ZEB Bus Safety
LA Metro Approach

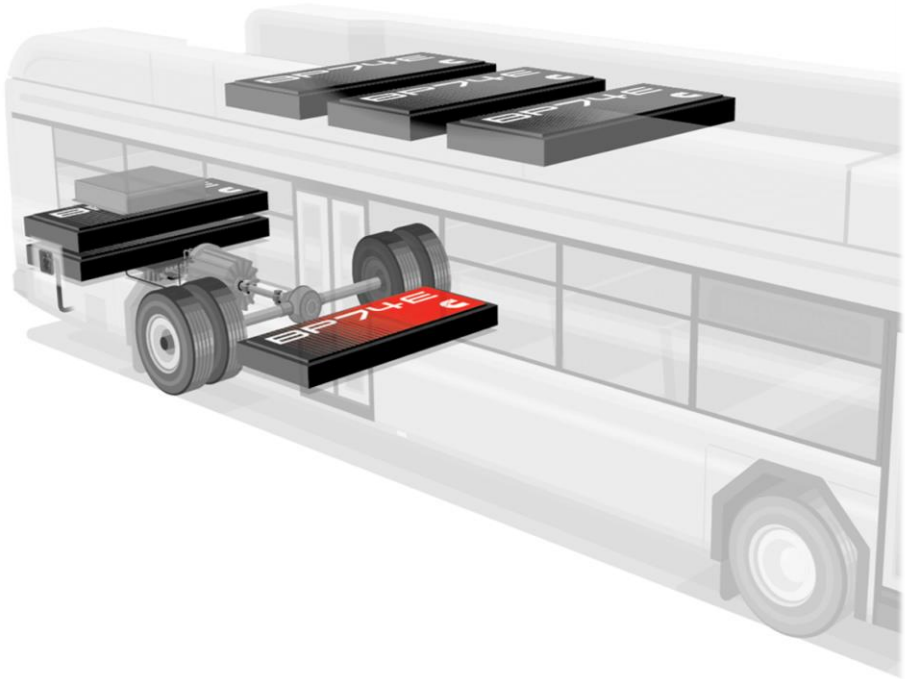
Nov 2, 2022

Agenda

- Zero Emission Buses
- Maintenance
- Regulations
- Technician Safety
- Workforce Development

What is a Zero Emission Bus

Battery Electric Bus



- Uses an electric motor and a battery.
- Charge through electrical grid and regeneration.
- 600V Battery Voltage
- 300kWh Battery Capacity
- Regen Voltage 300V

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Fuel Cell Electric Bus

- Uses both a hydrogen fuel cell and batteries to optimize performance.
- The fuel cell supplies the energy required for the vehicle operation, while the batteries serves to provide peak power to the motors to meet rapid acceleration and gradients.
- 400V Battery Voltage
- 100kWh Battery Capacity

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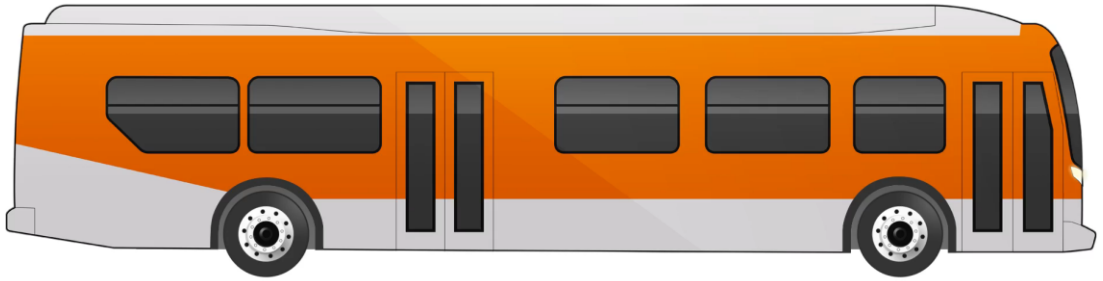
High Voltage (HV)

- NFPA70e - 50V or more
- The main dangers when repairing electric buses is electric shock, arc flash/blast.
- These are serious safety risks.



