Labeling to Article 690 of the National Electrical Code
Routing and Protecting PV Cables

- General overview of industry labeling
- Labeling updates and requirements for article 690
- Updated fire code labeling requirements.
- Best practices for routing and protecting PV cables

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Label Design Parameters

- Why are labels red in color?
- What are label requirements?
- How were sizes and designs selected?
- What is considered a “durable” label?
- How do engraved plates compare to labels?
There are two primary fire codes used in the US today. The International Fire Code (IFC) and the Uniform Fire Code (UFC) published by the National Fire Protection Association (NFPA).

The UFC is often referred to by the code designation NFPA 1.

Both 2012 draft documents are based on the CAL FIRE Guideline which does recommend red as the label color and that labels meet UL969.
Fire Safety Label Formats

- IFC 605.11.1.1 to IFC 605.11.1.4 and Cal Fire
- Red background (PMS-187 Red)
- White lettering – All Capital letters – Arial or similar font (Non-Bold)
- 3/8” Tall characters where required
- Reflective, weather resistant material. (Durable adhesive materials meet this requirement.)
- Cal Fire 1.0

“It is recommended that Underwriters Laboratories Marking and Labeling System 969 (UL969) be used as a standard to determine weatherability”.

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Reflectivity

[Images of reflective surfaces and instructions]
Label Durability

- **NEC110.21**
  The markings shall be of sufficient durability to withstand the environment involved.

- **NFPA 11.1.9.3.2**
  The marking shall be of sufficient durability to withstand the environment involved.

- **IFC 605.11.1.1**
  The materials used for marking shall be reflective, weather resistant and suitable for the environment.

- **Cal Fire 1.0**
  The materials used for marking must be weather resistant. It is recommended that UL969 be used as standard to determine weather rating.

- **Local codes will vary from city to city.**
Engraved Plates vs. Labels

- Engraved plates have square corners raised from the surface that can create a hazard.
- Engraved plates offer a possibility of only two colors, unless multiple layering is used.
- The subsurface engraving is easily vandalized.
- Engravings collect dirt over time and are best for clean environments.
- Phenolic plates are not typically available in reflective materials.
- Phenolic plates cannot meet the UL969 adhesive label standard.
- They must attach with externally applied adhesives or tapes because screws or rivets require drilling into enclosures which may void the warranty.
- A mechanical fastening requirement will often require the label to be mounted next to the equipment rather than on the equipment.
- Phenolic resin is typically not rated for outdoor use.
IFC 605.11.1.1: Marking shall be reflective.

IFC 605.11.1.4: Marking shall be placed on all interior and exterior DC conduit, raceways, enclosures, and cable assemblies every 10 feet (3048mm) within 1 foot (305mm) of all turns or bends and within 1 foot (305mm) above and below all penetrations for roof/ceiling assemblies and all walls and/or barriers.

Marker must also be on the main service disconnect.

PHOTOVOLTAIC POWER SOURCE

596-00206
Case Study

Rondo Library ballasted roof system, 40 kW, in St Paul
Circuit Routing:
Where circuits are embedded in build-up, laminate, or membrane roofing materials not covered by PV modules and associated equipment, the location of circuits shall be clearly marked.
As interpreted by the International Association of Electrical Inspectors (IAEI) in their 2011 NEC handbook on page 1105.
This marking shall also be placed adjacent to the main service disconnect in a location clearly visible from the location where the disconnect is operated.
For residential applications:
This reflective label to be placed within the main service disconnect unless operable with the service panel closed in which case the marking should be placed on the outside cover.

For commercial applications:
Place adjacent to the main service disconnect visible from a location where the lever is operated. Each PV system disconnecting means shall be permanently marked to identify it as a photovoltaic system disconnect.

CAUTION: SOLAR ELECTRIC SYSTEM CONNECTED
Each PV system disconnecting means shall be permanently marked to identify it as a photovoltaic system disconnect.
**Disconnection of PV Equipment:**
If the equipment is energized from more than one source, the disconnecting means shall be grouped and identified.
Installation and Service of an Array

WARNING:
TURN OFF PHOTOVOLTAIC AC DISCONNECT PRIOR TO WORKING INSIDE PANEL
The PV power source shall be labeled with the following warning at each junction box, combiner box, DC disconnect, and device where energized, ungrounded circuits may be exposed during service.

