

Participant Handbook

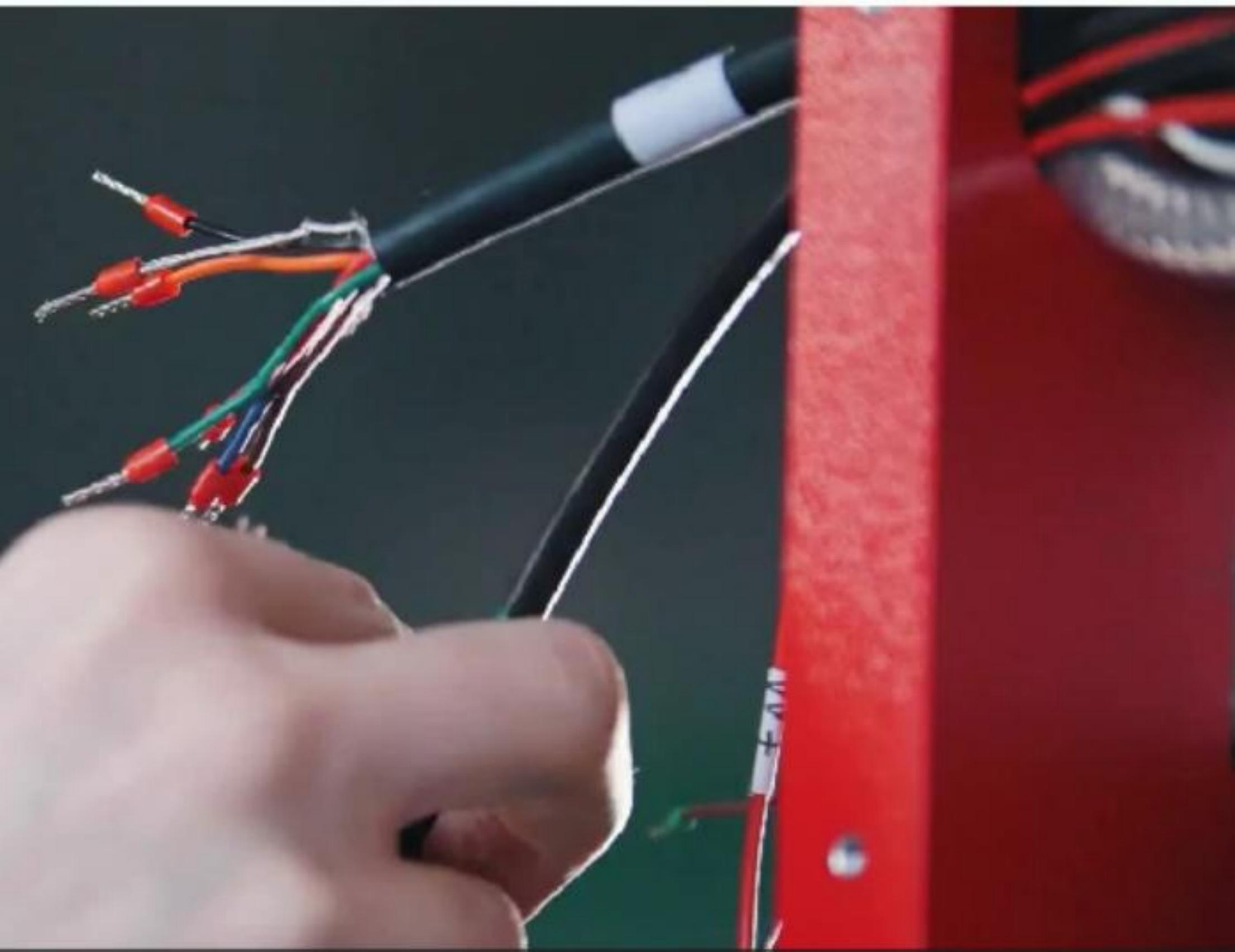


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Module Name:

Electrical Safety for Skilled Workers



Module Name: Electrical Safety for Skilled Workers



Session Overview

This module provides comprehensive guidance on electrical safety practices for skilled workers involved in installation, operation, testing, and maintenance of electrical systems. It focuses on hazard recognition, safe work practices for high-risk electrical panels and equipment, correct selection of protective devices, safe handling of batteries and capacitor banks, and best practices for electrical joints, terminations, and cable glands. The module aims to reduce electrical accidents, fires, and equipment damage by promoting compliance with established safety standards and procedures.