Maintenance

Conventional Maintenance

Does not require High Voltage Qualifications

- General PM
- Brakes
- Suspension
- Steering
- Interior
- Minor Bodywork

HV Maintenance

Requires High Voltage Qualifications

- HV Component PMI
- Drive Motors
- Electric Air Compressor
- Failure Repairs
- System Diagnosis
- HV PPE can be doffed once electrically safe work condition is established.

Regulations

Regulatory Requirements

- Federal OSHA/State OSHA
  - Indicates to Follow Industry Standards
  - Training – initial/refresher
  - Lockout/Tagout
  - Zero Voltage Verification
- National Fire Protection Association 70E
  - Safety Plan
  - Personnel Qualifications
  - Training -initial/refresher
  - Procedure Requirements

Regulatory Requirements

- Collaborate Internal Safety Department
  - Representative or Department
  - Provide Expertise
- Collaborate Equipment Manufacturer
  - Bus or System
  - Clarification on Regulations

"Failure to observe all high voltage electrical safety precautions may result in personal injury and/or death".

"When performing maintenance on our systems, it is the responsibility of employers and their employees to comply with all applicable laws, including health and safety regulations, within their jurisdictions.

Regulatory Requirements Agency Approach

Some procedures are a must:

- Training
- Qualified Personnel
- Personal Protective Equipment
- Lock-out/Tag-out
- Zero Voltage Verification

Regulatory Requirements Agency Approach

Other processes may vary depending on:

- Size of fleet
  - Dedicated bays for maintenance
- Size of staff
  - Smaller groups may require less oversight
  - Service agreements

Regulatory Requirements Compliance

- Electrical Plan
- Buddy System
- Work Briefing
- Checklist
- PPE Inspections
- Hot Work Permit
- Field Work Audit

Metro

Bus Maintenance Instruction
High Voltage Personal Protective Equipment Procedures

Issued by:	Bus Maintenance	M-SOP 2020-001
Subject:	High Voltage Personal Protective Equipment (PPE) Procedures	Date: Rev.a October 01, 2019 Rev.b July 15, 2020 Rev.c August 31, 2021

Purpose:

Qualified Personnel working on High Voltage (HV) systems or components performing Zero Voltage Verification or Hot Work must wear Arc Flash Personal Protective Equipment (PPE) as protection against electrical hazards. Electrical hazards, such as arc flashes, can cause serious

Training

Training

- General Awareness Training – for all maintenance employees that work around electric buses.
- Qualification Training – for personnel designated to work on HV equipment including regulatory and systems training.

General HV Electrical Safety Awareness Training

- Informs Maintenance Personnel of the general rules to follow around HV equipment.
- Outlines:
  - Personal Protective Equipment
  - Work Procedures
  - Training Requirements

Protective Equipment Training – Qualified Worker

- This class must cover High Voltage:
  - PPE types
  - Inspection, Maintenance, and Certification Intervals
  - Employee and Management Responsibilities
- Technicians need reliable protective equipment to safely carry out HV work electric buses.
- The wrong type of PPE or its improper use can cause significant danger to the user.

Protective Equipment

- Electrical Insulating Gloves
- Balaclava
- Arc Flash Face shield
- AR/FR clothing
- Rated Footwear
- Insulated Hand Tools
- Barrier
- Properly Rated Measurement Equipment

Lock-Out/Tag-Out Training– Qualified Worker

- This class must cover High Voltage:
  - System Deenergizing/Energizing
  - Lockout/Tagout (LOTO) Procedures
  - PPE Requirements
- Disables the bus from energizing when undergoing repairs or maintenance.
- Shift change procedure.

Zero Voltage Verification Training – Qualified Worker

- This class must cover High Voltage:
  - Zero Voltage Verification Procedure (ZVV)
  - Emergency Contingencies
- ZVV is performed to ensure an electrically safe work environment.
- Verifying zero voltage involves crossing the protection boundaries of exposed electrical parts.

