Wire Shielding on Ground Mount Solar Arrays

A look at NEC requirements

Are PV voltages and currents dangerous?

- Yes!
- The voltages approach 600 volts DC and in some cases 1,000 volts DC.
- The amperages far exceed those needed to cause electrocution.
- The IV curve sustains arcs, causing high likelihood of creating a fire.

Which NEC cycle applies?

- Most jurisdictions are using the 2011.
- Looking to the next iteration is valuable:
  - It allows us to create policies that will not need to be changed soon.
  - It gives us guidance as to what direction the code is headed on a particular subject.

First let's look at the 2011 NEC

- **690.31 Methods Permitted.**
  - (A): Where photovoltaic source and output circuits operating at maximum system voltages greater than 30 volts are installed in readily accessible locations, circuit conductors shall be installed in a raceway.

Now the 2014 NEC

- **690.31 Methods Permitted.**
  - (A) Where PV source and output circuits operating at maximum system voltages greater than 30 volts are installed in readily accessible locations, circuit conductors shall be guarded or installed in a raceway.
- As can be seen, the code is heading in a direction that emphasizes protection of conductors.

Definition: Readily Accessible

- What does “readily accessible” mean?
  - From 2011 NEC: **Accessible, Readily (Readily Accessible).** Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, and so forth.

Definition: Readily Accessible

- What does “readily accessible” mean?
  - **From 2014: Accessible, Readily (Readily Accessible).** Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to actions such as to use tools, to climb over or remove obstacles, or to resort to portable ladders, and so forth.

Readily Accessible

- If you can get to it without using a ladder or tools, it is readily accessible.

Are the undersides of ground mount arrays readily accessible?

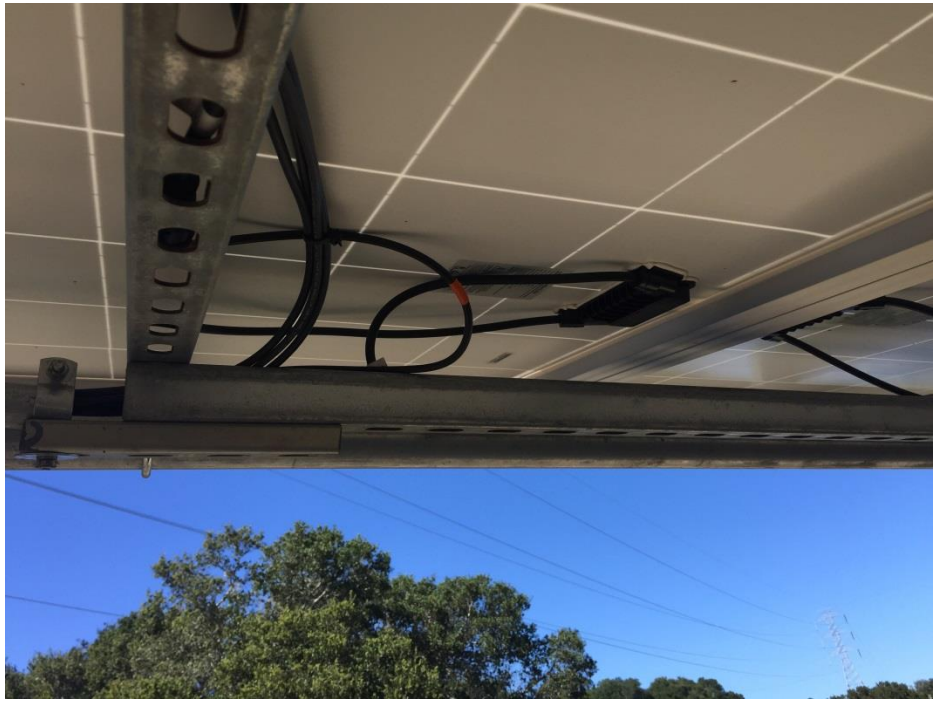
- Emphatically, yes!
- Particularly in regards to children.

