



**ALTERNATIVE
FUEL VEHICLES**
SAFETY TRAINING PROGRAM

ELECTRIC VEHICLE SAFETY FOR FIRST RESPONDERS

BASIC ELECTRICAL CONCEPTS AND HAZARDS

FIRE SERVICE EDITION

Program Goal

Prepare first responders to operate safely at incidents involving:

- Hybrid Electric Vehicles (HEVs)
- Plug-In Hybrid Electric Vehicles (PHEVs)
- Electric Vehicles (EVs)



Hybrid and Electric Vehicle Safety Training - Program Modules



Introduction



**Basic Electrical
Concepts &
Hazards**



**P/HEV & EV
Systems &
Safety Features**



**Charging
Stations**



**Initial Response:
Identify, Immobilize
& Disable**



**Emergency
Operations**

Basic Electrical Concepts & Hazards

OBJECTIVES

Following instruction, the student shall be able to:

- Describe basic electrical concepts that pertain to P/HEVs and EVs
- Define basic electrical terms
- Understand the concepts of electrical circuits and the flow of electricity



Basic Electrical Concepts & Hazards

OBJECTIVES

Following instruction, the student shall be able to:

- Explain the difference between electrical systems in structures and those in P/HEVs and EVs
- Describe how electricity affects the body and how to protect against electric shock



Basic Electrical Terms

Basic Electrical Concepts & Hazards

Voltage: Electrical Potential of a Circuit



Comparison

- Water pressure or PSI in a hose

Measured In:

- Volts

Basic Electrical Terms

Basic Electrical Concepts & Hazards

Current: Quantity of Electrons Flowing

Comparison

- Flow of water or gallons per minute (GPM)

Measured In:

- Amperes or Amps



Basic Electrical Terms

Basic Electrical Concepts & Hazards

Resistance: A Material's Opposition to the Flow of Electrons



Comparison

- Friction loss in hoselines or appliances

Measured In:

