

**CALACT SPRING 2023 CONFERENCE**

# **Writing a High-Voltage Safety Program**

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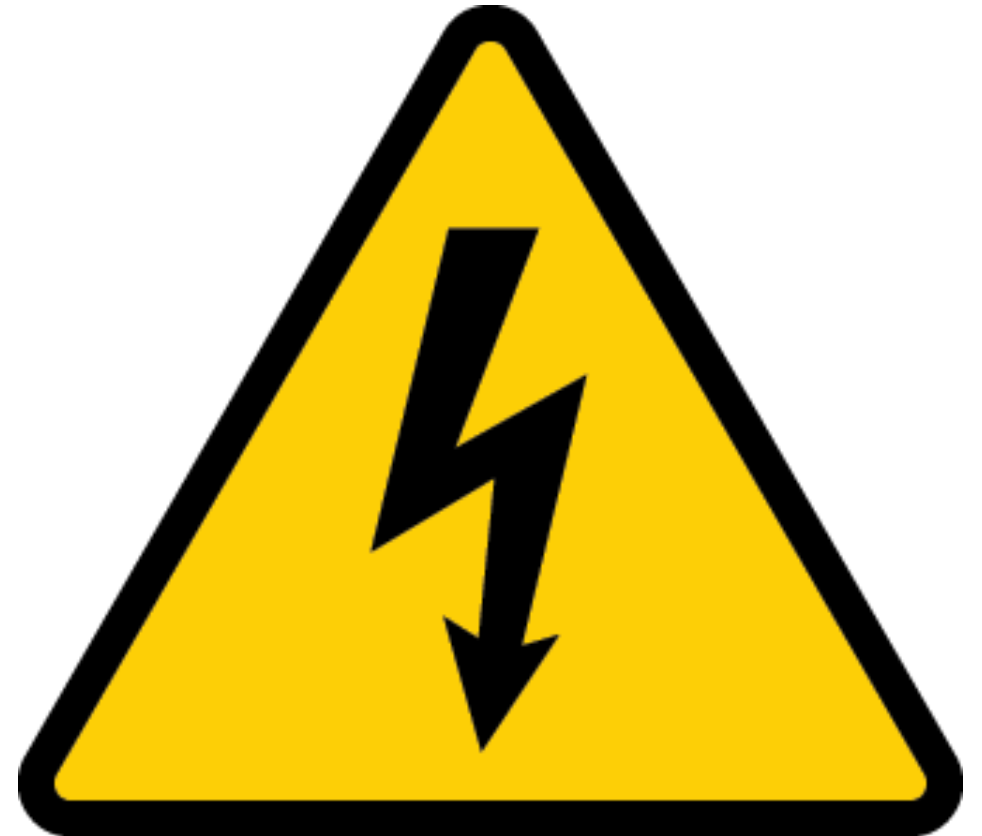
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# IMPORTANCE OF AN HV SAFETY PROGRAM FOR ZEBS

