MARK

Temperature Control Specialist

Standard Procedure

Electrical Safety Management

Abbreviations

- HSE - Health, Safety and Environment
- CHSEE - Centre for Health, Safety and Environment Excellence
- GMS - Group Manufacturing Services
- PPE - Personal Protective Equipment
- PSM - Process Safety Management
- GFCI - Ground Fault Current interrupter
- RCD - Residual Current Device
- IEC - International Electro technical Commission
- IP - Ingress Protection
- CPR - Cardiopulmonary resuscitation
- CES – Central Engineering Service
- CTS-Central Technical Services
- NFPA – National Fire Protection Association
- OEM – Original equipment manufacturer
- EC - European Commission
- CEST - Corporate Electrical Safety Team
- CEA – Central Electricity Authority
- QA - Quality Assurance
- SLD – Single Line Diagram
- PSSR – Pre Startup Safety Review

1. Introduction

Electricity is an inseparable entity while working in any industry or process. Electricity is recognized as one of the serious workplace hazards, exposing employees and contractor workmen to electrocution, burns, fires and explosions. World over, this hazard contributes to significant numbers of on the job and off the job fatalities every year. This procedure is developed to establish mandatory requirements and advisory guidance for practices to protect personnel from hazards associated with Electrical Safety

1.1. Intent and Purpose

This procedure has been developed following guidance of experts from DuPont Safety Resources. The requirements and practices which have been identified here are equally applicable across all plants and Electrical facilities. This will also help in bringing about a consistency in the process used across all individual plants.

These guidelines will also help to provide a new impetus towards achieving the best in class safety procedures. The release of the procedure is formulated based on world class practices and with the help of DuPont Safety Resources. Comments and feedback would be appreciated to further enhance this process. All such comments and feedback may be addressed to Mark Safety Lead. The comments and feedback would be consolidated and shall be used during the review and revision of future releases.

2. Scope and field of application

2.1. Scope

This procedure provides mandatory requirements and advisory guidance for establishing, sustaining, and improving the procedures and practices used to manage interaction with electrical equipment and systems to prevent injury, interruptions to operations, and impact on equipment critical to process safety.

It is mandatory to declare that local regulations might impose conditions not reflected in this procedure. Additional information on regulations comes from various sources, including Statutory/Regulatory Documents which will be maintained at a separate location. Depending on the job requirement reference shall be taken from these procedures as and when required depending on plant requirement.

2.2. Field of application.

Procedure is applicable at all plants

- Plant in Normal Operating Condition
- Plant under S/D
- Partial shutdown
- Confined spaces
- Zone I & Zone II Equipment
- Non flame proof equipment.
- Zone 0 Equipment
- Non hazardous area equipment
- Permanent Electrical Installations
- Activities involving non electrical equipment

4. Management responsibilities

Line management along with all the workers have the responsibility to implement this procedure. Effective electrical safety management involves, the focused application of principles outlined in Mark HSE Procedure Safety and Health Principles to the unique hazards of electrical energy. This should include

- Establishing electrical management resources and procedures that focus on providing each plant with an effective electrical safety management process.
- Committing resources to implement an electrical safety management program and to sustain continuous improvement of electrical safety.
- Establishing accountability for performance against specific safety goals and/or objectives.
- Verifying (via first- and second-party audits) the degree of compliance with established electrical safety procedures and practices and implementing appropriate corrective actions.
- Participating personally in activities that visibly demonstrate a commitment to electrical safety.

4.1. HSE & F Department

HSE & F department of provides the following resources and support:

- Assist the electrical group in providing and conducting electrical safety training
- Carrying out of audit and submitting report, compliance plan.
- Publishing and maintaining HSEF procedure.

4.2. Corporate Electrical Safety Team

The team's responsibilities should include, but not be limited to the following activities

- Engaging each Site in leading ongoing improvement in Electrical safety.
- Maintaining this procedure.
- Promoting corporate-wide awareness that electrical safety competency is an asset to manage.
- Enabling an organizational network to share and leverage information, knowledge, needs, and solutions with all appropriate personnel.

- Collecting and analyzing Mark and external electrical safety metrics for trends, key learnings, and appropriate corrective actions.
- Coaching the line organization in its electrical safety leadership role and responsibilities
- Provide guidelines on Best practices on Electrical Safety

4.3. Site Management

The operations and maintenance function should lead and manage electrical safety activities. The technology function should provide adequate resources to support the Electrical safety improvement process.

Site Management shall help ensure that proper resources are committed to supporting a sustainable electrical safety improvement process. This shall include designating an electrical safety champion for complex.

In addition, the Site Management responsibilities should include but not be limited to

- Demonstrating overall management leadership and commitment.
- Making electrical safety expertise available to plants.
- Promoting information exchange among plants.
- Confirming that electrical hazards are periodically assessed and the information is used to prioritize improvement of complex electrical safety programs.
- Paying adequate attention to electrical safety during such activities as forming joint ventures, making acquisitions, deactivating facilities, and dismantling facilities.

