is not feasible, it may be replaced suitably. If gloves were not issued for service, it may not be placed into service unless it has been electrically tested within the previous 12 months.* Gloves must be stored in glove bag and/or PPE cabinet to protect them from damage.

- Conductive jewelry shall be removed or covered while working on or near exposed energized electrical equipment.
- Minimum PPE for operating energized pole-top distribution switches shall be hard hat, safety glasses with side shields, FR coat, and voltage-rated gloves.

- **PPE for Arc Flash**

1. Arc flash PPE must be worn when working on or near energized electrical equipment (> 50 volts). Arc flash PPE must be inspected before each use. The hood, overalls, and jacket should be free on any cuts, stains, or other material defects.
2. Arc flash PPE is not required for:
   - Operation and switching of enclosed equipment operating at less than 250 volts and protected by fuses or circuit breakers less than 50 amps (eg. office light switch).
   - Operation of equipment labeled as Non-High Energy.
3. Equipment which poses an arc flash hazard must be labeled with the arc flash PPE Level (or specific PPE requirements) and the arc flash boundary.
4. Arc flash PPE number / letter designations are as follows: G=gloves, H=hood, C=coat, P=pants. Number is arc flash rating requirement. Available (calculated) energy is less than or equal to the number value stated (in units of calories per square centimeter).
5. FR pants may be omitted if all parts of the legs are outside the arc flash boundary or covered by the FR coat, and the equipment is labeled stating that this exception applies.
6. The arc flash PPE requirements should be based on calculations of the energy available at that equipment location within the unit's power distribution system.
7. PPE requirements must be re-evaluated for all major changes to the unit's power distribution system.

Flash Protection Boundary:

For systems which are 600Volts and below, the flash protection boundary shall be 4.0 ft, based upon the product of clearing time of 0.1 second and available bolted fault current of 50kA or any combination not exceeding 5000 Ampere seconds.

At voltage level above 600Volts, is the flash protection boundaries the distance at which the incident energy level equals 1.2 cal/cm2.

For situations where fault clearing time is 0.1 sec or faster the flash protection boundary is the distance at which the incident energy level is 1.5 cal/cm2.

1.5 Salient Features of Procedure -Testing for the absence of Voltage

- All circuits are considered energized until testing with a site-approved meter proves the circuit is de- energized and safe. This procedure defines voltage testing requirements which must be completed

  after the system has been properly locked out. Proper "Lock, Tag & Try" and the requirement for a "visual verification of a physical break in the electrical isolating device" are covered in LOTO standard.
- Each individual MUST perform or witness the "Test Before Touch" to ensure equipment is in a safe condition for work or verify that safety grounds have been installed.
- For contact type testers, the person performing the test must be absolutely certain the tester probe is connected to a reliable ground. The proper ground connection point depends on the equipment.

1.5 A. Extra High Voltage (EHV) (more than or equal to 33 KV)

- Ensure that PTW has been taken from both sending and receiving ends.

  Ensure that Switch yard breakers are OFF and associated isolators are in open condition. Ensure that Line PT is isolated and voltmeters are showing zero value.

  Ensure that Associated PT in LV side is in isolated condition.

  Ensure that Switch yard EHV isolators have been opened and earth switch is in engaged position.
- Ensure that Overhead lines have been grounded permanently through earth rods during job execution.
- Ensure that HT panel side terminals are discharged through earth rod.
- Verify the presence of any voltage through HT voltage Detector/Voltmeter reading.
- Check for any chance of back feed power.
- Check whether required PPEs are available with workmen.

1.5 B. High Voltage (HV) (more than 650 volts and less than 33KV)

- Ensure that PTW has been taken with power isolation.
- Control supply (AC/DC) is switched OFF and PTW is displayed.
- Breaker/ Vacuum contactor has been isolated.
- Verify the presence of any voltage through HT voltage Detector/Voltmeter reading.
- Terminals have been earthed twice with discharged rod.
- Check for any chance of back feed power.
- Check whether required PPEs are available with workmen.

1.5 C. Medium Voltage (MV) (more than 250 volts and up to 650V)

- Ensure that PTW has been taken with power isolation.
- Control supply (AC/DC) is switched OFF and PTW is displayed.
- Breaker/ Vacuum contactor has been isolated.

- Verify the presence of any voltage through digital voltage tester (e.g., Fluke-T+PRO).
- Terminals have been earthed twice with discharged rod.
- Check for any chance of back feed power.
  Check whether required PPEs are available with workmen.

1.5 D. Low Voltage (LV) (up to 250 volts)

- Ensure that PTW has been taken with power isolation.
- Isolator/ MCB / MCCB are in OFF condition.
- Ensure that ACB/power fuses are taken out and PTW is displayed on the panel.
- Check whether Voltmeter is showing zero value.
- Check for zero voltage through Voltage tester (e.g., Fluke-T+PRO).
- Ensure that Terminals have been earthed with discharged rod.
- Check for any chance of back feed power.
- Check whether required PPEs are available with workmen.