- Ohms

Electricity Types

Basic Electrical Concepts & Hazards

Types of Electricity Found in P/HEVs and EVs

DC

- Found in all P/HEVs and EVs
- All use batteries for Electrical storage

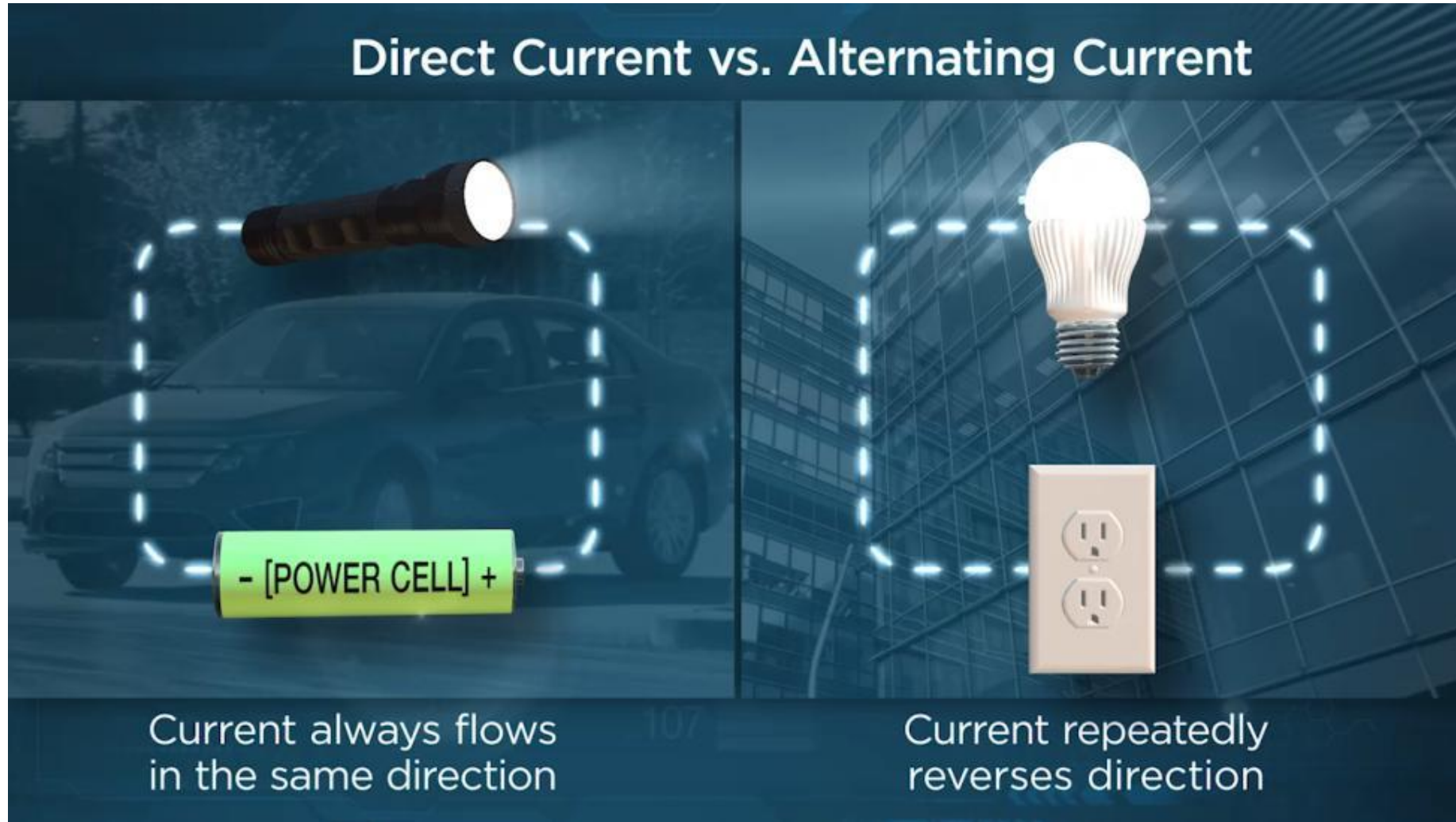
AC

- Found in most P/HEVs and EVs
- These models use AC motors
- DC converted to AC



Electricity Types

Basic Electrical Concepts & Hazards



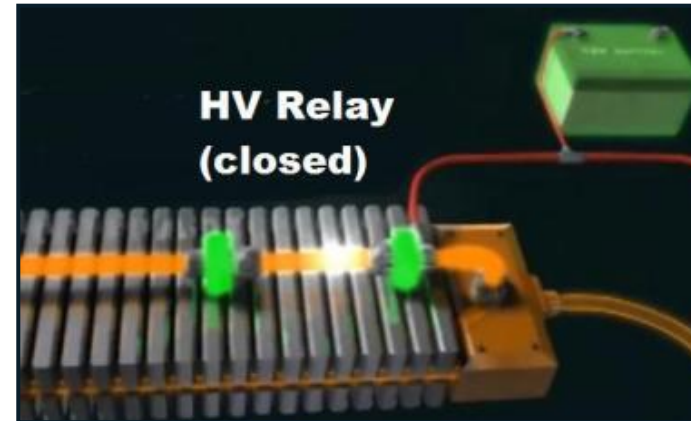
Electrical Circuits

Basic Electrical Concepts & Hazards

Understanding Electrical Circuits



Switch creates a break in circuit when off



Turning switch on completed the circuit; electricity flows

There must be a completed path for electricity to flow (AC or DC)

Electrical Circuits

Basic Electrical Concepts & Hazards



Entrance Wound





- Injury occurs when the body completes the circuit
- Don't become part of the circuit



Exit Wound

Electrical Circuits

Basic Electrical Concepts & Hazards

<h3>Building</h3> 	<ul style="list-style-type: none">• Grounded to Earth		<h3>Shock</h3> <ul style="list-style-type: none">• Only one side of circuit needs to be touched• Earth ground completes path
<h3>Vehicle</h3> 	<ul style="list-style-type: none">• Not grounded to earth• Isolated from chassis		<h3>Shock</h3> <ul style="list-style-type: none">• Both sides of circuit must be touched• Ground not part of circuit