Each plant of Mark 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 the following activities:

- Developing, documenting, and issuing site electrical safety procedures and practices
- Providing training in safe electrical work practices appropriate for job responsibilities for concerned personnel.
- Conducting first-party audits for compliance with site electrical safety procedures and practices, analyzing audit results and preparing reports for site management, acknowledging strengths, and recommending upgrades and corrective actions
- Developing and implementing improvement plans based on both on-site and off-site electrical incident findings and recommendations
- Identifying and promoting electrical facility improvement opportunities through the use of inherently safer electrical technology
- Identify and provide for a resource to implement the requirement of Electrical Safety management process.
- Involve employees in the Electrical safety improvement process.
- Providing site coordination for electrical safety, particularly where different business sectors are present
- Networking with other sites as appropriate

4.4. Electrical safety champion

The electrical safety champion usually will work in the plant operation section at site. This person should be qualified and recognized for his or her electrical expertise and have the appropriate training in this procedure and the associated audit protocol. The electrical safety champion should also be qualified to carry out the electrical safety responsibilities and accountabilities of the position.

These responsibilities should include but not be limited to

- Understanding the hazards associated with electrical energy and the association of electrical safety and process safety, fire.
- Being an Electrical Engineer with knowledge of Electrical Power systems.
- 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.
- Work with the team to develop Engineering solutions to eliminate, reduce and guard against personnel exposure to Electrical hazards.
- Should routinely participate in Electrical safety networking activities with similar resources from other sites to leverage and share information related to Electrical safety.
- Serving as a consultant to line management in fulfilling its electrical safety responsibilities addressed in this section.
- Monitoring operating unit electrical safety programs through reviews of serious incidents and other reports.
- Monitoring site compliance with the elements of electrical safety as described in Section 6, as well as monitoring compliance with local regulations.
- Coordinating exchanges (e.g., among sites, businesses, Locations, and subsidiaries) of pertinent electrical safety information, such as

    - Recognized and accepted good practices.
    - Changes in codes, procedures, and regulations
    - Serious incident investigations
    - Occurrences outside

- Assisting Mark staff with scheduling and providing resources for electrical safety audits.
- Coordinating with Corporate Electrical Safety Team in scheduling and providing resources for the second party electrical safety audits.

5. Definitions

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

Authorized - having been determined by management to be qualified and given permission and support to perform and/or direct specific tasks or functions.

Accessible - Means within physical reach without the use of any appliance or special effort.

Apparatus - Means electrical apparatus and includes all machines, fittings**,** accessories and appliances in which conductors are used**.**

Bare - Means not covered with insulating materials

Cable - Means a length of insulated single conductor (solid or stranded) or of two or more such conductors each provided with its own insulation, which are laid up together. Such insulated conductor or conductors may or may not be provided with an overall mechanical protective covering.

Circuit - Means an arrangement of conductor or conductors for the purpose of conveying electricity and forming a system or a branch of a system.

Circuit Breaker - Means a device, capable of making and breaking the circuit under all conditions, and unless otherwise specified, so designed as to break the current automatically under abnormal conditions.

~~Competent~~ - see "Qualified."

Covered with insulating material - Means adequately covered with insulating material of such quality and thickness so as to prevent danger.

Danger - Means danger to health or danger to life or any part of body from shock, burn or other injury to persons, or property, or from fire or explosion, attendant upon the generation, transmission, transformation, conversion, distribution or use of electricity.

Dead - Means at or about earth potential and disconnected from any live system. It is used only with reference to current carrying parts when these parts are not live.

Earthed or connected with earth - means connected with the general mass of earth in such manner as to ensure at all times an immediate discharge of electricity without danger.

Earthing System - Means an electrical system in which all the conductors and appliances are earthed.

Electrical Safety event - an unusual occurrence that did not, but could have, led to an electrical incident.

Electrical **Safety** incident — One of the following types of incidents:

- A fire, environmental, or process incident 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 procedure, or other injury that may result from direct exposure to electrical energy (e.g., 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.

Flameproof Enclosure - Means an enclosure for electrical machinery or apparatus that will withstand, when the covers, or other access doors are properly secured, an internal explosion of the inflammable gas or vapor which may enter or originate inside the enclosure, without suffering damage and without communicating the internal flammation (or explosion) to the external inflammable gas or vapor in which it is designed to be used, through any joints or other structural openings in the enclosure.

Flexible Cable - Means a cable consisting of one or more cores each formed of a group of wires, the diameter and the physical properties of the wires and insulating material being such as to afford flexibility.

GFCI (ground-fault circuit interrupter)—See "RCD."