Definition: Guarded

- 2011: **Guarded.** Covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger.
- 2014: Same

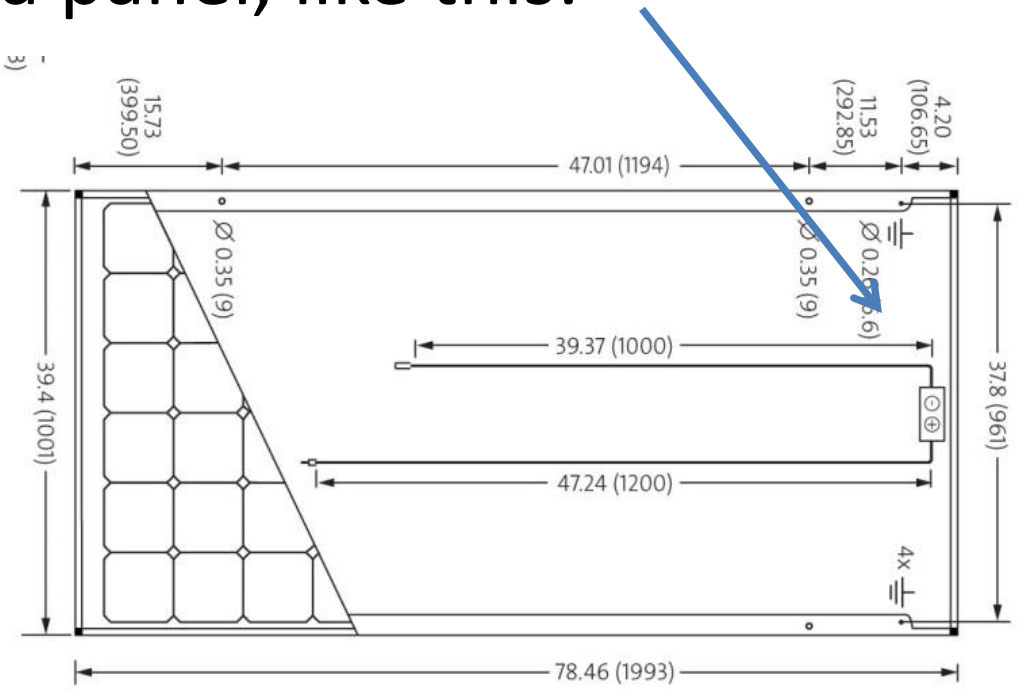
Do ground mount arrays needed wiring to be guarded?

- Yes! The photo below validates this point.



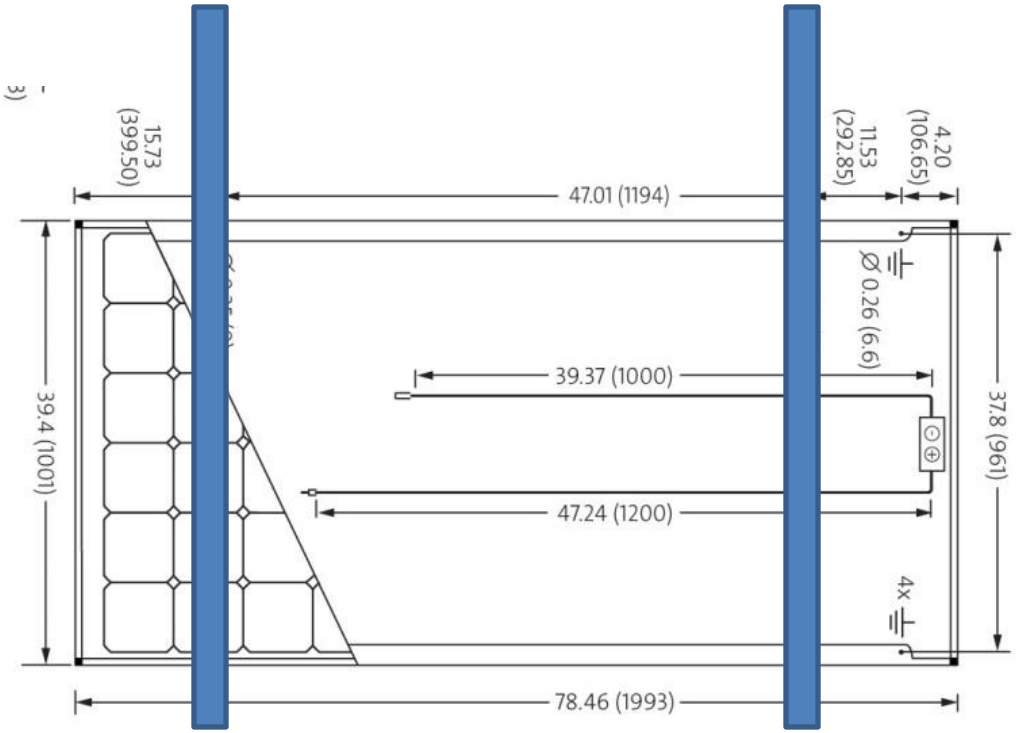
What about PV wiring run in the structural channel?