1.5 E. Testing Instruments Used for trouble shooting

- Testing instruments should be IS / CE mark.
- Testing instruments should be calibrated and certified for use.
- Operational training of user must be in place.
- Digital Multi Meter (DMM) used shall comply the safety requirement o Safety class – category III, for the voltage measuring range of DMM upto 1000V o Safety class – category IV, for the voltage measuring range of DMM upto 650V

S. No.	Make	Cat. No.	Description	Application	Description of alternate model	Model No.	Remark	Description
01	Fluke	T+PRO	Fluke T+Pro Electrical Tester	Check the presence / absence of AC/DC voltage, to be used for Test-Before-Touch in electrical circuitry	**Hioki**	**3246-60**	(it's Means value with 4199 cout**)	A true tool to measure and test the panels. Use the unit as two probe tester and don't need another person to hold the unit
02	Fluke	113	True RMS Digital Multimeter	Measure AC/DC Voltage	**Hioki**	**3244-60/ DT4224**	(It pocket type DMM) smaller and carrying case for protection.	CAT IV safety rated product. Rugged and performance oriented TRMS DMM
03	Fluke	114	Digital Multimeter	Measure AC/DC	**Hioki**	**DT4224**	6000 count, circuit breaker	CAT IV safety rated product.

				Voltage**(For Instt. Engg. discipline, especially)**			false trip prevention (protection). Voltage, frequency, continuity, resistance, capacitor, diode CATIV600V	Rugged and performance oriented TRMS DMM
04	Fluke	772	mA Process Clamp Meter	Measure(Sink) & Source DC 4-20 mA Current	**HIOKI**	**SS7012**	Source and measurement in same unit, high accurate for two wire sensor	
05	Fluke	A3000FC	Wireless True-RMS AC Current Clamp Meter	Measure 400A AC Current (Max.)	**Hioki**	**CM4371**	Jaw size 33mm,600A AC\DC with best resolution 0.01A	

<u>These are MANDATORY meters which are necessarily to be maintained & used by all the sites:</u>

1. Digital meters with two measuring probe ports are to be used ONLY which are used for measuring Voltage/Continuity/Resistance, etc. Remaining ports to be plugged immediately which is / are used for measuring Current.

2. Current measuring feature with Clamp are accepted ONL Y, <u>no direct contact type of measurements through test leads are allowed. (All such probe inserting holes for current measurement to be plugged as an immediate action by all sites till complete replacement).</u>

1.5 F. Salient Features of Procedure - Dismantle and remove and/or rearrange work

- Ensure that Job Risk Assessment has been done which includes the Electrical Safety aspect.
- Check the absences of electrical power while performing electrical dismantle or rearrange work.
- Check for removal of fuses, rack-out of breakers & permit to work before performing electrical dismantle or rearrange work.
- Check if there is a possibility of power feeding through alternative power source.
- Check availability of PPE during performing jobs at site & ensure all workmen are using it.

- Check that all safety instruction is given to concern for executing the jobs before start up the job.
- Check whether proper method is being adopted for shifting & lifting of electrical equipment to avoid physical injury or equipment damage.
- Check whether sufficient access & working space is provided with proper guard for moving equipment during shifting or lifting the equipment.
- Check whether adequate illumination is available at site.
- Check whether illumination is provided with 24 volt power supply in case of confined places.
- Incorporate the changes made during dismantle/rearrange work in the electrical drawing for ready reference in future.

1.6 Salient Features of Procedure - Excavations and Penetrations

- Ensure that Job Risk Assessment has been done which includes the Electrical Safety aspect.
- Check whether the Cable route has been identified and marked.
- Check whether the Excavation permit is duly signed by authorized person only after physical verification.
- Ensure that fixed barricade is provided 1 meter away from electrical cables / cable trench.
- De-energize the cable falling in the excavation area.
- Use HZL Excavation standard

1.7 Salient Features of Procedure - Cranes and mobile equipment movement under Over Head line

Minimum Clearances

While Working	
Line Voltage	**Distance**
50kV or below	10 feet
50kV and higher	10 feet + .4 inches for each 1kV above 50kV

In Transit	
Line Voltage	**Distance**
50kV and below	4 feet minimum
50kV to 345kV	10 feet
Over 345kV to 750kV	16 feet

Mark safe distance to over head line as per IE Rules, 1956.

If any fixed type barricade is to be removed, ensure the following steps:

i) Switch OFF power supply and then earth properly.
ii) Re-fix the barricade.
iii) Remove the earth and then charge the line.

- Ensure safety instruction has been given to Heavy Vehicle / Hydra operator before entering restricted area.
- Whether proper illumination has been provided, if required.
- Hydra / Crane shall be moved under close supervision of authorized/experienced personnel at the time of movement.
- Check whether the area is properly barricaded and caution strip is provided while shifting or lifting activities near to overhead line.
- Whether surface level is proper at permitted area under / nearby overhead line. Check whether the concerned department has confirmed the boom height in Permit.