Guarded - Means covered, shielded, fenced or otherwise protected by means of suitable casings, barrier, rails or metal screens to remove the possibility of dangerous contact or approach by persons or objects to a point of danger.

Intrinsically Safe - As applied to apparatus or associated circuits shall denote that any sparking that may occur in normal working is incapable of causing explosion of inflammable gas or vapor.

Increased Safety Type 'e' - Means a method of protection by which additional measures are applied so as to give increased security against the possibility of excessive temperatures and of occurrence of arcs and sparks in apparatus which does not produce arcs or sparks in normal service.

Lightning Arrester - Means a device which has the property of diverting to earth any electrical surge of excessively high amplitude applied to its terminals and is capable of interrupting flow current if present and restoring itself thereafter to its original operating conditions.

Live - Means electrically charged

Meter - Means a device suitable for measuring, indicating and recording consumption of electricity or any other quantity related with electrical system and shall include, wherever applicable, other equipment such as Current Transformer (CT), Voltage Transformer (VT), or Capacitor Voltage Transformer (CVT) with necessary wiring and accessories.

Neutral Conductor- Means that conductor of multi-wire system, the voltage of which is normally intermediate between the voltages of the other conductors of the system and shall also include return wire of the single phase system.

Open sparking - Means sparking which owing to the lack of adequate provision for preventing the ignition of inflammable gas external to the apparatus would ignite such inflammable gas.

Portable apparatus- Means an apparatus which is so designed as to be capable of being moved while in operation.

Portable Hand Lamp - Means a portable light fitting provided with suitable handle, guard and flexible cord connected to a plug.

Practice - an accepted and recognized work method that is aligned with applicable national and local regulations and procedures and is also aligned with corporate policies, procedures, and guidelines.

Procedure - A documented method or process of carrying out work activity that is aligned with applicable national and local regulations and procedures and is also aligned with corporate policies, procedures, and guidelines.

Qualified—having validated skills, knowledge, ability, training, and experience to perform the job safely and to recognize personal limitations in these areas. (In some Locations, the term "competent" is used instead of "qualified.")

A qualified individual has the following characteristics 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 hazard
- Is able to recognize and manage changing conditions of equipment or operation
- Knows the local mandatory (i.e., legal) requirements related to Electrical safety.

RCD (residual current device)—an electrical safety device that functions by sensing leakage of current to ground associated with electric shock and de-energizing the
Circuit . National procedures and regulations determine the performance parameters of RCDs and GFCIs.

Note: The term "GFCI" is commonly used in North America. The term "RCD" is commonly used in other global Locations.

Risk assessment—a systematic and structured process whereby hazards present in a workplace, or arising from workplace activity, are identified; risks are evaluated; and protective and preventive measures, including procedures and practices, are put in place to reduce risks to acceptable levels.

Switch - Means a manually operated device for opening and closing or for changing the connections of a circuit.
Switchboard - Means an assembly including the switchgear for the control of electrical circuits, electric connections and the supporting frame.
Switchgear - Shall denote switches, circuit breakers, cut-outs, and other apparatus used of the operation, regulation and control of circuits.
Voltage - Means the difference of electrical potential measured in volts between any two conductors or between any part of either conductor and the earth as measured by a voltmeter meeting Indian Standards

"Working near" energized electrical equipment - any activity involving crossing or working inside the shock hazard Limited Approach Boundary (see Table 1) and/or crossing or working within the Flash Hazard Boundary established by hazard analysis.

"Working on" energized electrical equipment - any activity involving crossing or working inside the shock hazard Prohibited Approach Boundary (see Table 1) or coming into contact with exposed, energized electrical conductors or circuit parts with tools, probes, or test equipment, regardless of the personal protective equipment a person is using.

6. Procedures / guidelines -

Electrical technology

Electrical Hazards can result from poor physical condition of equipment or facilities (unsafe condition) or from careless or inadvertent action of people (unsafe act). Proper precautions to avoid such unsafe acts or unsafe conditions should be taken from initial design stage through installation, start up & maintenance.

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. Personal protective equipment technologies and mandatory requirements outlined in Section 6.4.6 should be considered the last line of defense. It is important to understand the four main phases of protection from electrical hazards.

- Design, Procurement, testing & installation of Electrical equipment to be made safe by complying with statutory requirements and good Engineering practice.
- Maintain in depth Electrical equipment integrity.
- Establish safe working conditions before working on the equipment.
- Establish safe working practices, operating procedures and provide adequate protective equipment, tools & testing equipment and training to employees / contractor workers.

6.1. Design, Procurement, & Installation of Electrical Equipment

Design, Procurement, testing and installation of Electrical equipment to be made safe by complying with statutory requirements and good Engineering practices.

- Minimizing personnel exposure to electrical hazards through process and equipment design and specification, installation details, maintenance, and operation of electrical equipment and systems.
- Guarding exposed parts operating at >50 V within enclosures to prevent inadvertent contact.