- Is this wiring guarded?
- No. The wires on a solar panel connect to the end of a panel, like this:



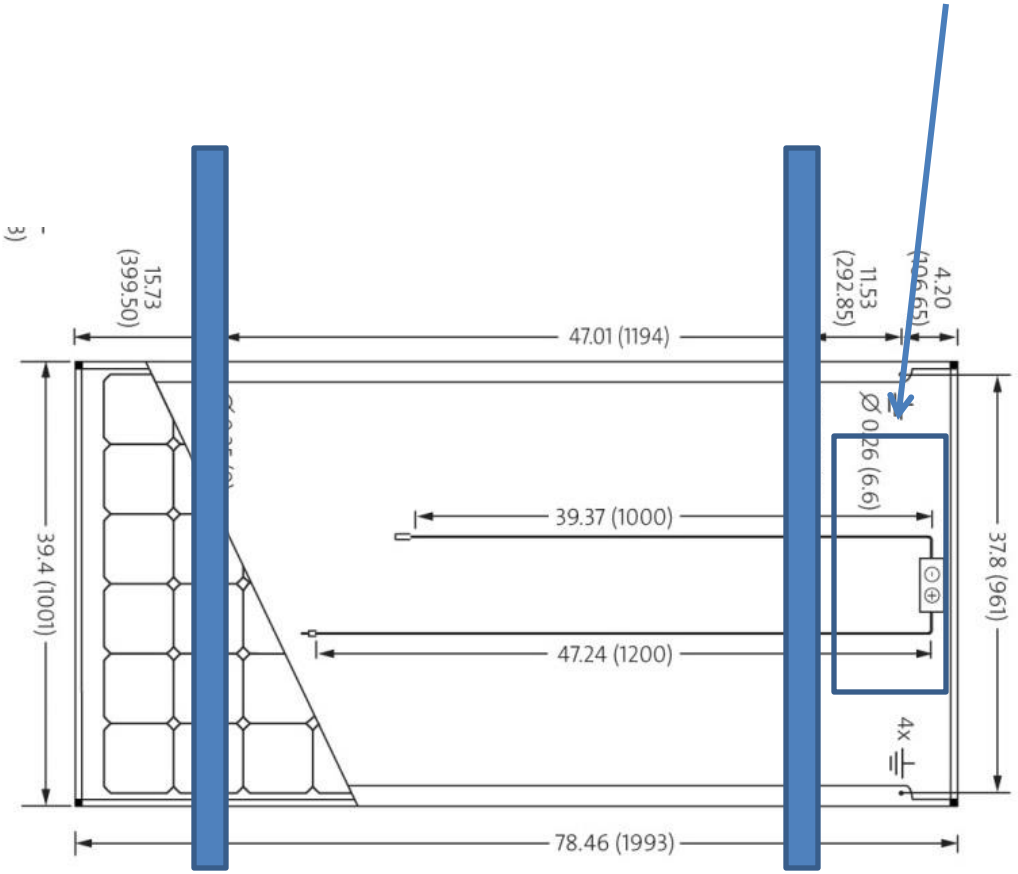
What about PV wiring run in the structural channel?