1.8 Salient Features of Procedure - Water and/or steam cleaning

- Ensure that Job Risk Assessment has been done which includes the Electrical Safety aspect.
- Ensure that submersible pumps/ portable electric-powered cleaning equipment are protected with 30 mA RCD (RCBO / RCCB+MCB) protection.
- Check whether all electrical installations are IP67 rated.
- Check whether adequate illumination is provided.
- Check whether electrical installation area is free from flammable and combustible material.
- Permission for usage of submersible pumps, temporary connections should be integrated with PTW and work can't be initiated without PTW to ensure mentioned recommendations.
- Make usage of non-conductive gum-shoe mandatory by employees and contract workmen who are engaged in dewatering activities and in cable cellar.

1.9 Salient Features of Procedure – Temporary Electrical Cable Laying

- The wring shall be installed in such a manner that it is not subjected to physical damage.
- Vegetation such as trees shall not be used for the support of overhead service conductor. (NEC- 230.10)
- Flexible cords and cables shall be protected from accidental damage. The sharp corners and projections should be avoided while laying the cable.
- The wiring shall be adequately protected while passing through the door ways or other pinch points
- In no case the Twin twisted wires shall be used for temporary connections. Even for the extension boards and for temporary lighting, minimum TRS (Toughened rubber sheath) cables, having continuous current rating suitable for the required load, shall be used.

- If the feeder is rated for 600 V or more than the feeder cable shall be labeled with its circuit voltage, size of cable, its point of origin and destination at points along its length in such a way that the label is visible from all viewing locations along its route.
- Plug receptacles shall not be installed on a branch circuit that supply temporary lighting.
- Earth leakage protective device shall be used for the ground fault protection of all routine / non-routine electrical installations /pumps either used within the plant or at Mines or associated activities.
- The rating of the RCD shall be 30mA with the fault clearing time less than 40ms
- All the 220V single phase receptacles more than 15A which are not part of the permanent wiring shall have RCD. The rating of RCD shall be as mentioned above.
- Lockable (Without Key) type Plug and socket assembly should be preferred for power receptacles for temporary power connection so that the plug does not come out easily.
- The temporary lights having metallic case should have separate earthing point and should be properly earthed. *It is recommended to place temporary illuminating lamp over wooden or other non- conducting base to avoid electrocution.*
- Ensure that the cable for temporary lighting should not be loaded beyond 70% of its rated capacity to avoid any heating of cable.
- Do not suspend temporary lights by their electric cords, unless cords and lights are designed for this means of suspension.
- For temporary wiring above 600V provide suitable fencing, barriers, or other effective means to prevent access of anyone other than authorized and qualified personnel.
- Label all the receptacles on temporary racks with the circuit voltage present and the identification of source power.
- Areas where disconnect switch racks, distribution panel, and Motor control centers (MCCs) are located, mark the floor with yellow caution paint 3 feet (1 meter) in front of the equipment, or install a permanent barricade. This is to prevent personnel from blocking access to the operating handles. For short term installations, use safety tape in place of paint.
- All equipment should be properly earthed. Integrity of earthing connection from equipment to earth pit should be ensured and healthiness of earthing pit should be maintained.
- All temporary overhead cable should be laid more than 2.4m height on insulated or wooden support.

1.10 Salient Features of Procedure – Electrical Earthing System

1.10.1 System/Neutral Earthing

It is the term used for electrical connection of neutral conductor of a 3-phase 4-wire system, middle conductor of a 2-phase 3-wire system, one point of single phase supply or artificial neutral point created by having earthing transformer in 3 phase, 3 wire system to general mass of earth.

System/Neutral earthing is provided basically for the purpose of preserving the security of the system by ensuring that the voltage on each live conductor is restricted to such a value with respect to potential of general mass of earth as is consistent with level of insulation applied and other safety equipment.

1.10.2 Equipment Earthing

It is the term used for electrical connection of the non-current carrying metallic parts in the neighborhood of electrical circuits of apparatus/ equipment to general mass of earth.

The objective of equipment earthing is to ensure effective operation of protective gear in the event of leakage through such metal work, the potential of which with respect to neighbouring objects may attain a value which would cause danger to life or risk of fire.

1.10.3 Design and Application

The design of earthing system for any scheme is developed on the basis of basic requirements. Five important factors related to earthing shall be considered as follows:

- **I.** The selection of the conductor of the earthing system or the metal part of equipment to be grounded.
- **II.** The selection of the point where the conductor is to be earthed.
- **III.** The selection of the size of the earth wire/lead and the arrangement of its mechanical protection and the mode of its connection to the earth electrodes.
- **IV.** The selection of the earth electrodes and the limitation of their resistance to the ground.
- **v)** Fault current of the system.

Location of the earthing system with the precise location of the earthing station shall be shown in the project drawing. This drawing shall be a dimensional layout drawing and Displayed permanently and prominently in the substation for convenience of maintenance and testing personnel.

The earthing should be so constructed that individual resistance for the earthing system is < 2 ohm while combined resistance is <1 ohm.

In underground mines, electrical installations Earthing shall be done as per IS 3043(1987), IEC 60364-1.
Integrity of Earthing shall be checked and ensures, and mechanism for the same shall be available in site specific procedure, wherein the scheduled maintenance should be a part.