The following elements shall be considered in the project design stage-

a. Protection against shock , burn and blast
b. Fire Protection
c. Illumination
d. Working space; Ergonomics to be taken care while designing the work space
e. Drawings
f. Equipment identification & marking
g. Grounding & bonding
h. Provision for future expansion
i. Electrical protection system
j. Equipment suitability to Area classification
k. System stability study
l. Inspection Provision

During Electrical equipment installation, following points must be adhered to, to ensure electrically safe facility.

a. Establish procedures for Equipment receipt, storage & preservation
b. Ensure availability of proper lifting tools & tackles
c. Ensure availability of trained personnel
d. Ensure Installation of equipment in accordance with operating drawings, OEM instruction, procedure Engineering practice, guidelines, check sheets & other design documents.
e. Compliance to Statutory requirements (e.g. CEA Regulations etc.)
f. Identify conflict & resolve, if discrepancy is observed w.r.t statutory requirements, design documents etc.
g. Carry out Electrical safety and Fire protection audit after installation of equipment.
h. Check & ensure Maintainability of equipment
    - The installed equipment shall be mapped in SAP system by project team in consultation with CES Elect / Planning / Plant maint.
    - Once the equipment is installed, the PM planning and scheduling shall be done as per the established maintenance procedure.
i. Ensure proper Documentation of tasks carried out.
j. Electrical protection systems must be installed as per design and tested for correct operation.
k. Equipment inspection and test plan.

Equipment Commissioning -

Plant 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 need to plan energy isolation and lockout/tagout is available.

Equipment construction and installation are in accordance with design specifications, local regulations, and RIL procedures.

Any alteration / addition of electrical equipment shall be installed with prior approval from Electrical Inspector. Approval shall be taken from Electrical Inspector before charging a new or altered installation above 650V or where the installation is being charged after a shutdown of 6 months or more. The record of the approval shall be maintained. For new installations (excluding the equipment as in CEA Regulation) of 415V level the Electrical Inspector shall be informed before energizing along with the relevant test certificate.

Periodic Inspection by authorities-

CES Electrical shall ensure that the periodical inspection of the site Electrical installations is carried out by the Electrical Inspector on a yearly basis.

6.2. Electrical Equipment Integrity

Each plant shall have procedures and practices to manage the integrity of electrical equipment, including grounding / earthing and bonding conductors; electrical equipment auxiliary facilities; and tools and equipment critical to the safety and reliability of the electrical equipment in accordance with local regulations and Mark procedures.

Electrical Equipment integrity shall be maintained by ensuring following –

a. Monitor equipment performance w.r.t design window
b. Perform periodic Installation integrity audits including checking of earthing / grounding.
c. Carry out Preventive maintenance as per schedule and Predictive maintenance of equipment.
d. Corrective repairs on equipment shall be done whenever required.
e. Obsolescence abatement & asset renewal
f. Coordination of protection shall be ensured for upstream and downstream connection involving equipment.

6.3. Safe Working Conditions

Electrically safe work conditions shall be ensured by following –

a. Periodical Audit of installations as per OISD standards and CEA Regulations and in conformance to the Mark standards.
b. Adequate illumination at work site

c. Proper Housekeeping
d. PPEs availability
e. Required drawings, SLDs, equipment nomenclatures & documents are displayed at work locations.
f. Following safe working procedures & Practices.

6.4. Operating procedures and safe practices

Plants shall have electrical 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. These procedures should cover normal and emergency operations associated with the electrical supply utility.

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

Comparisons of work performance with standard operating procedures shall be included as part of the site first-party audit process.

SMP for all electrical equipment shall be prepared and made available to the work force.

SOP shall be prepared and duly approved and made available for all the electrical operations. These shall be easily accessible to the operating personnel. Along with these SOPs, checklist shall be used for step-by-step operations while executing the task.
Generic Risk Assessment shall be prepared and made available for reference; Task based Risk Assessment shall be prepared with the help of Generic RA sheets.

Task based SOP / SMP may be prepared, if not available as and when required when the job is required to be executed.

6.4.1. Working on or near energized electrical equipment

The goal is that no work should be performed within the Prohibited 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.
Efforts shall be taken for minimizing exposure of working on or near un-insulated or unguarded electrical circuits and conductors energized >50 V, including the contact of tools or any part of the body, regardless of personal protective equipment used.

Work within the Prohibited Approach Boundary shall only be performed when all of the following mandatory requirements are met.

- Only authorized personnel trained on the specific task are permitted to perform work within prohibited Approach boundary

- Line management participates in the decision to authorize work within prohibited Approach boundary. Each plant shall establish the level of management approval for this authorization.
- A specific job plan is written for the task.