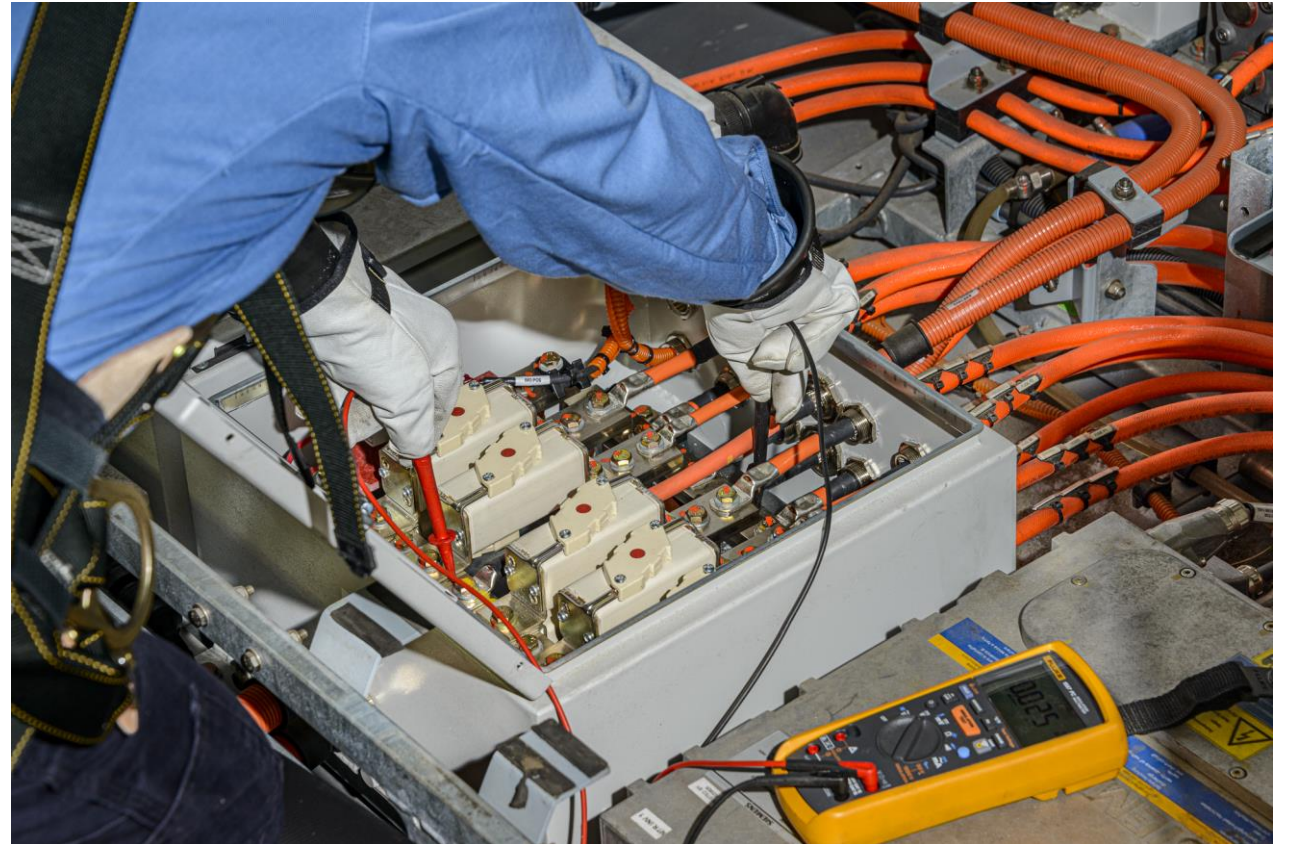
As the demand for zero-emission buses (ZEBs) continues to rise, it is important to prioritize the safety of employees working with High-Voltage (HV) electrical systems. In this presentation, we will:

- Explore key components of a successful HV safety program
- Highlight potential risks associated with ZEBs
- Discuss the benefits of an HV safety program, including improved morale and less downtime from accidents
- Provide action items for organizations to develop and maintain a strong safety culture



# UNDERSTANDING HIGH VOLTAGE

- What is high voltage?
- Types of high-voltage systems
- Risks associated with HV systems
- Voltage levels and their effects on the human body



# WHAT IS HIGH VOLTAGE?

For zero-emission buses (ZEBs), high voltage typically applies to the energy storage system, which operates at voltages above 50 volts DC.



# HIGH-VOLTAGE SYSTEMS

## Types of High-Voltage Systems

- Traction batteries (Energy Storage System)
- Charging system
- Electric drive system
- Fuel cell

