



**ENERGY STORAGE  
SYSTEMS**  
SAFETY TRAINING PROGRAM

# **PHOTOVOLTAIC & BATTERY ENERGY STORAGE SYSTEMS SAFETY TRAINING**

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## **BASIC ELECTRICAL THEORY**

# Program Goal

## **Prepare first responders to:**

- Properly identify the presence of PV and battery energy storage systems
- Understand the different types of battery chemistries used and their related hazards
- Identify and implement proper response procedures based on the type of incident

# Program Modules

BESS Safety Training for First Responders



**Introduction**



**Basic Electrical Theory**



**PV (Solar)**



**Battery Energy Storage Systems (BESS)**



**Pre-Incident Planning**



**Emergency Response Operations**

# Basic Electrical Theory

## OBJECTIVES

**Following instruction, the student shall be able to:**

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 Define the following electrical terms:

- ✓ Voltage
- ✓ Current
- ✓ Resistance
- ✓ Power
- ✓ Energy



# Basic Electrical Theory

## OBJECTIVES

**Following instruction, the student shall be able to:**

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- ☒ Define and describe the difference between alternating current and direct current
- ☒ Understand the concepts of electrical circuits and the flow of electricity
- ☒ Describe how electricity affects the body and how to protect against electric shock

# Basic Electrical Terms

## Basic Electrical Theory

### **Voltage:** Electrical Potential of a Circuit



#### Comparison

- Water pressure or PSI in a hose



#### Measured In:

- Volts

# Basic Electrical Terms

## Basic Electrical Theory

### **Current:** Quantity of Electrons Flowing

#### **Comparison**

- Flow of water or gallons per minute (GPM)