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Session Outcomes

By the end of this module, participants will be able to:

- ❖ Identify electrical hazards associated with HT panels, LT panels, capacitor panels, and battery banks
- ❖ Apply safe work practices while working on high and low voltage electrical systems
- ❖ Select appropriate earth leakage and short-circuit protective devices
- ❖ Follow safety precautions while working with capacitor banks and battery installations
- ❖ Understand battery hazards and apply correct PPE and preventive measures
- ❖ Perform electrical joints and cable terminations safely and correctly
- ❖ Select suitable MCBs, RCCBs/RCBOs, and cable glands for different applications



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Electrical Safety for Skilled Workers

Topics Covered

- 01 Electrical Safety Objectives
- 02 Safe Working on HT Panels
- 03 Safe Working on LT Panels
- 04 Safe Working on Capacitor Panels
- 05 Battery Hazards and Safe Practices
- 06 Selection of Earth Leakage Protective Devices
- 07 Selection of MCBs and Utilization Categories
- 08 Electrical Joints and Jointing Techniques
- 09 Cable Termination – Do's and Don'ts
- 10 Cable Glands – Purpose and Selection



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Electrical Safety Objectives

This module helps participants to:

Recognize hazards and establish safe work practices while working on:

o HT panels

o LT panels

o Capacitor panels

o Battery banks

Understand how to select protective devices such as:

o Earth leakage protective devices

o Short-circuit protective devices

Gain awareness of:

o Various types of electrical joints

o Do's and Don'ts in cable termination

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Safe Working on HT Panels

Understanding High Voltage Systems

Electrical systems operating between 1.1 kV and 33 kV are classified as high voltage systems. These systems present severe risks such as electric shock, arc flash, fire, and fatal injuries if handled improperly.





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Key Safe Work Practices

- ❖ Treat all electrical equipment as live until isolated and proven dead
- ❖ Allow only **qualified and authorized personnel** to work on HT panels
- ❖ Wear appropriate **Personal Protective Equipment (PPE)** such as rubber gloves, arc flash PPE, rubber mats, helmets, and protective clothing
- ❖ Ensure availability of **first aid and emergency equipment** such as Ambu bags, AEDs, and arc flash burn kits
- ❖ Identify and clearly mark isolation points, especially for panels with multiple power sources
- ❖ Define clear roles and responsibilities for all personnel involved
- ❖ Ensure a minimum of **two authorized electrical persons** are present during HT panel operations
- ❖ Follow approved **Lock-Out Tag-Out (LOTO)** procedures
- ❖ Maintain minimum safe clearances:
 - o 2.6 m for systems up to 12 kV
 - o 2.8 m for 33 kV systems
- ❖ Never bypass interlocks such as door, shutter, or breaker interlocks
- ❖ Stop work and seek guidance if unsure about the equipment or situation



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Vital Precautions for HT Panels

- ❖ Switch off the panel remotely whenever possible
- ❖ Do not open panel doors when energized
- ❖ Do not rack circuit breakers in or out with doors open
- ❖ De-energize the panel before opening cable compartments
- ❖ Do not perform live thermography by opening HT panel doors
- ❖ Discharge residual energy from cables and capacitor banks
- ❖ Prove each phase is dead using an approved high-voltage testing device
- ❖ Screen nearby live parts to prevent accidental contact
- ❖ Avoid temporary or non-standard arrangements
- ❖ Use testing instruments, tools, and PPE rated for the operating voltage
- ❖ Replace insulating gloves with IS certification annually
- ❖ Remove temporary earth connections and tools before energization



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Safe Working on LT Panels

Key Safety Practices

- ❖ Avoid live work; if unavoidable, use arc flash protection techniques
- ❖ Prevent accidental contact with nearby live terminals
- ❖ Avoid dropping tools near exposed conductors
- ❖ Use double-insulated tools for live work
- ❖ Never test voltage at main bus bars or incoming feeder links
- ❖ Test only at the output side of protective devices
- ❖ Ensure phase segregation barriers and shrouds are in place
- ❖ Avoid multiple load connections from a single feeder
- ❖ Practice LOTO before commencing work
- ❖ Ensure no back-feed from DG sets, transformers, or tie feeders
- ❖ Use CAT III or CAT IV rated testing instruments
- ❖ Use appropriate PPE and voltage-rated tools



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Safe Working on Capacitor Panels

Stored Energy Hazards

Capacitor banks store electrical energy and can remain charged even after isolation, posing a lethal shock hazard.

Safe Practices

- ❖ Discharge stored energy using grounding hooks, bleed resistors, or automatic grounding devices
- ❖ Always use grounding hooks even if automatic discharge devices are present
- ❖ Ensure grounding hooks are rated for operating voltage and discharge current
- ❖ Allow a minimum five-minute retention time before accessing capacitor banks

APFC Panel Precautions

- ❖ Keep auto/manual switch in manual mode during maintenance
- ❖ Stop individual capacitor feeders before isolation
- ❖ Switch off energy control devices such as MCBs or SFUs
- ❖ Prefer shutting down the entire APFC panel during maintenance



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Capacitor Fire Prevention

- ❖ Capacitor fires often result from internal failures and incorrect protection
- ❖ Select protective devices and cables rated at 1.5 times the capacitor current
- ❖ Use capacitor-duty contactors with damping resistors to control inrush current





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Battery Hazards and Safe Working Practices

Battery Hazards

- ❖ Batteries remain energized due to stored energy
- ❖ Shock, arcing, fire, and chemical hazards are present
- ❖ VRLA batteries, though maintenance-free, require careful handling