Although voltage testing, current measurements 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 mandatory requirements are met:

- Convergence on the make and model of test instruments to simplify training and qualification requirements.
- Compliance of test instruments with current local industry and national procedures for mechanical integrity, over-voltage protection, and user safety.
- Test instruments should be on hand before covers, guards, or barriers are removed.
- No body part should pass the plane of enclosure openings before the test instrument.
- The person performing the test is qualified and authorised to perform voltage testing as part of his job responsibility.

6.4.2. Testing for absence of Voltage

SOP/ SMP checklist shall include the test for the absence of voltage before touching bare conductors or parts (i.e., Test before Touch).
Personnel should test every circuit and every conductor, every time, to verify the absence of voltage before touching and appropriate personal protective equipment should be used until the absence of voltage is verified.
The practice of "*Test Before Touch*" is the critical step that minimizes risk of contacting an energized conductor due to unexpected and unplanned situations, such as:

- Unexpected energisation from failure of equipment insulation or isolation
- Equipment or circuit labeling errors
- Wiring errors
- Drawing or other documentation errors
- Unintentional breaching of the safe working zone during planned work activity
- Errors in equipment identification due to physical orientation, symmetry, or similar appearance
- Unauthorized re-energisation or other failure of the lockout procedure
- Accidental or un-intended Auto Changeovers
- Redundant supply coming in line.

Use of contactless voltage detecting instruments is preferred over any other instrument for safety of person using the same. Healthiness of contactless voltage detecting instrument is to be ensured by the user before actual use.

All personnel performing testing for the absence of voltage shall be trained in the

procedures and practices for voltage testing. Training and qualification shall be specific for each voltage test instrument.

Selection and use of test instruments shall be done addressing following points –

- Removal of obsolete and defective instruments from service.
- Standardization on the make and model of test instruments to simplify training and qualification requirements.
- Compliance of test instruments with current local industry and national standards for mechanical integrity, over-voltage protection, and user safety.
- Test instruments should be available on hand with work force before covers, guards, or barriers are removed.
- No body part should pass the plane of enclosure openings before the test instrument.

For testing of the absence of voltage A single-function instrument shall be used to reduce the risk of misreading due to scaling, ranging, or other errors that can occur with multimeters.

6.4.3. 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 the following:

- Single line drawings
- Schematic diagrams
- Equipment Layout diagrams
- Maps of underground electrical services
- Area classification drawing
- Panel schedules
- 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 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.

6.4.4. Energy isolation

In addition to the mandatory requirements of Mark Mumbai HSE Procedure Lockout/Tagout procedures for isolating electrical energy shall include

- The application of temporary safety grounding / earthing as determined by risk assessment.

- Test Before Touch (see Section 6.4.2), 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. People 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 Centre, 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-through, 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, turnover to operations, maintenance, and other situations in which control responsibility may change. This will part of the job plan.

6.4.5. Job and task planning

Careful planning is fundamental for understanding, assessing, and managing potential exposure to hazards. Plant may find it beneficial to break jobs into individual tasks to assist in identifying the hazards and safe work practices for each task.

Task based Risk Assessment (TBRA) along with generic RAs as per Mark Mumbai Procedure for Risk Assessment, applicable work permit and applicable check sheet shall form part of job plan for identifying the hazards and safe work practices for each task. If the job cannot be completed as planned or if conditions change, work shall be stopped and re-planned.
Job plan shall be effectively communicated to everyone involved with and affected by the work, including operations and emergency response personnel, where appropriate.

The need for standby person and his responsibilities during the electrical job shall be included in Risk Assessment process for.
The responsibilities of the standby person should include

- Being aware of the hazards involved in the task.
- Being qualified to switch off the power to the equipment being worked on.
- Being able to initiate the alarm.
- Being trained in the administration of appropriate first aid (e.g., cardiopulmonary resuscitation or treatment of burns) where there is recognized risk of electric shock and/or 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.
- Doing no other work that interferes with his or her ability to perform any of the above duties.
- He shall also perform the duties of Electrical Safety observer during any job involving system of above 1.1KV rating.

Individual Electrical Safety Principles

A Proven and effective planning aid is the use of "My Electrical Safety Principles." 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).

- Plan every job
- Use procedures as tools
- Assess people's abilities
- Anticipate unexpected events
- Fully understand the scope of job
- Identify the hazard.
- Minimize the hazard
- Protect the person
- Isolate the equipment
- Use the right tool for the job
- Audit these principles

6.4.6. Personal protective equipment

Selection, approval, application of Personnel Protective Equipment shall be carried out by CES-Electrical along with the Safety department and Electrical Safety committee in accordance with the guidelines from CHSEE and COE. Appropriate quantity of PPE shall be maintained by Material Management Centre in consultation with CES Electrical and Safety department. This includes provision for storage and maintenance of all electrical PPE. Table1 and Table2 in the annexure shall form the basis for the selection of proper PPE.