#### **Measured In:**

- Amperes or Amps



# Basic Electrical Terms

## Basic Electrical Theory

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

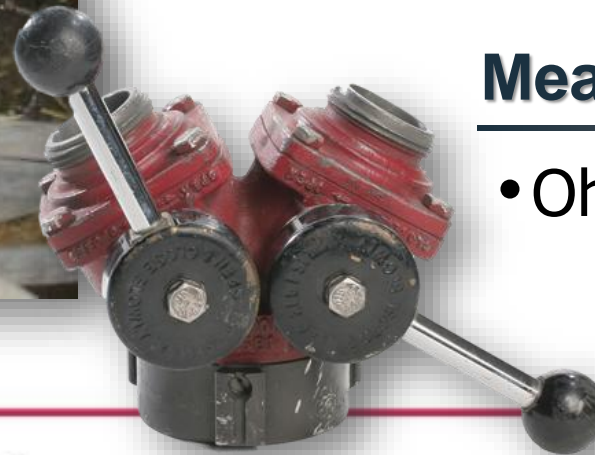


#### Comparison

- Friction loss in hoselines or appliances

#### Measured In:

- Ohms





# VIDEO

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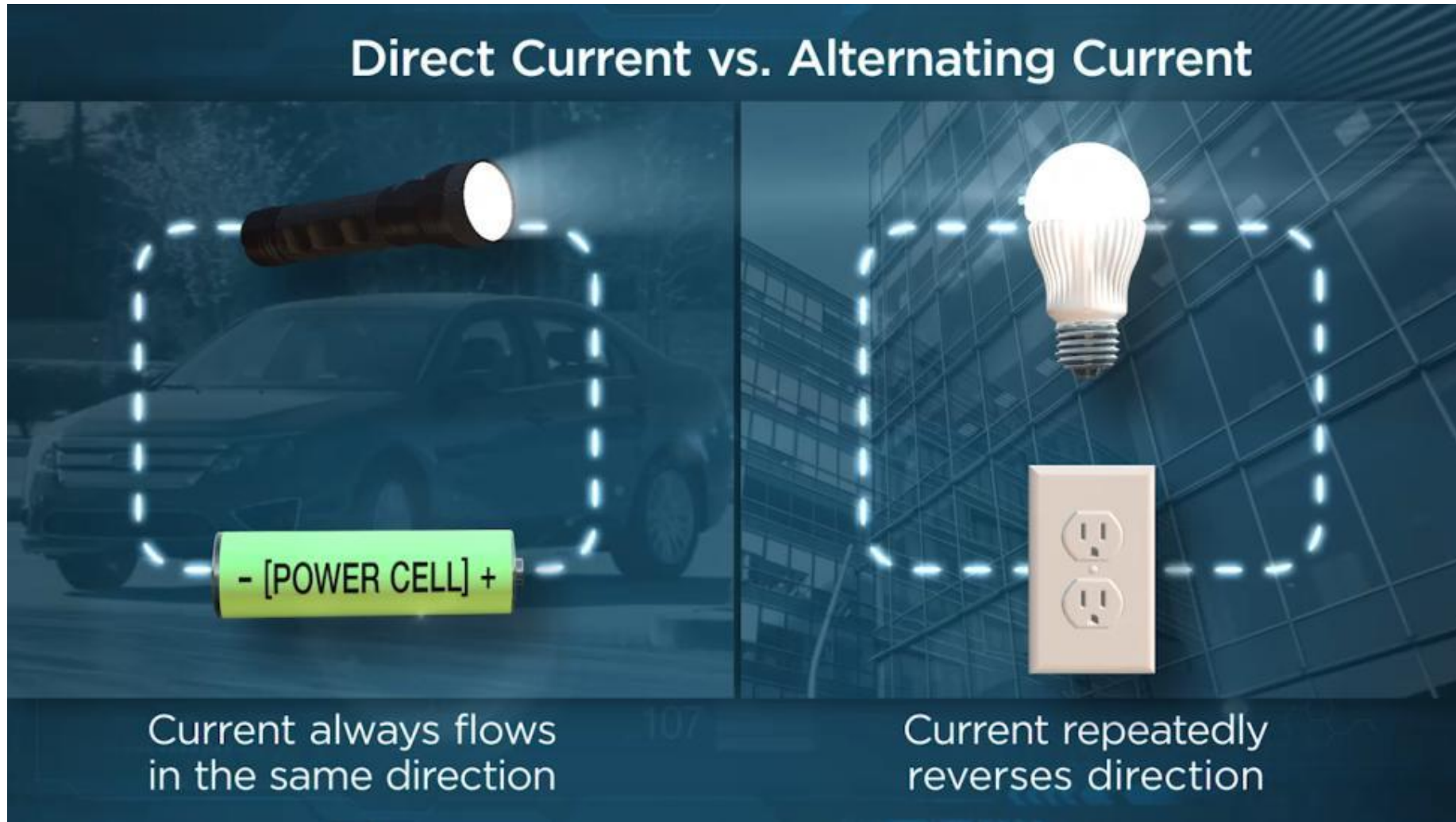
**ADVANCE SLIDE TO PLAY**