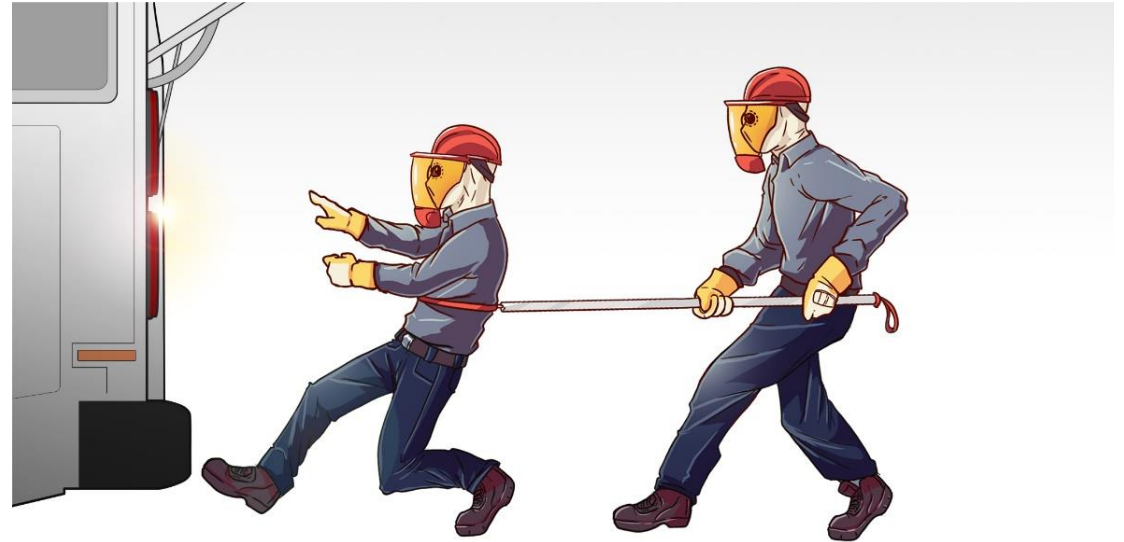
Major system component	Voltage
High-Voltage Battery Packs	74 kwh (each) and 660 VDC (nominal)
High-Voltage Battery Thermal Management System	380 VAC and 750 VDC
Traction Motor and Traction Motor Inverter	750 VDC
High-Voltage Junction Box	750 VDC
DC-to-DC Converter	750 VDC
Air Compressor and Air Compressor Inverter	350 VAC and 750 VDC
HVAC and HVAC Inverter	380 VAC and 750 VDC
Coolant Heater	750 VDC
Power Steering Pump	24 VDC

**Example from a battery electric bus**

# ELECTRICAL HAZARDS

## Risks Associated with HV Systems

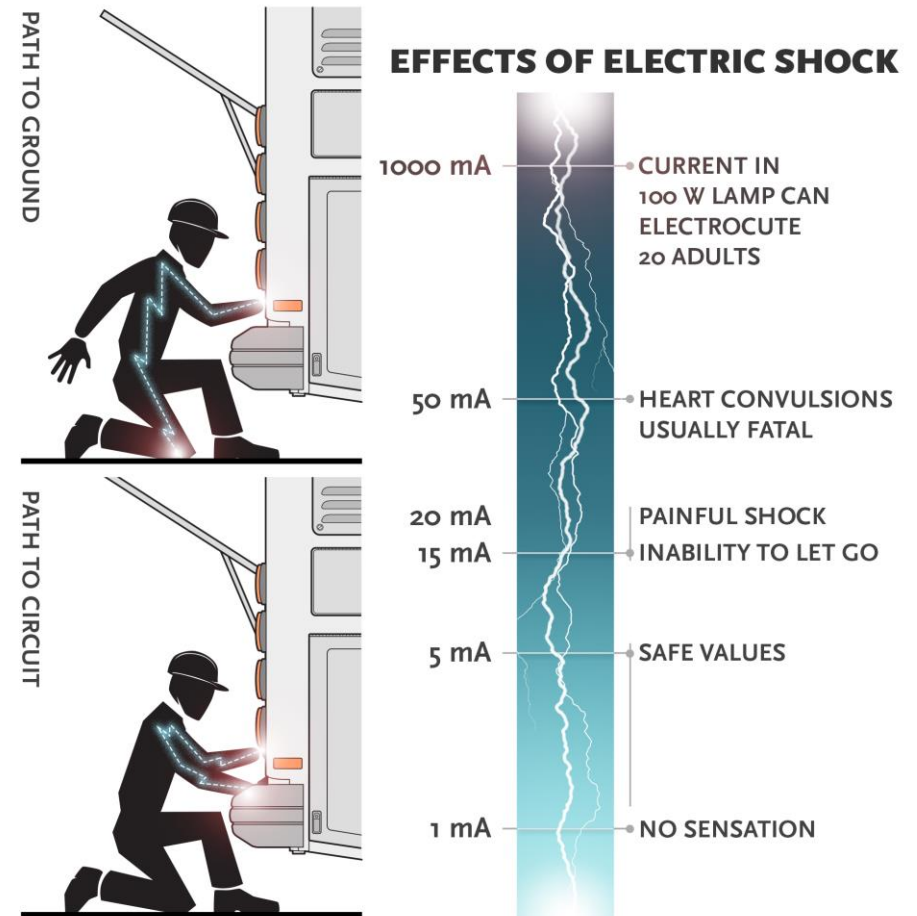
- Electric Shock
- Arc Flash
- Thermal Burns
- Fires