6.4.7. Troubleshooting

As outlined in Section 6.4.1, plants shall define the safe work practices for troubleshooting. Working on line / energised circuits shall be avoided to the extent possible. Emphasis shall be given to follow de-energised trouble shooting techniques and other practices that reduce exposure to energized circuits and conductors.

Based on the requirement, Risk assessment shall be conducted and control measures shall be adopted to minimize the risk of injury to people and minimize the disruption of operations.

6.4.8. Dismantle and remove/rearrange work

Dismantling and removal work for electrical installation shall be done only in de-energised condition unless approved. De-energizing ensures reduced exposure to energised live parts.

Control measures shall be identified and implemented in case dismantling and removal is to be done in energised circuits to reduce exposure to energised parts. These shall be covered in Task Based Risk assessment sheets.

6.4.9. Excavations / penetrations

Electrical lines, conduits and cables in the area of work activity shall be identified before performing excavations, concrete floor penetrations and wall penetrations as per RIL JMD procedure for Excavation. All the requirement of the clearances and precautions while carrying out any excavation activity in the complex is covered in the procedure for excavation. The boundary limit for approaching underground lines (energised or de-energised) with mechanized and hand-held tool excavation methods, shall be included as part of job planning.

All excavation 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, the use of up-to-date site drawings showing underground cables, plus the use of electronic tracer systems for locating cables before excavation commences.

6.4.10. Cranes and mobile equipment

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

For movement of crane & other heavy equipment in plant area, care shall be taken for the electrical cables laid on cable trays/pipe rack. Path of cranes and mobile equipment shall be planned in such a way that it does not damage the cable tray. This shall be addressed specifically in rigging plan/RA sheet of the specific job.

6.4.11. Water / steam cleaning

Plants those use water/steam cleaning shall have procedures and practices to prevent hazards associated with moisture ingress to nearby electrical conductors and equipment. Portable electric-powered cleaning equipment should be protected with ground-fault circuit interrupter (GFCI) or residual current device (RCD) protection.

6.4.12. Power distribution operations

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

Only personnel authorized by site management shall manage and execute power system operations activities. Procedures shall be developed and duly approved, for all the power system operation activities, to eliminate hazards where feasible and minimize risk of personal injury and disruption of power to operations.

In addition to the mandatory requirements in this procedure, plant procedures and practices should address the following.

- Routine switching of feeders and equipment
- Control of temporary safety grounds/earths
- Switching sequences to minimize risk of and exposure to arc flash hazards
- System studies updates (e.g., arc flash hazard analysis, protection coordination, and others deemed appropriate by each site)

6.5. Management of change—technology

Design changes and field modifications in electrical systems are reviewed, approved, documented, and communicated to personnel who may be affected by the changes as per the Mark HSEF procedure for Management of Change. This also includes study of impact of safety performance on electrical equipment / system for design change and field modification in non-electrical system.

All Management of Change proposals are routed through Mark Electrical Head which ensures involvement of qualified electrical person in approval of new electrical technology and equipment and in assessing the impact of the changes in electrical safety management.

6.6. Management of electrical hazards

6.6.1. Arc hazards

Arcing faults in electrical equipment are multi-energy events (i.e., involving heat, blast, light, and sound) that generally produce burn and explosive blast hazards. Plant shall have procedures and practices to reduce potential exposure to electric arc hazards.

Plant shall have a process to help ensure an arc hazard analysis of site electrical systems is performed and documented to determine the level of arc energy and the consequences of an arcing fault.

Where the incident energy is greater than the exposure levels in Table 2, plant shall have a process 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
- PPE to be used

In some cases, the level of risk may lead to the conclusion that the work is too hazardous to carry out 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 the

enclosure or tank can result in a burn hazard from 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 devices operating, and hot oil can be expelled in all directions in the immediate area of the unit. The hot oil can ignite when it exits the unit's relief device or ruptured tank and contacts oxygen. Burn injuries or fatalities may result from the burning liquid igniting anything with which it comes in contact. Plants with liquid-filled, insulated electric
power distribution equipment shall have a process (i.e., process hazard analysis or another method deemed appropriate by site management) for assessing the additional potential hazards of liquid-filled, insulated equipment that is part of the electric power distribution system. The analysis should consider the following:

- For 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 so that these devices are operated only under de-energized conditions

6.6.2. Shock hazard

Each plant shall have procedures and practices to assess and manage shock hazards.

Proper design, installation, and maintenance of equipment grounding/earthing and bonding are critical to managing shock hazards. Mandatory requirements for managing the mechanical integrity of grounding/earthing and bonding are described in Section 6.2. Sites shall also have a procedure for installations that require GFCIs or RCDs. At a minimum, all portable tools and all appliances, temporary wiring, and extension cords >50 V to ground that are frequently subjected to rough service and/or are routinely plugged and unplugged must be protected by permanent or portable GFCIs or RCDs. These devices shall have 30 mA sensitivity

On other electrically operated equipment that is connected with a cord (e.g., vending machines and other equipment in kitchens, cafeterias, and break rooms; water fountains; laboratory equipment and portable fans), the use of GFCIs or RCDs should be considered.