1.10.4 **Barricading:** The earthing station area shall be barricaded suitably by means of wire mesh fencing and shall be reckoned as a part of the protected area. The wire mesh shall be earthed separately.
In case where barricading is not possible for extensions to existing installations, a feeder pillar box of suitable size may be used to protect the earthing pit. The feeder-pillar box shall be earthed separately.

1.10.5: **Height:** Height of the wire-mesh fencing shall be 1.2 meters.

1.10.6: Name Plate: The name plate details of the earthing pit shall be written over the box at Conspicuous location. To maintain the records of previous testing, a name plate of size 300 x 220mm near the earthing station (painted with red background color for neutral earthing station and with black background colour for equipment earthing station) shall be provided.

Name plate shall be installed at the masonry work separately by an angle and will be raised above the level of the masonry work

1.10.7 : Away from Roads: Such un-barricaded earthing pits shall be at least 1.2 meters away from the roads, through fares, passage ways etc.

Annexure – 2

Arc flash PPE identification as described in NFPA 70E 2024 are:

One of the following methods shall be used for selection of arc flash PPE:
(1) The incident energy analysis method in accordance with 130.5 (G)
(2) The arc flash PPE category method in accordance with 130.7 (C) (15) Either, but not both, methods shall be permitted to be used on the same piece of equipment. The results of an incident energy analysis to specify an arc flash PPE category in table 130.7 (C) (15) (C) shall not be permitted.

Δ Table 130.5(G) Selection of Arc-Rated Clothing and Other PPE When the Incident Energy Analysis Method Is Used

Incident energy exposures equal to 1.2 cal/cm^2 up to and including 12 cal/cm^2
Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy[a]
Arc-rated long-sleeve shirt and pants or arc-rated coverall or arc flash suit (SR)
Arc-rated face shield and arc-rated balaclava or arc flash suit hood (SR)[b]
Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner, high-visibility apparel) (AN)[e]
Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with protectors (SR)[c]
Hard hat
Safety glasses or safety goggles (SR)
Hearing protection
Leather footwear[d]
Incident energy exposures greater than 12 cal/cm^2
Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy[a]
Arc-rated long-sleeve shirt and pants or arc-rated coverall or arc flash suit (SR)
Arc-rated arc flash suit hood
Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner, high-visibility apparel) (AN)[e]
Arc-rated gloves or rubber insulating gloves with protectors (SR)[c]
Hard hat
Safety glasses or safety goggles (SR)
Hearing protection
Leather footwear[d]

SR: Selection of one in group is required.
AN: As needed.
[a]Arc ratings can be for a single layer, such as an arc-rated shirt and pants or a coverall, or for an arc flash suit or a multi-layer system if tested as a combination consisting of an arc-rated shirt and pants, coverall, and arc flash suit.
[b]Face shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area are required by 130.7(C)(10)(c). Where the back of the head is inside the arc flash boundary, a balaclava or an arc flash hood shall be required for full head and neck protection.
[c]Rubber insulating gloves with protectors provide arc flash protection in addition to electric shock protection. Higher class rubber insulating gloves with protectors, due to their increased material thickness, provide increased arc flash protection.
[d]Footwear other than leather or dielectric shall be permitted to be used provided it has been tested to demonstrate no ignition, melting, or dripping at the estimated incident energy exposure.
[e]The arc rating of outer layers worn over arc-rated clothing as protection from the elements or for other safety purposes, and that are not used as part of a layered system, shall not be required to be equal to or greater than the estimated incident energy exposure.

Table 130.7(C)(15)(a) Arc Flash PPE Categories for Alternating Current (ac) Systems

Equipment	Arc Flash PPE Category	Arc Flash Boundary
Panelboards or other equipment rated 240 volts and below Parameters: Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	1	485 mm (19 in.)
Panelboards or other equipment rated greater than 240 volts and up to 600 volts Parameters: Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	900 mm (3 ft)
600-volt class motor control centers (MCCs) Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	1.5 m (5 ft)
600-volt class motor control centers (MCCs) Parameters: Maximum of 42 kA available fault current; maximum of 0.33 sec (20 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	4	4.3 m (14 ft)
600-volt class switchgear (with power circuit breakers or fused switches) and 600-volt class switchboards Parameters: Maximum of 35 kA available fault current; maximum of up to 0.5 sec (30 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	4	6 m (20 ft)
Other 600-volt class (277 volts through 600 volts, nominal) equipment Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	1.5 m (5 ft)
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)
Metal-clad switchgear, 1 kV through 15 kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)
Metal enclosed interrupter switchgear, fused or unfused type construction, 1 kV through 15 kV Parameters: Maximum of 35 kA available fault current; maximum of 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)
Other equipment 1 kV through 15 kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)
Arc-resistant equipment up to 600-volt class Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	N/A	N/A
Arc-resistant equipment 1 kV through 15 kV Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	N/A	N/A

N/A: Not applicable
Note:
For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.
*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:
(1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.
(2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.
(3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.
(4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").
(5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.
(6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): See IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*, for an example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a).

Informational Note No. 4 to Table 130.7(C)(15)(a): See Informative Annex O.2.4(9) for information on arc-resistant equipment.