- Support for the panels needs to be located in about 20% of the width, like this:



What about PV wiring run in the structural channel?

- Leaving this much of the wire exposed:



So how do you “guard” the wiring?

- You can put a child-proof fence around the array.
- You can install a wire shield:

What is the County's policy?

- County appears to require compliance with 690.31. From County PV checklist:

Ground mounted arrays:

- Engineering is required for arrays exceeding six feet above adjacent grade
- Show method of compliance with NEC 690.31 A & B

What is the County's policy?

- It appears the County is not enforcing the requirements:
- Per Matt Varvel, via e-mail:
  - the County's stance is that if the wiring is properly managed additional guarding with fences, or screens are not required.
- Per Matt Varvel via telephone conversation:
  - If the wiring is placed inside of the support rails it is considered guarded.

What do the industry experts say?

- Bill Brooks
  - Readily accessible wiring needs to be shielded.
- Mike Holt
  - William, your interpretation is 100% correct.
- City of Atascadero
  - Requires wire shielding (Dave Mulhousen).
- Professional Engineers
  - Licensed as electrical engineers and they all concur.

What is the responsibility of the building department?

- From book Design Guide to the 1997 Uniform Building Code by Richard T. Conrad:
  - *The enforcement official who chooses to ignore the code...places both the jurisdiction and the official in serious jeopardy. Cases have ruled that both the individual and the jurisdiction can sustain liability if the action by the official was knowingly wrong.* (page 415)

What should be done?

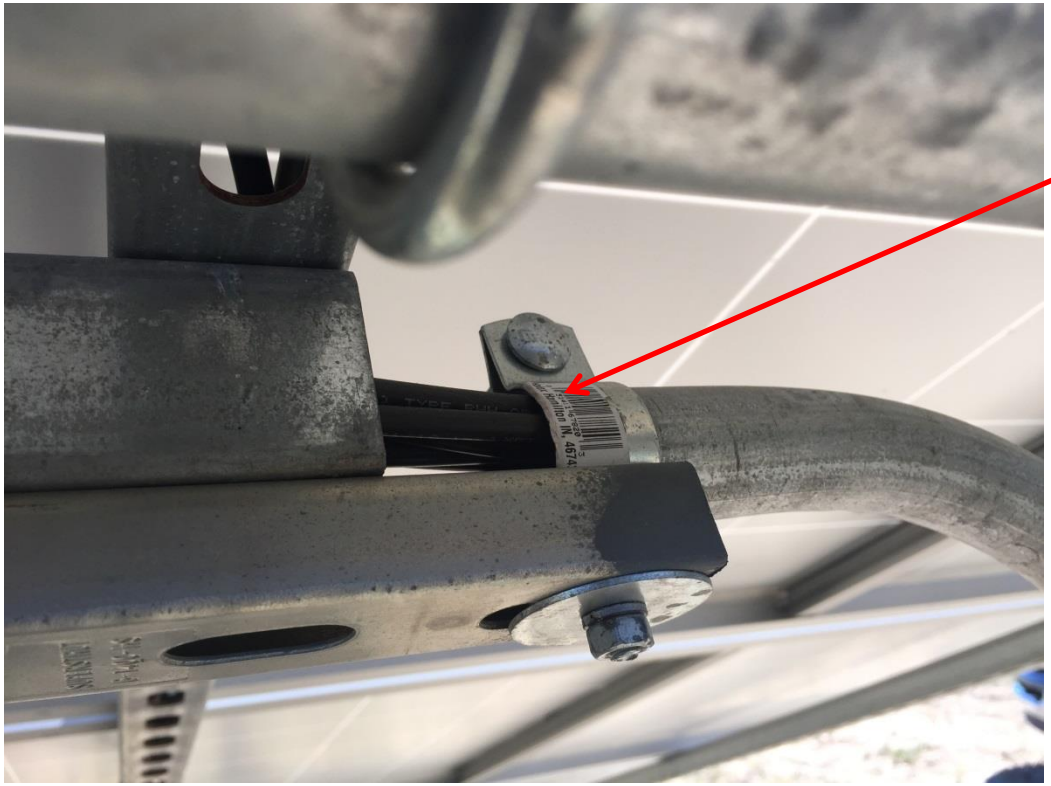
- The County should immediately adopt policies requiring wire guarding for any readily accessible installation.
- Require fencing or shielding before final inspection sign-off.
- Fence must be child-proof.
- Shielding must be permanent, sturdy, and if metallic, bonded.