Precautions for Battery Safety

- ❖ Avoid wearing conductive objects such as jewellery
- ❖ Restrict unauthorized access
- ❖ Prohibit open flames, sparks, and smoking
- ❖ Keep battery areas free of tools and foreign objects
- ❖ Do not remove pressure relief valves
- ❖ Check voltage to ground (AC and DC) before work
- ❖ Ensure adequate ventilation
- ❖ Maintain clear exit paths and proper lighting
- ❖ Follow manufacturer guidelines for cell orientation



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Required PPE for Battery Work

- ❖ Safety glasses, goggles, or face shields
- ❖ Electrically insulated gloves
- ❖ Protective aprons and safety shoes
- ❖ Water facilities for eye and skin rinsing
- ❖ Class C fire extinguisher
- ❖ Acid neutralizing agents
- ❖ Insulated tools
- ❖ Suitable lifting devices



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Battery Do's and Don'ts

Do's

- ❖ Clean batteries regularly
- ❖ Tighten terminal bolts with specified torque
- ❖ Conduct thermography on terminals
- ❖ Measure and record cell internal resistance
- ❖ Check individual cell voltages
- ❖ Record maintenance parameters as per instructions

Don'ts

- ❖ Do not exceed 2.30 V per cell charging voltage
- ❖ Do not tamper with cell vents
- ❖ Do not over-tighten terminals
- ❖ Do not mix batteries of different makes
- ❖ Do not replace only one or two failed cells
- ❖ Do not boost charge beyond 12 hours
- ❖ Do not charge batteries in sealed cubicles



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Selection of Earth Leakage Protective Devices

RCCB / RCBO Selection Criteria

- ❖ Rated current
- ❖ Rated residual operating current
- ❖ Short-circuit withstand capacity
- ❖ Number of poles

Rated Residual Operating Currents

- ❖ **30 mA:** Personal protection against electrocution; mandatory for sockets and portable equipment
- ❖ **100 mA:** Protection against indirect contact and fire; used for lighting DBs
- ❖ **300 mA:** Fire protection for electrical installations



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Selection of MCBs

Purpose of MCB

- ❖ Protects against overload and short circuit
- ❖ Used up to 100 A; MCCBs used above 100 A

Selection Based on Current

- ❖ Rated current: Typically 1.25 times load current
- ❖ Short-circuit breaking capacity (Icu): Must match panel fault level

Utilization Categories

- ❖ **Type B:** Resistive loads, lighting circuits
- ❖ **Type C:** Inductive loads such as motors and pumps
- ❖ **Type D:** High inrush loads like transformers
- ❖ **Type K:** Motors with very high inrush currents
- ❖ **Type Z:** Sensitive electronic and semiconductor devices



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Electrical Joints

Importance of Proper Joints

Improper joints can generate heat, melt insulation, cause short circuits, and lead to fires.

Steps in Making a Joint

- ❖ Remove insulation
- ❖ Clean the conductor
- ❖ Twist and overlap conductors
- ❖ Splice and solder
- ❖ Insulate properly

Common Types of Joints

- ❖ Pig tail / Rat tail / Straight joint
- ❖ Western Union joint
- ❖ Married joint
- ❖ Tee joint



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Cable Termination

Proper Termination Practices

- ❖ Remove insulation in a tapered manner
- ❖ Bend conductor into a loop
- ❖ Bend in the same direction as tightening screw
- ❖ Ensure secure tightening to prevent overheating

Do's and Don'ts of Cable Termination

- ❖ Do use correct lugs for multistrand cables
- ❖ Do use correct lug and die size
- ❖ Do not use oversized or undersized connectors
- ❖ Do not enlarge lug holes



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Cable Glands

Purpose of Cable Glands

- ❖ Provide mechanical holding force
- ❖ Ensure earth continuity
- ❖ Offer environmental protection

Selection Criteria

- ❖ Armoured or unarmoured cable
- ❖ Aluminium or copper conductor
- ❖ Type of insulation and number of cores
- ❖ Correct gland size as per cable diameter
- ❖ Thread specification and entry type
- ❖ Corrosion resistance and IP rating
- ❖ Single or double compression requirement
- ❖ Need for earth tag or grounding locknut



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Summary

Electrical safety for skilled workers requires strict adherence to safe work practices, correct use of PPE, proper selection of protective devices, and sound installation techniques. By understanding hazards, following procedures, and applying best practices in jointing, termination, and equipment handling, workers can significantly reduce the risk of electrical accidents, fires, and equipment failures.



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Reflect

1. Why must HT systems always be treated as live until proven dead?
2. How do correct protective devices prevent electrical fires and electrocution?
3. Why is it unsafe to rely only on automatic discharge devices for capacitor banks?
4. How can improper battery handling lead to fire incidents?



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Knowledge Check

1. What minimum clearance is required for working near a 33 kV system?
2. Why are 30 mA RCCBs mandatory for socket outlets?
3. What hazards can arise from improper electrical joints?
4. Why should capacitor feeders be rated at 1.5 times the capacitor current?