Δ Table 130.7(C)(15)(b) Arc Flash PPE Categories for dc Systems

Equipment	Arc Flash PPE Category	Arc Flash Boundary
Storage batteries, dc switchboards, and other dc supply sources Parameters: Greater than 150 volts and less than or equal to 600 volts Maximum arc duration and minimum working distance: 2 sec @ 455 mm (18 in.)		
Available fault current less than 1.5 kA	2	900 mm (3 ft)
Available fault current greater than or equal to 1.5 kA and less than 3 kA	2	1.2 m (4 ft)
Available fault current greater than or equal to 3 kA and less than 7 kA	3	1.8 m (6 ft.)
Available fault current greater than or equal to 7 kA and less than 10 kA	4	2.5 m (8 ft)

Notes:

(1) Apparel that can be expected to be exposed to electrolyte must meet both of the following conditions:

(a) Be evaluated for electrolyte protection

Informational Note: See ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, for information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

Informational Note: See ASTM F1891, *Standard Specification for Arc and Flame Resistant Rainwear*, for information on evaluating arc-rated apparel.

(2) A two-second arc duration is assumed if there is no overcurrent protective device (OCPD) or if the fault clearing time is not known. If the fault clearing time is known and is less than 2 seconds, an incident energy analysis could provide a more representative result.

Informational Note No. 1: See D.5 for the basis for table values and alternative methods to determine dc incident energy. Methods should be used with good engineering judgment. When determining available fault current, the effects of cables and any other impedances in the circuit should be included. Power system modeling is the best method to determine the available short-circuit current at the point of the arc. Battery cell short-circuit current can be obtained from the battery manufacturer.

Informational Note No. 2: The methods for estimating the dc arc flash incident energy that were used to determine the categories for this table are based on open-air incident energy calculations. Open-air calculations were used because many battery systems and other dc process systems are in open areas or rooms. If the specific task is within an enclosure, it would be prudent to consider additional PPE protection beyond the value shown in this table.

Informational Note No. 3: See the following references for dc voltages below 150 volts nominal:

(1) J. G. Hildreth and K. Feeney, "Arc Flash Hazards Station Battery Systems," 2018 IEEE Power & Energy Society General Meeting (PESGM), 2018, pp. 1–5.

(2) US Department of Energy Bonneville Power Administration Engineering and Technical Services Report BPA F 5450.05, "DC Arc Flash: 125V, 1300 amp-hour battery," May 11, 2017, doi: 10.1109/PESGM.2018.8586181.

(3) K. Gray, S. Robert, and T. L. Gauthier, "Low Voltage 100–500 Vdc Arc Flash Testing," 2020 IEEE IAS Electrical Safety Workshop (ESW), 2020, pp. 1–7, doi: 10.1109/ESW42757.2020.9188336.

△ Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

Arc-Flash PPE Category	PPE
1	**Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm^2 (16.75 J/cm^2)[a]** Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated face shield[b] or arc flash suit hood Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)[f] **Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts)[c] Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with protectors (SR)[d] Leather footwear[e] (AN)
2	**Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm^2 (33.5 J/cm^2)[a]** Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated flash suit hood or arc-rated face shield[b] and arc-rated balaclava Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)[f] **Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts)[c] Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with protectors (SR)[d] Leather footwear[e]
3	**Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm^2 (104.7 J/cm^2)[a]** Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves or rubber insulating gloves with protectors (SR)[d] Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)[f] **Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts)[c] Leather footwear[e]
4	**Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm^2 (167.5 J/cm^2)[a]** Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves or rubber insulating gloves with protectors (SR)[d] Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)[f] **Protective Equipment** Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts)[c] Leather footwear[e]

AN: As needed (optional). AR: As required. SR: Selection required.
[a]*Arc rating* is defined in Article 100.
[b]Face shields are to have wrap-around guarding to protect not only the face but also the forehead, ears, and neck, or, alternatively, an arc-rated arc flash suit hood is required to be worn.
[c]Other types of hearing protection are permitted to be used in lieu of or in addition to ear canal inserts provided they are worn under an arc-rated arc flash suit hood.
[d]Rubber insulating gloves with protectors provide arc flash protection in addition to electric shock protection. Higher class rubber insulating gloves with protectors, due to their increased material thickness, provide increased arc flash protection.
[e]Footwear other than leather or dielectric shall be permitted to be used provided it has been tested to demonstrate no ignition, melting or dripping at the minimum arc rating for the respective arc flash PPE category.
[f]The arc rating of outer layers worn over arc-rated clothing as protection from the elements or for other safety purposes, and that are not used as part of a layered system, shall not be required to be equal to or greater than the estimated incident energy exposure.

Annexure - 3 : Arc Flash Hazard Identification for AC & DC Systems

Task

Reading a panel meter while operating a meter switch

Normal operation of a circuit breaker (CB), switch, contactor, or starter

For ac systems: Work on energized electrical conductors and circuit parts, including voltage testing

For de systems: Work on energized electrical conductors and circuit parts of series-connected battery cells, including voltage testing

Voltage testing on individual battery cells or individual multi-cell units

Removal or installation of CBs or switches

Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare energized electrical conductors and circuit parts

Removal of bolted covers (to expose bare energized electrical conductors and circuit parts). For de systems, this includes bolted covers, such as battery terminal covers.