# CURRENT

## Understanding Voltage Levels and Their Effects on the Human Body

The effects of electric current on the human body depend on the current level, exposure duration, and the path the current takes through the body.



# Q & A



# COMPONENTS OF AN HV SAFETY PROGRAM

- Risk Assessment and Hazard Identification
- Emergency Response Plan (ERP)
- Personal Protective Equipment (PPE)
- Lockout/Tagout (LOTO) Procedures
- Training and Education Programs
- Incident Reporting and Investigation

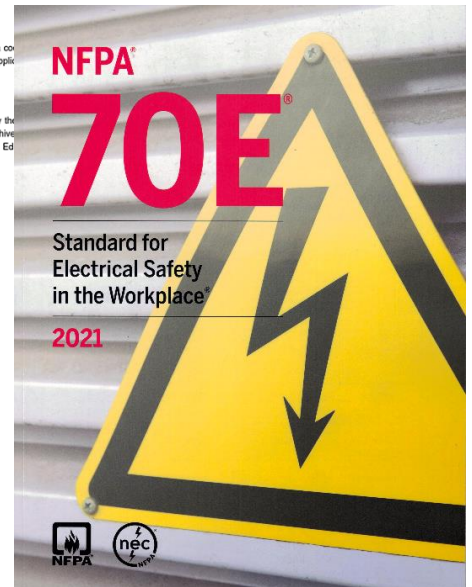


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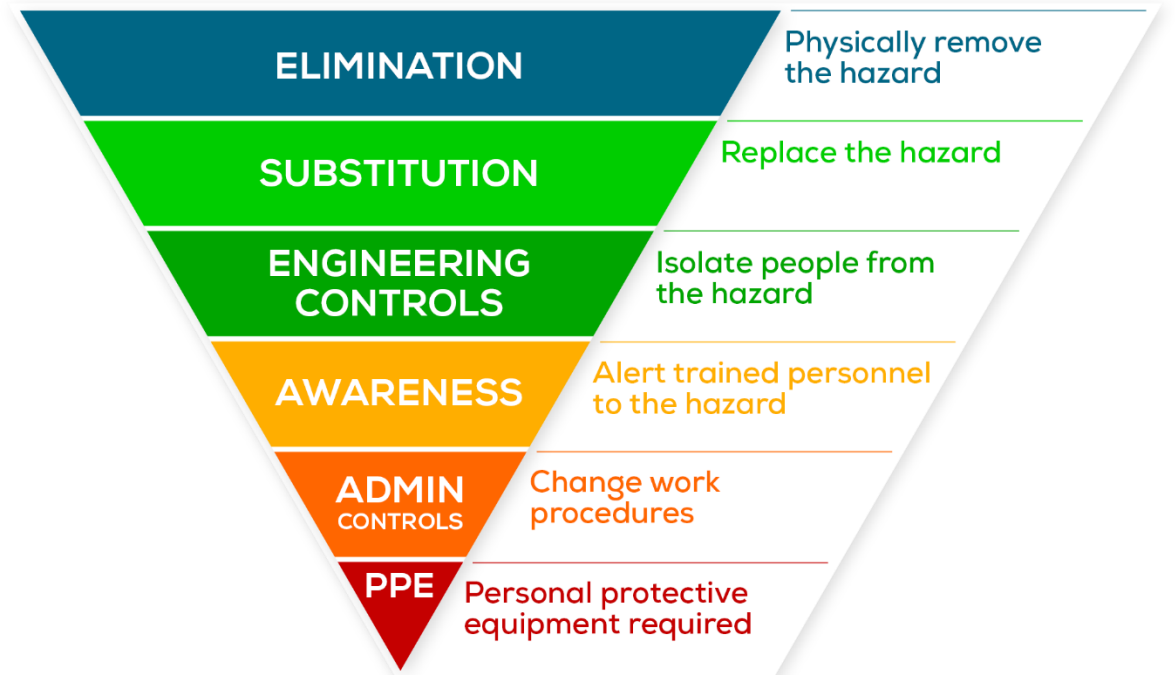
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# RISK ASSESSMENT & HAZARD IDENTIFICATION