## Power vs. Energy

# Electricity Types

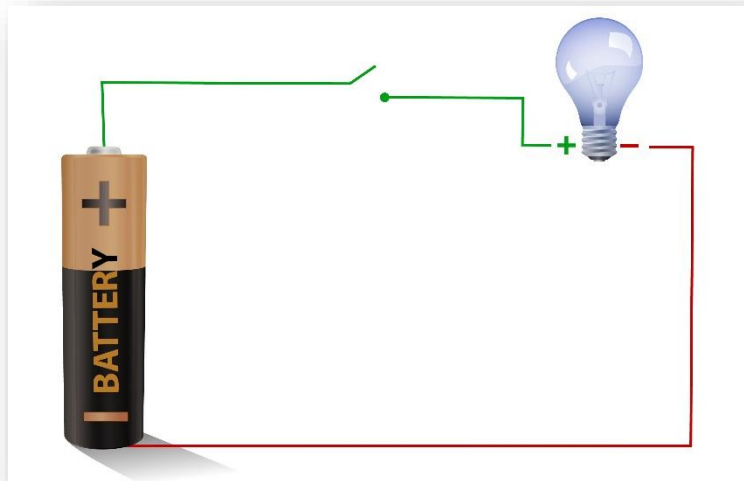
## Basic Electrical Theory



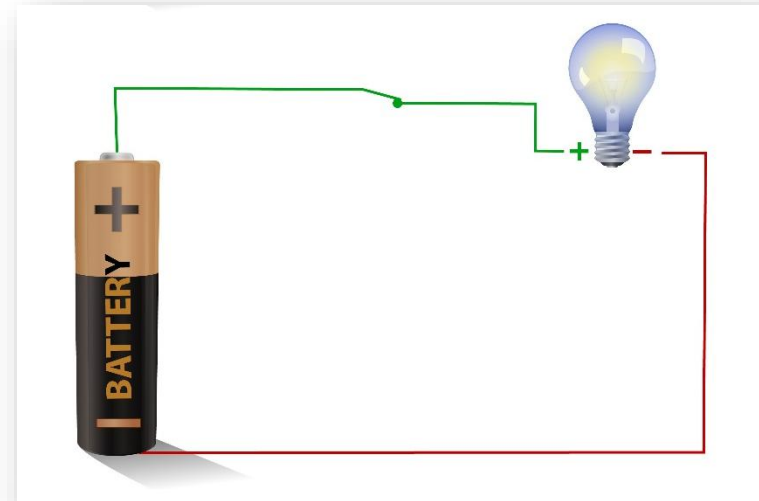
# Electrical Circuits

Basic Electrical Theory

## 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)

# VIDEO

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**ADVANCE SLIDE TO PLAY**







# Understanding Electrical Circuits



# How Electricity Affects the Body

## Basic Electrical Theory

		Voltage	Amperage	Contact
<b>9 Volt Battery</b>		9 V	500 mAH	<ul style="list-style-type: none"><li>• Dry Skin: No detection, insufficient voltage</li><li>• Wet Tongue – Tingling sensation</li></ul>
<b>12 Volt Vehicle Battery</b>		12 V	400+ A	<ul style="list-style-type: none"><li>• Dry Skin: No detection, insufficient voltage</li><li>• Sufficient amperage to kill</li></ul>
<b>Stun Gun</b>		25,000+ V	2-4 mA	<ul style="list-style-type: none"><li>• Muscle contractions – impairment</li><li>• Amperage below lethal levels</li></ul>
<b>PV+ Battery</b>		400-1500 V	8-100+ A	<ul style="list-style-type: none"><li>• Voltage sufficient to overcome skin resistance</li><li>• Amperage sufficient to cause death</li></ul>

# Electricity and Hose Streams

Basic Electrical Theory

## UL & Utility Research

- Applications of water to energized electrical equipment
- Safe to apply water at up to 1,000 volts under certain conditions
- Utility scale installations may have voltages at much higher levels

### Safe Water Application

- Fog pattern 10° or more
- Minimum 5' distance



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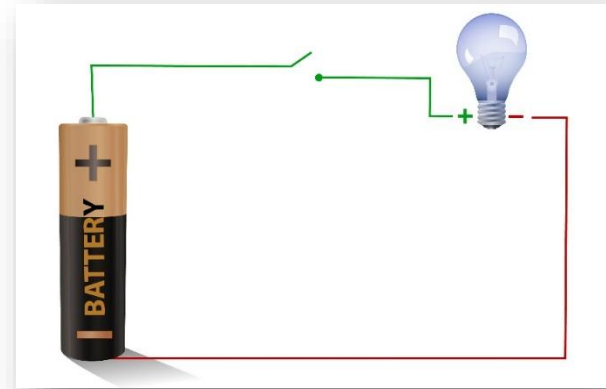
- Solid stream
- Minimum 20' distance

# Section Review

## Basic Electrical Theory



**What electrical property can protect you from getting shocked?**



**What is the difference between AC & DC?**