Equipment Condition*

Any

All of the following:

The equipment is properly installed The equipment is properly maintained All equipment doors are closed and secured All equipment covers are in place and secured There is no evidence of impending failure

One or more of the

following:

Arc Flash PPE Required No

Yes

The equipment is not properly installed
The equipment is not properly maintained
Equipment doors are open or not secured
Equipment covers are off or not secured
There is evidence of impending failure

Yes

No

Any

(continues)

Any

All of the following:

Yes

The equipment is properly installed The equipment is properly maintained
Covers for all other equipment are in place and secured There is no evidence of impending failure

Yes

One or more of the following:

Yes

The equipment is not properly installed
The equipment is not properly maintained
Equipment doors are open or not secured
Equipment covers are off or not secured
There is evidence of impending failure

No

Any

All of the following:

The equipment is properly installed
The equipment is properly maintained
There is no evidence of impending failure

Yes

Any of the following:

Yes

The equipment is not properly installed
The equipment is not properly maintained
There is evidence of impending failure

No

Any

Task Condition*	Equipment	Arc Flash PPE Required
Removal of battery intercell connector covers following:	All of the	
	The equipment is properly installed. The equipment is properly maintained Covers for all other equipment are in place and secured There is no evidence of impending failure	No
	One or more of the following: The equipment is not properly installed The equipment is not properly maintained Equipment doors are open or not secured Equipment covers are off or not secured There is evidence of impending failure	Yes
Opening hinged door(s) or cover(s) (to expose bare energized electrical conductors and circuit parts)		Yes
Perform infrared thermography and other noncontact inspections outside the restricted approach boundary. This activity does not include opening of doors or covers.	Any	No
Application of temporary protective grounding equipment after voltage test	Any	Yes
Work on control circuits with exposed energized electrical conductors and circuit parts, 120 volts or below without any other exposed energized equipment over 120 V including opening of hinged covers to gain access	Any	No
	Any	
Work on control circuits with exposed energized electrical conductors and circuit parts, greater than 120 V	Any	Yes

Insertion or removal of individual starter buckets from motor control center (MCC) Any Yes

Insertion or removal (racking) of CBs or starters from cubicles, doors open or closed Any Yes

Insertion or removal of plug-in devices into or from busways Any Yes

Insulated cable examination with no manipulation of cable Any No

Insulated cable. examination with manipulation of cable Any Yes

Work on exposed energized electrical conductors and circuit parts of equipment directly supplied by a panelboard or motor control center Any Yes

Yes

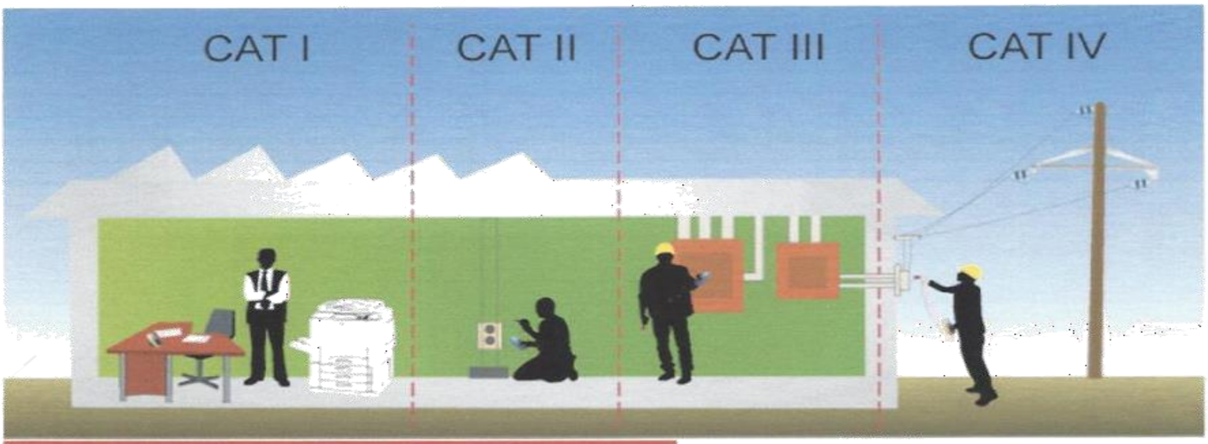
No

	Equipment Conditi on*	Arc Flash PPE Requir ed
	Any	No
	Any	Yes
	--	
-Insertion or removal (racking) of CBs from cubicles -Insertion or removal (racking) of ground and test device -Insertion or removal (racking) of voltage transformers on or off the bus	All of the following: The equipment is properly installed The equipment is properly maintained All equipment doors are closed and secured All equipment covers are in place and secured There is no evidence of impending failure	No
	One or more of the following: The equipment is not properly installed The equipment is not properly maintained Equipment doors are open or not secured Equipment covers are off or not secured There is evidence of impending failure	Yes Yes Yes Yes

Opening voltage transformer or control power transformer compartments	Any
Outdoor disconnect switch operation (hookstick operated) at 1 kV through 15 kV	Any
Outdoor disconnect switch operation (gang-operated, from grade) at I kV through 15 kV	Any

Note: Hazard identification is one component of risk assessment. Risk assessment involves a determination of the likelihood of occurrence of an incident, resulting from a hazard that could cause injury or damage to health. The assessment of the likelihood of occurrence contained in this table does not cover every possible condition or situation. Where this table indicates that arc flash PPE is not required, an arc flash is not likely to occur. "The phrase *properly installed,* as used in this table, means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase properly maintained, as used in this table, means that the equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. The phrase evidence of impending failure, as used in this table, means that there is evidence of arcing, overheating, loose or bound equipment parts, visible damage, deterioration, or other damage.