- Conduct a comprehensive risk assessment to identify potential electrical hazards
- Evaluate the likelihood and severity of injury resulting from identified hazards
- Establish risk-control measures



# EMERGENCY RESPONSE PLAN (ERP)

- Develop a written emergency response plan
- Provide guidelines for responding to emergencies
- Conduct regular drills and exercises



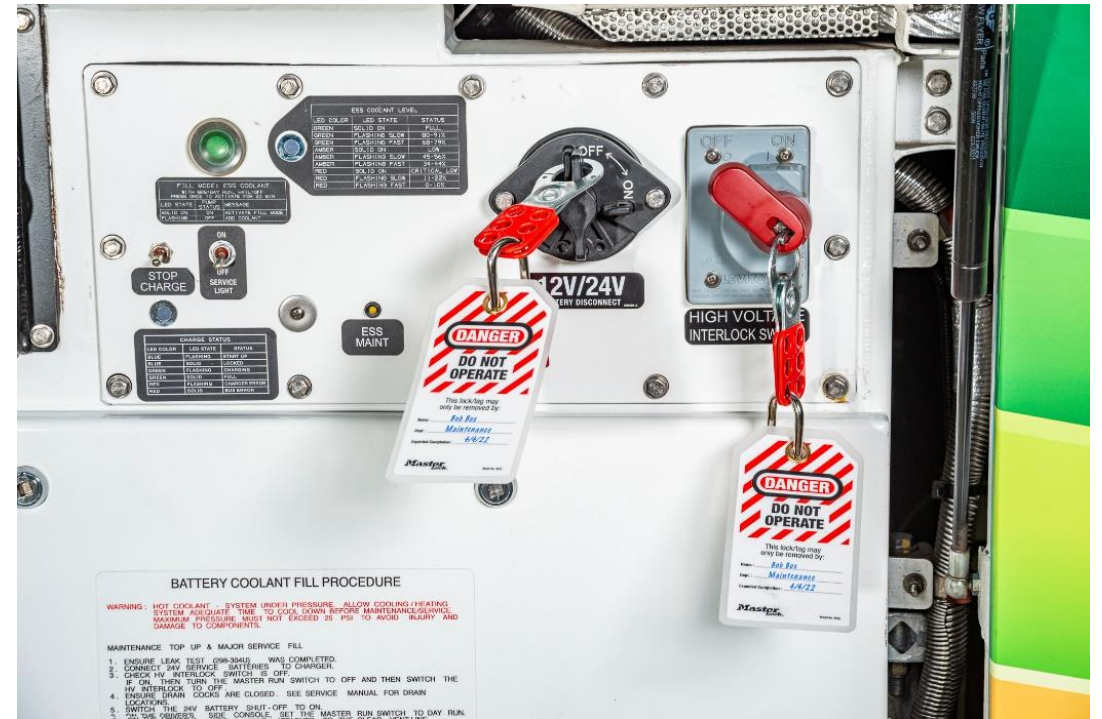
# HIGH-VOLTAGE PERSONAL PROTECTIVE EQUIPMENT (HVPPE)

- Establish requirements for the selection, use, and maintenance of PPE
- Provide training on the proper use, inspection, and maintenance of PPE
- Ensure that PPE is readily available, in good condition, and used correctly by employees working with high-voltage systems



# LOCKOUT/TAGOUT (LOTO) PROCEDURES

- Develop and implement Lockout/Tagout (LOTO) procedures
- Train employees on the proper application and removal of LOTO devices
- Conduct periodic inspections to ensure compliance with LOTO procedures and identify areas for improvement



# TRAINING AND EDUCATION

- Implement comprehensive high-voltage training programs
- Provide ongoing refresher courses to keep knowledge and skills sharp
- Verify that qualified personnel possess the necessary skills, training, and experience



