AGENDA

- INTRODUCTION
- CELLS AND COMPONENTS
- PV PERFORMANCE
- PV APPLICATIONS
- CODES AND STANDARDS
- EMERGENCY RESPONSE

"We are here to make a choice between the quick and the dead"

Bernard Baruch, U.N. Atomic Energy Commission, 1946

Objective

To identify and mitigate potential hazards while working around PV at the site of an emergency

To use this information to develop a standard operating guideline for your department

EMERGENCY RESPONSE

Fire Fighter Hazards

Inhalation Exposure Hazards

Electrical Shock & Burns

Falls from Roof Operations

Roof Collapse

Batteries

Emergency Response

How do you work with PV

What not to do around PV

EMERGENCY RESPONSE

Inhalation Hazards

During a fire or explosion the PV frame can quickly degrade exposing hazardous chemicals to direct flame and become dissipated in the smoke plume

EMERGENCY RESPONSE

Inhalation Hazards

Boron- No health effects to humans or the environment

Cadmium Telluride- A known carcinogen, the primary route of exposure is inhalation

Gallium Arsenide- The health effects have not been studied, it is considered highly toxic and carcinogenic

Phosphorus- The fumes from compounds are considered highly toxic. NIOSH recommended exposure limit to phosphorus is 5 mg/m3. A lethal dose of phosphorus is 50 milligrams

EMERGENCY RESPONSE

Inhalation Hazards

Recommended Practice:

- Wear SCBA and full protective clothing
- Shelter-in-place populations-at-risk downwind of fire

EMERGENCY RESPONSE

Electric Hazards

NIOSH reports reveal the number of firefighters who are killed and injured annually in electrical incidents

Electricity can cause a variety of effects, ranging from a slight tingling sensation, from involuntary muscle reaction to burns and death!

EMERGENCY RESPONSE

Electric Hazards

The physiological effects produced by electricity flowing through the body include:

Perception – (1 mA) tingling sensation

Startle Reaction – (5 mA) involuntary muscle reaction

Muscle Tetanization – (6 to 30 mA) painful shock

Respiratory Arrest – (.5 to 1.50 Amps) stop breathing

Ventricular Fibrillation – (1 to 4.3 Amps) heart stops

EMERGENCY RESPONSE

Electric Hazards

Variables in human resistance to electricity:

Amount of current flowing through the body

Path of current through the body

Length of time the body is in the current

Other Factors: Body size and shape, Area of contact, Pressure of contact, Moisture of contacts, Clothing & jewelry, Type of skin

EMERGENCY RESPONSE

Electric Burns

Burns that can occur in electrical accidents include electrical, arc, and thermal

With electrical burns, tissue damage occurs because the body is unable to dissipate the heat from the current flow

Temperatures generated by an electric arc can melt nearby material, vaporize metal in close vicinity, burn flesh and ignite clothing at distances of up to 10 feet

Arc temperatures can reach 15,000 to 35,000 degrees

A firefighter should never pull the electrical meter as a means of shutting-down power to a building!

EMERGENCY RESPONSE

Roof Hazards

In roof operations consider the weight of the PV array on a weakening roof structure and the fact that you may not be able to access the roof over the fire

To cut ventilation, select a spot at the highest point of the roof and as close to the fire as possible

Do not cut into PV modules!

Consider cross ventilation?

Roof vents, skylights, solar thermal panels, and PV array pose a trip hazard to fire fighters conducting roof operations

EMERGENCY RESPONSE

Battery Hazards

As a rule, batteries do not burn; or rather, they burn with great difficulty

If batteries are exposed to fire, however, the fumes and gases generated are extremely corrosive

Spilled electrolyte can react and produce toxic fumes and release flammable and explosive gases when it comes into contact with other metals

Due to the potential of explosive gases, prevent all open flames and avoid creating sparks

EMERGENCY RESPONSE

Battery Hazards

In battery emergencies, wear full protective clothing and SCBA on positive pressure

Extinguish lead-acid battery fires with CO2, foam or dry chemical fire extinguishers

Do not use water!

Never cut into the batteries under any circumstances!

If the battery is punctured by a conductive object, assume that the object has electrical potential

EMERGENCY RESPONSE

Personal Protective Equipment

Firefighters should follow the minimum standard in NFPA 1971, Protective Ensemble for Structural Firefighting and NFPA 1500, Chapter 7 Personal Protective Equipment

This would include:
Turnout pants
Turnout coat
Boots
Gloves
Hood
Helmet
SCBA

Note: Jewelry such as; watches, rings, and necklaces are all a good conductor of electricity and should not be worn around electrical components

EMERGENCY RESPONSE

Personal Protective Equipment

When working in proximity to electrical circuits, use insulated hand tools

To check for electricity flowing between two contacts an AC/DC meter should be employed

Typically, hot sticks on many engines can only detect alternating current and would not detect curent in PV wiring or battery conductors

EMERGENCY RESPONSE

Emergency Operations

Size-Up – the roof and look for warning labels on electrical disconnects

Lock-Out & Tag-Out - all electrical disconnects, isolating the PV system at the inverter

Ventilation - consider where to cut or whether to use cross ventilation

Shelter-in-Place – Does the size of the emergency and the involvement of the array constitute the need to protect populations downwind?

EMERGENCY RESPONSE

Emergency Operations

The PV array will always generate electricity when the sun shines- there is no turning it off!

Walking or breaking PV modules could release all the energy inherent in the system simultaneously

Cut or damaged wires from a nighttime operation could become energized in the day-time

Spotlights during an evening operation is not bright enough for the PV system to generate electricity

Lightening is bright enough to create electrical surge!

EMERGENCY RESPONSE

Emergency Operations

You cannot block all the sunlight on the array with foam or a salvage cover

Foam will not block out all the sunlight and will slide off the array

Salvage cover will significantly reduce sunlight to the array but electricity can still be generated through the material of the salvage cover

EMERGENCY RESPONSE

Emergency Operations

Locate battery storage area (if applicable)

Extinguish lead-acid battery fires with CO_2, foam or dry chemical fire extinguishers

Use Class C extinguishing agents- CO_2 or dry chemical if a PV system shorts and starts a fire

Should the array become engulfed in a roof fire, use water in a fog pattern on the PV array

Be aware that biting and stinging insects could inhabit the module frame and junction boxes

SUMMARY

Photovoltaic technology is around you every day and it is here to stay!

Your fundamental understanding of photovoltaic systems will improve your confidence in working with and around solar technology safely.

The photovoltaic industry is counting on the fire service industry to operate safely and effectively around photovoltaic systems.