Contact Release Training– Qualified Worker

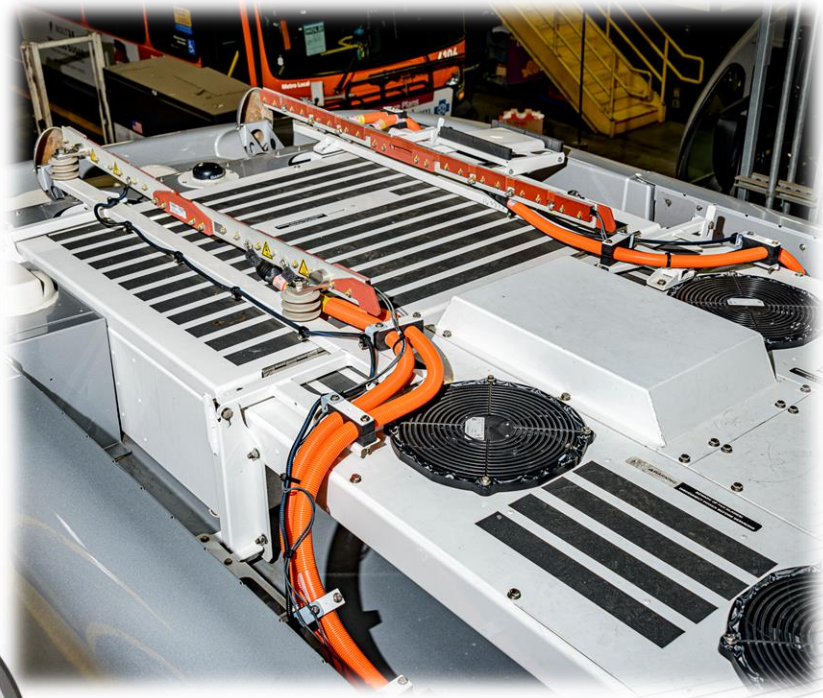
- This class must cover High Voltage:
  - Electrical Shock Symptoms
  - Contact Release Steps
  - Emergency Procedures and First Aid
- Contact Release is the action taken to forcibly dislodge a person who is unable to release themselves from contact with electrical current.

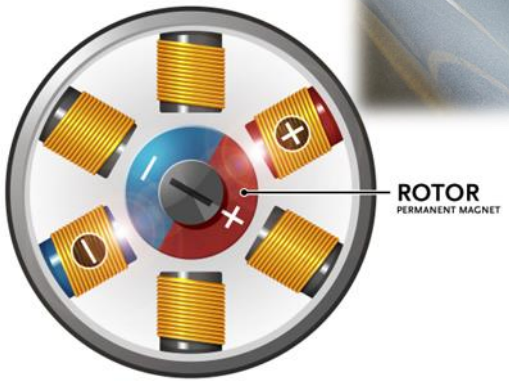
Hot Work

- Work performed when the system is not deenergized.
  - Inspecting battery packs
  - HV Diagnosis

Bus Systems Training

- Training in the operation, maintenance and repair of HV systems and components on the bus, such as:
  - Motors
  - Inverters
  - Batteries
  - HV Cooling Systems
  - Overhead Charge Rails





Qualified Worker

After complying with regulations and providing employees with training, you have a qualified worker.

“one who has demonstrated skills and knowledge related to the operation of bus electrical equipment and has received safety training to identify the hazards and reduce the associated risk” when performing maintenance on high voltage systems on Zero Emission Buses.

Documentation

Program Documents

- Electrical Plan
- Training Reports
- Standardized Operating Procedures
- Briefing Form
- Checklist
- Audit Inspection

Summary

ZEB's are Here	**Different Types**
Maintenance	**Conventional and High Voltage**
Regulations	**Are evolving – no specific vehicle regulation**
Technician Safety	**Training required for all employees** **Qualified Personnel must receive additional training**

Questions