# INCIDENT REPORTING & INVESTIGATION

- Establish incident and near-miss reporting system
- Investigate to determine the root cause and preventive measures
- Share findings with employees to enhance the HV safety program



# Q & A



# IMPLEMENTATION

## Implementing a High-Voltage Safety Program for Zero-Emission Buses

- Identify risks associated with zero-emission vehicles
- Develop policies for handling high-voltage systems
- Create training programs for workers
- Integrate safety procedures into maintenance and repair operations
- Conduct regular safety audits and reviews



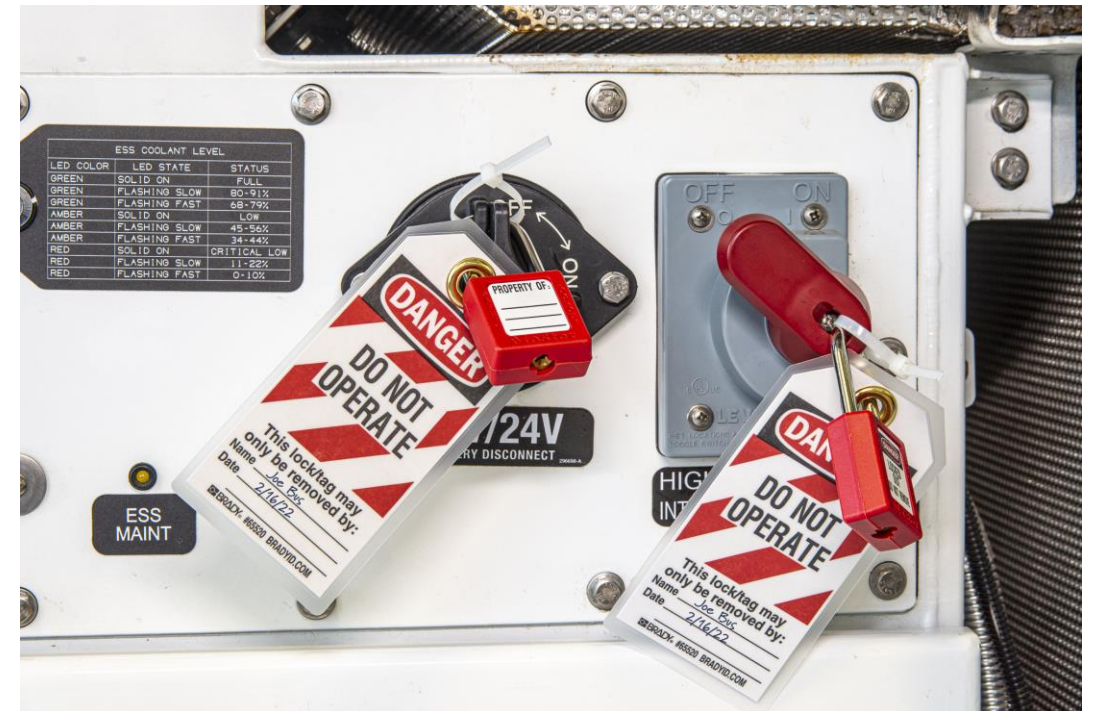
# IDENTIFY RISKS

- Assess the unique risks related to high-voltage ZEBs
- Evaluate the risks associated with components:
  - Traction batteries
  - Charging systems
  - Electric drive systems
  - High-voltage cabling
- Conduct a thorough risk assessment by considering the type of ZEB, work environment, and level of expertise



# DEVELOP POLICIES & PROCEDURES

- Establish clear policies and procedures:
  - Lockout/Tagout (LOTO)
  - Minimum approach distances
- Develop guidelines for PPE use, inspection, and maintenance
- Outline emergency response procedures, including first aid and rescue operations
- Create an incident and near-miss reporting system



# TRAINING DEVELOPMENT

- Educate workers on high-voltage system risks and safety precautions
- Train workers to use PPE properly, follow LOTO procedures, and respect minimum approach distances
- Train workers on emergency response procedures
- Provide regular refresher training to keep knowledge and skills sharp