Only needed for ungrounded systems
Switch or Circuit Breakers

Where all terminals of the disconnecting means may be energized in the open position, a warning label shall be mounted on or adjacent to the disconnecting means.

Combiner Box or DC Breaker Box

AC Breaker Box, main breaker panel

Also NEC 705.22(4) for alternate power sources in general.
Section 690.53

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Max Power-Point Current</td>
<td>77.8 A DC</td>
</tr>
<tr>
<td>Rated Max Power-Point Voltage</td>
<td>417.2 V DC</td>
</tr>
<tr>
<td>Maximum System Voltage</td>
<td>556 V DC</td>
</tr>
<tr>
<td>Short Circuit Current</td>
<td>128.8 A DC</td>
</tr>
<tr>
<td>Max Rated Output Current of the Charge Controller If Installed</td>
<td>N/A</td>
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</tbody>
</table>
Interactive System Point of Interconnection

All interactive system(s) points of interconnection with other sources shall be marked at an accessible location at the disconnecting means as a power source and with the rated AC output current and the nominal operating AC voltage.
AC Disconnect Before and After
Solar Labels

This was an 8.4kw commercial job that passed inspection using pre-printed HellermannTyton Solar Installation labels.
Where are these labels applied?
Materials used for marking shall be reflective, weather resistant, and suitable for the environment. IFC 605.11.1.1.

The markings shall be of sufficient durability to withstand the environment involved. NEC 110.21

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Conductors at switch or circuit breakers (pull boxes) per NEC 690.4
Main circuit breaker panel and meter per NEC 690.17, Dual power source NEC 705.12(D)(4) and Back-Fed Breakers per NEC 705.22.4 and NEC 690.64.
Easy to Use – Quick to Apply
Cable Management to Article 334.30 of the National Electrical Code
Routing and Protecting PV Cables

Article 334 cable routing requirements from the NEC 2011 Edition

- General overview of industry routing
- Routing updates and requirements for article 334
- Best practices for routing and protecting PV cables

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Nonmetallic-sheathed cable shall be supported and secured by staples, cables ties, straps, hangers, or similar fittings designed and installed so as not to damage the cable, at intervals not exceeding 1.4M (4-1/2 ft) and within 300mm (12”) of every outlet box, junction box, cabinet, or fitting.

Flat cables shall not be stapled on edge.

Sections of cables protected from physical damage by raceway shall not be required to be secured within the raceway.
Bundling and Securing

- Cable management is one of the quickest ways to read the competence of the installation team or contractor.
- Conductors should be as close to invisible as possible.
- Using the correct material is an important factor.
- Cable tie material should be applicable to the environment where it is being used.
- There is more than one way to secure cables.
Common Cable Management Mistakes

- Wrong cable management material is used.
- Cable ties are pulled too tight or mounted on cut points.
- Not enough supports to properly support the cables.
- Cables touching an abrasive surface or mounted on a cut point.
- Plug connectors are not fully engaged.
- Very sloppy cable management.
Use the proper material

- Cable ties must be UV stabilized.
- Cable ties must have the proper temperature rating at least -40°F to 225°F.
- Cable ties must be suitable for outdoor use.
- Stainless steel is acceptable, but be aware that it can be sharp.
- Watch the use of Nylon 6.6 with galvanized steel.
Cable Management Solutions

Recommendations

- Nylon 66 UV stabilized cable ties.
- Specially designed for the solar industry.
- Available in a variety of lengths, tensile strengths and bundle diameters.
- Must have 2% carbon to be UV stabilized.
Solar E-Clips are designed specifically to route cables by securing them to a metal or plastic frame rail edge, eliminating the need for mounting holes and mechanical fasteners.

- Clip is easy to secure.
- Clip has high-extraction force.
- Ensures long-term reliability.
Cable Management Solutions

Recommendations
Nylon 6.6 HIRHSUV
- Nylon 6.6
- Impact Modified
- Heat Stabilized
- UV Stabilized
Product Features and Benefits

- Integrated design allows for easy insertion by hand.
- Curved ends that prevent the clip from chaffing and damaging the PV cable.
- Double-compression design that accommodates various sizes of wire and cable.
- Manufactured of corrosion-resistant 304 stainless steel.
- Requires no installation tools, speeding up installing time.
- Accommodates single or multiple cables.
- Fits up to 1-3 mm in thickness.
- Presents a high extraction force for withstanding extreme conditions.