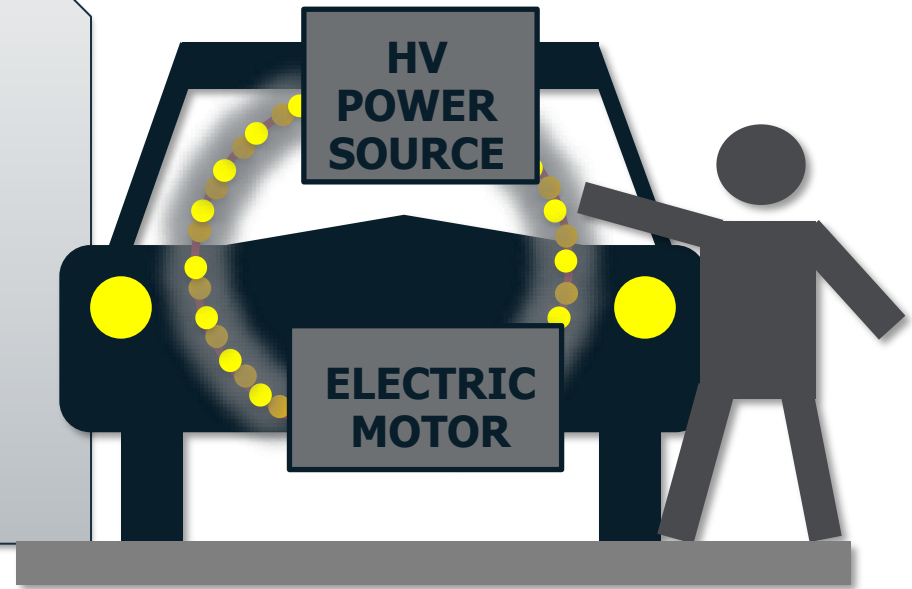
Safeties shut down HV system if it loses isolation and comes in contact with vehicle chassis.

Electrical Circuits

Basic Electrical Concepts & Hazards

Vehicle Electrical Circuits

- Body must become part of circuit to receive a shock
- Unlike a structure, the earth is not part of the circuit design
- Electricity follows the path of least resistance



Creating a path to ground by touching or spraying water on a vehicle will not, by itself, complete the circuit

VIDEO

ADVANCE SLIDE TO PLAY

Electrical Circuits



Effects on the Body

Basic Electrical Concepts & Hazards



- Sufficient voltage required to overcome skin's resistance
- Extent of damage usually based on amperage
- P/HEV and EV HV circuits have enough voltage and amperage to be dangerous

Effects on the Body

Basic Electrical Concepts & Hazards



At 40 psi, a hose stream flowing 10 gpm would not hurt if directed at you







At 3,000 psi, a pressure washer flowing 2.5 gpm can cause harm

Higher pressure (voltage/psi) allows current (amperage/gpm) to overcome your skin's resistance

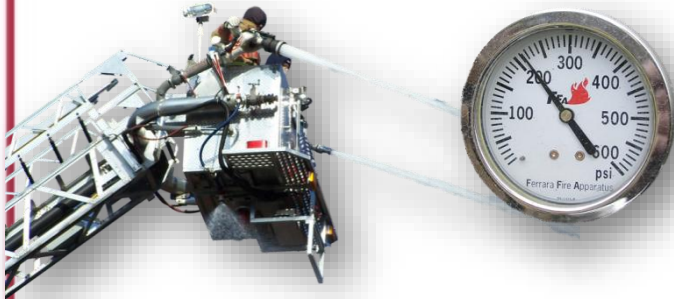
Effects on the Body

Basic Electrical Concepts & Hazards

		Voltage	Amperage	Contact
9 Volt Battery		9V	.5 amps	<ul style="list-style-type: none"> • Dry Skin: No detection, insufficient voltage • Wet Tongue – Tingling sensation
12 Volt Vehicle Battery		12V	400+ amps	<ul style="list-style-type: none"> • Dry Skin: No detection, insufficient voltage • Sufficient amperage to kill
Stun Gun		25,000V+	.0001-.0004 amps	<ul style="list-style-type: none"> • Muscle contractions – impairment • Amperage below lethal levels
High Voltage Battery		100-800V+	100+ amps	<ul style="list-style-type: none"> • Voltage sufficient to overcome skin resistance • Amperage sufficient to cause death

Module Review

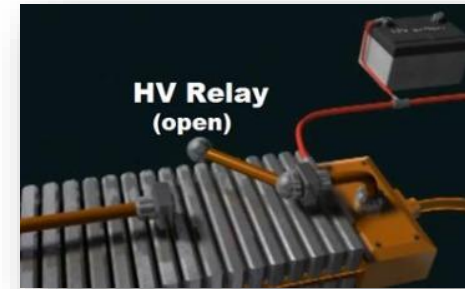
Basic Electrical Concepts & Hazards



What is the difference between voltage & current?



What are the two types of electricity used in P/HEVs & EVs?



For current to flow, what must be completed?



What is a major difference between AC electrical systems in cars and AC electrical systems in structures?



The risk of shock occurs when the body becomes part of the ____?