Annexure : 4 Rating of Test Instruments



Measurement safety categories

The International Electrotechnical Commission (IEC) Standard 61010 describes performance specifications for low voltage (< 1000 V) test equipment. The higher the category, the higher the power available in that environment and the higher the test tool's ability to withstand transient energy.

Measurement category	In brief	Examples
CAT IV	Three-phase at utility connection, any outdoor conductors	• Refers to the "origin of installation", i.e., where low-voltage connection is made to utility power. • Electricity meters, primary overcurrent protection equipment. • Outside and service entrance, service drop from pole to building, run between meter and panel. • Overhead line to detached building, underground line to well pump.
CAT III	Three-phase distribution, including single-phase commercial lighting	• Equipment in fixed installations, such as switchgear and polyphase motors. • Bus and feeder in industrial plants. • Feeders and short branch circuits, distribution panel devices. • Lighting systems in larger buildings. • Appliance outlets with short connections to service entrance.
CAT II	Single-phase receptacle connected loads	• Appliance, portable tools, and other household and similar loads. • Outlet and long branch circuits. – Outlets at more than 10 meters (30 feet) from CAT III source. – Outlets at more that 20 meters (60 feet) from CAT IV source.
CAT I	Electronic	• Protected electronic equipment. • Equipment connected to (source) circuits in which measures are taken to limit transient overvoltages to an appropriately low level. • Any high-voltage, low-energy source derived from a high-winding resistance transformer, such as the high-voltage section of a copier.

Measurement categories. IEC 61010 applies to *low-voltage* (< 1000 V) test equipment.

Annexure-5 : Sample Job Briefing and Planning Checklist

Identify

- Hazards
- Voltage levels involved
- Skills required
- Any "foreign" (secondary source) voltage source
- Any unusual work conditions
- Number of people needed to do the job
- Shock protection boundaries
- Available incident energy
- Potential for arc flash (Conduct an arc flash hazard analysis.)
- Arc flash boundary

Ask

- Can the equipment be de-energized?
- Are back feeds of the circuits to be worked on possible?
- Is a standby person required?

Check

- Job plans
- Single-line diagrams and vendor prints
- Status board
- Information on plant and vendor resources is up to date
- Safety procedures
- Vendor information
- Individuals are familiar with the facility

Know

- What the job is ?
- Who else needs to know – Communicated ?
- Who is Incharge ?

Think

- About the unexpected event ... What if ?
- Lock - Tag - Test - Try
- Test for voltage - FIRST
- Use the right tools and equipment , including PPE .
- Install and remove temporary protective grounding equipment
- Install barriers and barricades
- What else ?

Prepare for an Emergency

- Is the standby person CPR trained?
- Is the required emergency equipment available? Where is it?
- Where is the nearest telephone?
- Where is the fire alarm?
- Is confined space rescue available?
- What is the exact work location?

- How is the equipment shut off in an emergency?
- Are the emergency telephone numbers known?
- Where is the fire extinguisher?
- Are radio communications available?

Annexure- 6 : Establishing an Electrically Safe Work Condition

1) Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
2) After properly interrupting the load current, open the disconnecting device(s) for each source.
3) Wherever possible, visually verify that all blades, of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the fully disconnected position.
4) Apply lockout tagout devices in accordance with a documented and established policy.
5) Use an adequately rated test instrument to test each phase conductor or circuit part to verity it is de- energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the test instrument is operating satisfactorily through verification on a known voltage source

Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.

Annexure 7: List of Applicable IS Standards (Electrical)