# INTEGRATION

## Integrate Safety Procedures into Routine Maintenance and Repair

- Incorporate HV safety procedures into standard operating procedures
- Ensure workers follow established LOTO procedures
- Encourage workers to use checklists and other tools to create and maintain a safe work environment



# CONDUCT SAFETY AUDITS & REVIEWS

- Schedule periodic safety audits to verify compliance with high-voltage safety policies and procedures
- Identify areas of improvement and update safety and training programs as needed
- Conduct regular safety meetings to discuss incidents, near-misses, and lessons learned

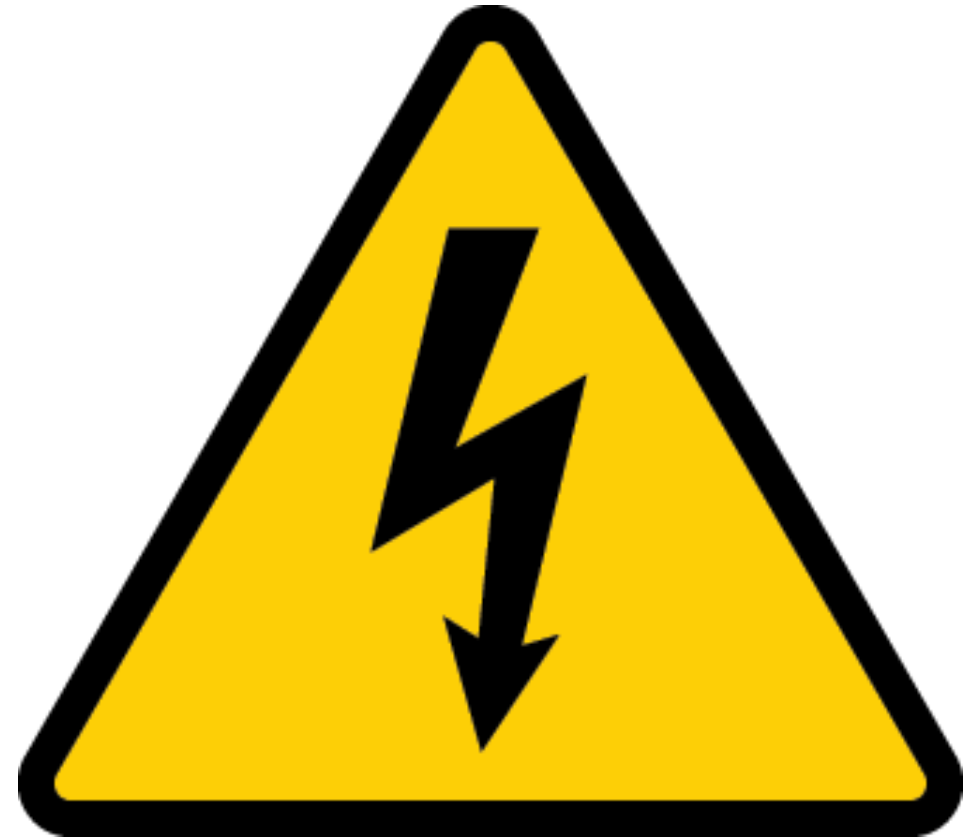


# Q & A



# RECAP

- High-voltage safety programs are crucial for reducing risks and ensuring the safety of employees working with ZEBs
- Components of a successful program include risk assessment, emergency response plans, PPE, training and education, and incident reporting
- Regularly reviewing and updating safety procedures, training programs, and equipment helps maintain a strong safety culture



# IMPORTANCE OF HV SAFETY PROGRAM

- ZEBs operate with high-voltage electrical systems, posing potential risks such as electric shock, burns, and fires
- Proper training and safety measures are essential to protect employees, reduce incidents, and ensure smooth operation and maintenance of ZEBs
- Implementing a high-voltage safety program enhances overall safety



# CALL TO ACTION

- Review high-voltage safety procedures and identify areas for improvement
- Develop a comprehensive high-voltage safety program tailored to the specific needs and risks associated with your ZEB operations
- Train employees on safety procedures
- Encourage employees to report incidents and near-misses
- Regularly review and update safety measures
- Continuously monitor the effectiveness of your high-voltage safety program
- Make adjustments as needed to maintain a safe work environment

# Q & A



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