All plants should have a program to expand shock-hazard protection. This may include reducing the amount of socket-fed equipment, expanding the use of GFCIs/RCDs during retrofits and design of new facilities, and evaluating the benefits of converting existing socket-fed equipment to hard-wired. This technology and the regulatory requirements for preventing shock hazards are evolving toward protecting all socket-fed equipment.

The following technologies shall be followed to complement the overall shock protection program and to minimize risk of shock.

- Battery – powered tools
- Reduced – voltage equipment
- Double-insulated equipment
- Shrouding and barriers (e.g., to IEC 60529 requirements for IP 20 finger-safe terminals [see Section 2])
- Insulated or voltage-rated protective tools

- Voltage-rated personal protective equipment (e.g., gloves, hats or safety helmets)
- Arc flash protection suits of appropriate rating
- Insulated mats /paint of appropriate voltage rating on the floors
- Insulated, flexible barriers for exposed equipment parts
- Where multiple voltage sources exist in equipment, job specific risk assessment shall be used to manage shock hazard exposure. This shall include, but not limited to, the following supplementary 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 IP 20 (or equivalent) finger-safe terminals to prevent finger contact.
- Barriers
- Insulated, voltage-rated tools to minimize the hazards of accidental contact
- Labeled back feed, temporary feeds, and dual feeds
- Identification of common or borrowed neutral
  (note: The use of common or borrowed neutrals is not recommended.)

Instructions for the resuscitation of persons suffering from electrical shock shall be displayed in a conspicuous place in English/Hindi and Gujarati language in all the Substations.

6.6.3. Static electricity hazards

Where applicable, plants shall have procedures and practices 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. Examples of process operations that may have static electricity hazards include but may not be limited to 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.

6.6.4. Explosion hazards

The primary guidance for managing the explosion hazards in non-hazardous atmospheres from arcing faults in electrical equipment is found under the “Arc hazards” heading in Section 6.6.1. The primary mandatory requirements and advisory guidance for managing ignition sources in potentially explosive atmospheres is covered in Mark HSE Procedure Process Safety Management and associated process safety management procedures.

Plants shall have procedures and practices 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 in accordance with 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 explosiometers.

6.7. Personnel

In order to comply with this procedure, each plant must have qualified (competent) personnel.

6.8. Training and performance

Procedures and practices shall be implemented to help ensure compliance with the following mandatory requirements.

- Personnel shall receive training in and shall be qualified in recognizing and managing the electrical hazards to which they may be exposed in their jobs.
- Personnel shall receive training in and shall be qualified in the use of electrical safety procedures and practices. Training, validation, and refresher training at an appropriate interval to keep the knowledge and skills current and active shall be documented.

Documentation may take the form of written test, record of verbal affirmation, documented job cycle tests, or a combination of these.

6.9. Contractor administration

In the development of conditions for contractors, the contract administrator shall incorporate all applicable mandatory electrical safety requirements in the contract. These mandatory electrical safety requirements shall comply with local and national regulations and consensus procedures and with this procedure.

The contract administrator can seek assistance from the Mark Mumbi electrical champion / site head and consult with the complex electrical safety resource to comply with these mandatory requirements. Consideration should be given to including long-term contractors on the site electrical safety team.

Plant Electrical section head shall verify that contractors have received electrical safety training aligned with site requirements. This should include compliance with government regulations and site conditions.

6.10. Management of change—personnel

Specific electrical jobs shall carry a specific mandatory training/qualification requirement. Only authorized personnel shall perform work involving electrical hazards.

Training and refresher training shall be imparted to ensure that people 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 those listed below

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

6.11. Incident investigation and reporting

RIL HSE Procedure Incident Investigation provides mandatory requirements and advisory guidance for incident investigation. A member of the site electrical team or an electrical resource shall participate in the investigation of electrical incidents and events. If the incident involves injury, the business/Location electrical safety champion shall be consulted to help ensure appropriate resources participate in the investigation.

Unusual events occurring during electrical tasks and during work on electrical equipment provide learning opportunities. These events shall be investigated and the finding shall be communicated to all concerned in Mark

6.12. Emergency planning and response

To ensure preparedness for electrical safety emergencies (e.g., rescue and treatment for electric shock, arc flash burns, blast injuries, or fire involving electrical equipment), the following activities shall be carried out in consultation with Mark HSEF department
Preparations for response to electrical emergencies should include but not be limited to

- Providing CPR training to first responders and personnel in high-risk exposure to electric shock.
- Conducting mock drills of electrical injury emergencies.
- Marking energy isolation points.
- Having emergency equipment, including communications equipment, available and accessible.
- Having procedures established for securing the scene of an electrical incident. The procedure should address the safety of people in the area as well as the preservation of evidence for the investigation.
- Having procedures and training on the appropriate use of personal protective equipment.

