

AGENDA

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



“Progress imposes not only new possibilities for the future but new restrictions.”
Norbert Wiener, The Human Use of Human Beings, 1954

Objective

To reference codes and standards as they relate to personnel safety and photovoltaic systems

CODES & STANDARDS

Wiring Identification

Direct current photovoltaic conductor (wiring) is run outside a building membrane in metallic conduit



National Electric Code specifies that conductors of different output systems will be contained in separate raceways, cable trays, cable, outlet box, junction box, or similar fittings

CODES & STANDARDS

System Disconnects

The Uniform Fire Code specifies that the disconnecting means is accessible to the fire department



In this system the inverter is flanked by two disconnects the right disconnects the array and the left disconnects the inverter from the main electrical panel



CODES & STANDARDS

System Disconnects

NEC requirements provides the detail for disconnecting all components and conductors in the system

Disconnects can be located next to the meter, main electrical panel, the inverter, the controller, and the battery bank

Each PV disconnect shall be permanently marked to identify it as a photovoltaic system disconnect

CODES & STANDARDS

System Disconnect and Warning Labels





CODES & STANDARDS

System Disconnects

Importantly, a grid-tied PV system can operate as a stand-alone system to supply loads that have been disconnected from electrical production and distribution network sources

You would find this arrangement in grid-tied systems in a battery back-up or generator back-up system



CODES & STANDARDS

Wiring (Conductors)

Low voltage DC systems often have larger wiring sizes compared to AC systems

The circuit conductors and overcurrent devices are sized to carry not less than 125 percent of the maximum calculated currents

Wiring exposed to the weather must be rated and labeled for outdoor use

To reduce fire hazards, roof mounted PV systems, conductors, and components are all required to be grounded



CODES & STANDARDS

Ground Fault Protection

Specific requirements are listed in the NEC for providing ground fault protection for PV systems and components

Labels and markings applied near the ground-fault indicator at a visible location, stating that, if a ground fault is indicated, the normally grounded conductors may be energized and ungrounded

In one- and two-family dwellings, live parts in photovoltaic source circuits and photovoltaic output circuits over 150 volts to ground shall not be accessible to other than qualified persons while energized

CODES & STANDARDS

Ground Fault Protection

Locating the grounding connection point as close as practical to the photovoltaic source better protects the system from voltage surges due to lightning



Exposed non-current-carrying metal parts of module frames, equipment, and conductor enclosures shall be grounded regardless of voltage

Installer connecting ground wire to module frames.

CODES & STANDARDS

PV Modules

In a PV module, the maximum system voltage is calculated and corrected for the lowest expected ambient temperature

This voltage is used to determine the voltage rating of cables, disconnects, overcurrent devices, and other equipment





CODES & STANDARDS

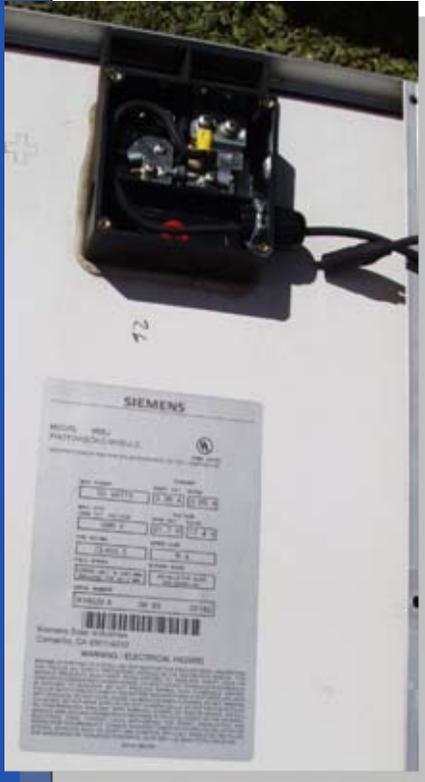
PV Modules

In one and two-family dwellings, photovoltaic source circuits and photovoltaic output circuits are permitted to have a maximum photovoltaic system voltage of up to 600 volts

Installations with a maximum photovoltaic system voltage over 600 volts shall comply with Article 490

CODES & STANDARDS

PV Modules



A label for the photovoltaic power source will be provided at an accessible location at the disconnecting means for the power source providing information on:

Operating current

Operating voltage

Maximum system voltage

Short-circuit current

The rated capacity of the module is provided on the back of each panel

CODES & STANDARDS

PV Batteries

Storage batteries in a photovoltaic system should be installed in accordance with the provisions of NEC Article 480

Storage batteries for dwellings will have the cells connected to operate at less than 50 volts nominal

Lead-acid storage batteries for dwellings shall have no more than twenty-four 2-volt cells connected in series (48-volts nominal)



CODES & STANDARDS

PV Batteries

Flooded, vented, lead-acid batteries with more than twenty-four 2-volt cells connected in series (48 volts, nominal) shall not use conductive cases or shall not be installed in conductive cases

Conductive racks used to support the nonconductive cases shall be permitted where no rack material is located within 150 mm (6 in.) of the tops of the nonconductive cases

Some batteries do require steel cases for proper operation as these battery types such VRLA or nickel cadmium can experience thermal failure when overcharged



CODES & STANDARDS

PV Batteries

Chapter 52, NFPA 1, Uniform Fire Code (2006)

Valve-regulated lead–acid (VRLA) battery systems should have a listed device or other approved method to preclude, detect, and control thermal runaway

Provide an approved method and material for the control of a spill of electrolyte

Provide ventilation for rooms and cabinets in accordance with the mechanical code



CODES & STANDARDS

PV Batteries

Chapter 52, NFPA 1, Uniform Fire Code (2006)

Provide signs on rooms and cabinets that contains lead–acid battery systems

In seismically active areas, battery systems shall be seismically braced in accordance with the building code





CODES & STANDARDS

Fire Service Responsibilities

During plan review ensure that there is adequate access to the roof for firefighting operations

Fire Inspectors need to stay involved in the permit and plan review process

Pass available building and PV information on to the operational section of your department

Firefighters need to take this information and develop pre-emergency plans for these facilities



SUMMARY

Automatic and manual disconnects throughout the PV system allow firefighters to contain the electricity at the source

Firefighters have successfully dealt with lead acid batteries and battery systems for decades

The Building, Electrical, and Fire Codes ensure the safety for occupants and emergency responders