What should be done?

- Inspectors must be trained on what to look for on solar installations.

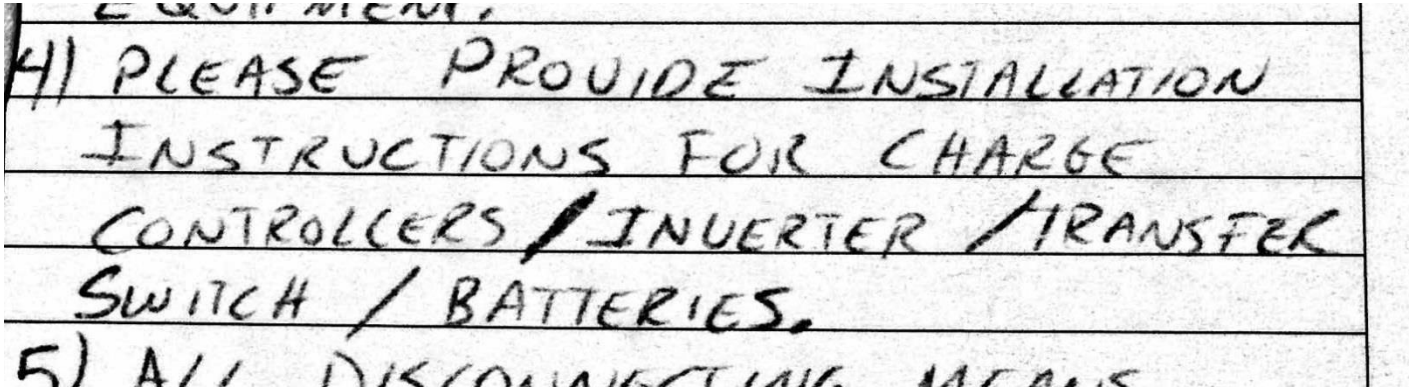
Inspection Problems

- This conduit termination is not allowed:



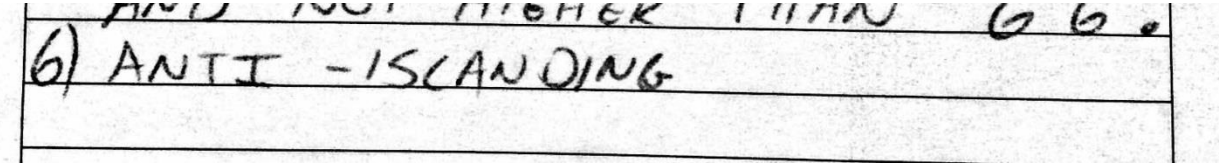
Inspection Problems

- We cannot allow manuals to leave the job:



Inspection Problems

- We need inspectors that have a basic understanding of grid-tie and off-grid systems:



Conclusion

- We look forward to a better understanding of the requirements of wire guarding.
- We offer our help in training building inspectors.