6.13. Management of subtle change—facilities

Plant shall have procedures and practices to manage subtle change that affects exposure to electrical hazards. Examples of subtle change include but may not be limited to the following:

- 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, type, or settings of circuit protection devices
- Abandoned electrical equipment, including raceways, cables, and wiring. Site practices should emphasize the removal of abandoned electrical equipment to control "creep" in increased complexity of site electrical

7. Management systems

7.1. Support resources

Site and business electrical safety resources are available to provide assistance with the implementation of this procedure.

- The Centre for HSE Excellence maintains consulting resources to help resolve issues of regulatory and policy requirements.

- Mark Corporate Electrical Safety team is staffed to resolve questions regarding regulatory intent, interpretations and enforcement activities, and to assist sites undergoing regulatory audits.

- Mark Mumbai electrical safety champion to assist plants in electrical safety management activities, where appropriate, and to represent the business/Location on the Corporate Electrical Safety Team.

7.2. Management records

Records shall be retained in compliance with Regulatory requirement and Corporate Records and Information Management Program.

7.4. Procedure renewal process

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

Section 8: Illustrations:

Table 1: Minimum approach boundaries for applying shock protection measures

(Sections 6.4.1 and 8)

Limited Approach Boundary: This Boundary shall be crossed only by qualified persons or by unqualified person escorted and supervised by qualified person.

Restricted Approach Boundary: for circuit part and conductors without IP 20b equivalent design, only qualified person who must use shock protection techniques and equipment shall cross this boundary.

Prohibited Approach Boundary: For circuit parts and conductors without IP 20b equivalent design, this boundary shall be crossed only by qualified persons who must use the same protection procedures and technique of shock protection as and when direct contact is made with a live part.

	Limited approach Boundary			
Line to Line Voltage	Overhead Electrical lines (Not enclosed in conduits or cable trays)	For circuits parts and conductors without IP 20b equivalent design	Restricted Approach Boundary	Prohibited Approach Boundary c d
51 to 300 a	3.1 m / 10’	1.0 m / 3’ 3”	Assume high probability of un intentional contact	
301 to 750 a	3.1 m / 10’	1.0 m / 3’ 3”	0.3 m / 1’	0.03 m / 1”
751 to 13,800	3.1 m / 10’	1.5 m / 4’ 11”	0.7 m / 2’2”	0.18 m / 7”
13,801 to 34,500	3.1 m / 10’	1.8 m / 6’	0.8 m / 2’7”	0.26 m / 10”
34,501 to 115,000	3.3 m / 10’ 8”	2.4 m / 8’	1.05 m / 3’5”	0.81 m / 2’8”
115,001 to 230,000	4.0 m / 13”	4.0 m /13’	1.6 m / 5’3”	1.50 m / 4’11”

a Tasks involving circuits less than 600 V create the most frequent exposure to electric shock.
b EC 60529 IP 20 design, or equivalent, provides guarding, shrouding, or other means to prevent finger contact with bare conductors and circuit parts (see Figure 1).
c Voltage testing is routinely performed within the Prohibited Approach Boundary. See Section 6.4.2 for mandatory requirements to manage risk.
d Troubleshooting and other diagnostic testing are routinely performed within the Prohibited Approach Boundary. See Section 6.4.1 for mandatory requirements to manage risk.

Table 2: Minimum arc incident energy levels for applying arc flash burn protection measures

Arc flash incident energy	Exposure Consequence
1.2 cal/cm^2 (5.0 joule/cm^2)	Energy exposure > 1.2 cal/cm^2 (5.0 joule/cm^2) can result in second and/or third degree burns to bare, unprotected skin
3.0 cal/cm^2 (12.6 joule/cm^2)	Energy exposure > 3.0 cal/cm^2 (12.6 joule/cm^2) can ignite non-flame resistant clothing, which can cause extensive second and/or third degree burns

Table 3: Recommended Arc Flash protection suit for different voltage levels activities

Activity	Recommended Arc Suit Rating
MCC/ PCC/ LV Panel Rack in / Rack out	8 cal / cm^2
6.6KV Breaker rack in / Rack out	8 cal / cm^2
6.6KV Cover opening / Thermography	25 cal / cm^2
11KV Breaker rack in rack out	25 cal / cm^2
11KV Cover opening / Thermography	25 cal / cm^2
33KV Breaker Rack in / Rack out	40 cal / cm^2
33Kv Breaker Rack in / Rack out	40 cal/ cm^2

Figure 1. Illustration of IEC 60529 IP 20 finger-safe terminal design