Standard	Subject
2512-1978	Batteries (lead acid type) for miners cap lamp
5133 Part 1-1969	Boxes for enclosure of electrical accessories
6789-1972	cable couplers and adapters, bolted flame proof.
2593-1964	Cable flexible for miner's cap lamp.
1026-1966	Cable flexible trailing for use in quarries.
4821-1968	Cable glands and sealing boxes for use in mines.
691-1966	Cable rubber insulated flexible trailing for in coal mines
4817-1968	Cable rubber insulated for mines.
3202-1965	Climate Proofing of Electrical Equipment
3043-1987	Code of practice for earthing
6665-1972	code of practice for industrial lighting.
4591-1968	Code of practice for installation and maintenance of escalators.
3072-1975	Code of practice for installation of Switchgear
2309-1969	Code of Practice for Lightnig Protection
3106-1966	Code of practice for Selection, Installation and Maintenance of Fuse (upto 650volts)
2274-1963	Code of Practice for Wiring Installations (exceeding 650 volts)
9249 part I 1979,part II-1982	Common safety requirements for Electrical Measuring & Recording Instruments
2551-1963	Danger notice plates
2147-1962	Degree of Protection provided for enclosure for Sw-gear and control gear low voltage.
1248-1983	Direct Acting Electrical Indicating Instruments
3051-1965	Earthing for transformers.
1913-1969	Electric lighting fittings general and safety requirements for(first revision)
4648-1968	Electrical layout in residential buildings
7693-1975	Electrical apparatus for use in explosive gas atmospheres, oil immersed.
6381-1972	Electrical apparatus with type of protection 'e' construction and testing
5571-1970	Electrical equipment for hazardous areas, guide for selection
7724-1975	Electrical equipment for use in explosive atmosphere sand filled protection
4051-1967	Electrical equipment in mines, code of practice for maintenance
8607 part II – 1978	Electrical equipment- protection against explosion hazards.
3034-1981	Fire Safety of Industrial Buidling : Electrical generating and distributing stations.
1646-1982	Electrical installations.
8945-1976	Electrical instruments for Hazardous atmospheres

732 - partI-1982, partII-1983,partIII-1982	**Electrical wiring installation** Definition and general installations. Design and construction,Inspection and testing of installation
2274-1963	Electrical wiring installation, system voltage exceeding 650 volts code of practice for.
732-1963	Electrical wiring installation, system voltage not exceeding 650 volts, code of practice for.
732-1989	Electrical Wiring Installations (upto 650 V)
4691-1968	Enclosure for rotating electrical machinery, degree of protection
7385-1974	Enclosure pressured of electrical equipment for use in hazardous areas.
3682-1966	Flame proof AC motors for use in mines.
2206-partI- 1962	Flame proof electric lighting fitting part-1 well glass and bulk head type.
2148-1968	Flame proof enclosures of electrical apparatus
4237—1982	General Requirements for Switch gears not exceeding 1000 v.
3770-1968	Gloves, rubber for electrical purposes.
5578-1984	Guide for marking of Insulated Conductors.
5216-1969	Guide for Safety Procedures and Practices in Elect.work.
7689-1974	Guide for the control of undesirable static electricity.
5572-partI- 1978	Hazardous areas (other than mines) for electrical installations, classification of part I areas having flammable gases and vapours (first revision)
1818-1972	Isolator and Earthing switches
1651-1991	Lead Acid Cell Batteries
8216-1976	Lift wire ropes, guide for inspection
1860-1968	Lifts electric, passenger and goods code of practice for installation, operation and maintenance
4666-1968	Lifts electric, passenger and goods.
6620-1973	Lifts electric, service, code of practice for installation operation and maintenance of
4850-1968	Lightening arresters for AC systems, expulsion type application guide for.
3070 part I -1974	Lightening arresters of AC system Part I non-linear type (first revision)
2493-1963	Lighting, fitting, well-glass for use in underground mines (non-flame proof type.)
3070-1993 (Part 1)	Lightning Arresters
5424-1960	Mats, rubber for electrical purposes
2772 part I -1964	Oil immersed type transformers for use below ground, mining, non-flame proof part I
7321-1974	Overhead power and telecommunication lines, code of practice for selection handling and erection of concrete poles for.
802-part I 1973	Overhead transmission in line towers, code of practice for use of structural steel in: part I Loads and permissible stresses (first revision)
8607-1978	Protection against electric shock.
6970-1973	Protection against possible hazard in radio transmitting equipment.
1554-1998	PVC Insulated cables – Heavy Duty

694-1990	PVC Insulated Cables and Cords for Power/Lighting
5780- 1970	Safe intrinsically, electrical apparatus and circuits.
2834-1986	Shunt capacitor for power system
4004-1978	Surge arrestors for AC system non-linear resistor type application guide
10406-1983	Transformers intrinsically safe.
1416-1972	Transformers, safety.
8923-1978	Warning symbols for dangerous voltages.
9921	Switchyard Isolators
398	Overhead Aluminium Conductor
802 & 4091	Overhead Transmission line Tower
2026	Specs of Power Transformer
3347	Porcelin Insulator bushing for Trafo
5216	Recommendations on Safety Procedures & Practices in Electrical Work
335	Trafo oil Specs
1866	Maintt and Supervision of Mineral Oil
2099	Bushings
3639	Transformer Fittings
4257	Clamping Porceilin Bushings
6088	Specs of Heat Exchangers for Trafo
7098	HT Cables
12063	Degree of Ingress Protection
12463	Inhibiting Insulating Oil
15652	Insulating Rubber Mat
9409	Classification of Electrical & Electronic Equipments wrt Shock Hazard
12459	Code for Fire Safety in Cable Cellers
13408	Code for Electrical Installations in Hazardous Area
13770	Insulating Rod for Live Working
8478	Onload Tap Changers
15405.1.2003	Live Working Flame Resistant material of Clothing for thermal protection of workers
13585	Shunt Capacitors up to 1000V