WHITE PAPER

PV LABELING

NEC 2014 SECTION 690 SOLAR PHOTOVOLTAIC SYSTEMS

HellermannTyton

BACKGROUND

This white paper summarizes some of the current and new requirements regarding proper labeling for standard solar installations.

If there is one thing that every installer, engineer and designer can agree on is that there has been no universal consensus on the definition of acceptable photovoltaic infrastructure labeling. The industry is young and the codes and regulations are so diverse that most installers are left on their own to figure out how to ensure they pass inspection, while still meeting the labeling requirements of the National Electrical Code (NEC) and the International Fire Code (IFC). Both standards go hand in hand and address key issues of PV labeling.

The NEC 2014 code goes a long way towards bridging the label gap between the two standards. The Fire Marshall is very worried about the safety of first responders and emergency personnel. Because of this concern, the International Fire Code 2012 took the step of defining details about specific label formats that were designed to be highly visible in emergency situations. Section 690 of the 2011 edition of the NEC code outlined the basic parameters for labeling, while the IFC went a step further in defining the size of text, color and physical properties of the label. The IFC label requirements are now supported and re-enforced in the NEC 2014 code requirements of Article 690.

However, there is still a lot of confusion and misunderstood information when it comes to photovoltaic (PV) labeling. It is not uncommon for an installer to believe that the use of etched plates are a directive of the NEC code, or that markers are mandated to last 20+ years on a solar installation. Yet, what are the true requisites of PV system labeling? How should the installer address the complex and often diverse issues regarding labeling and how that relates to passing inspections by the Authority Having Jurisdiction (AHJ)?

First, the NEC and IFC do not identify a particular method of marking the infrastructure. In NEC 2008, there is a phrase that reads as follows: *"The labels are required to be a durable, unalterable material permanently attached to the device. The most common type of labeling is engraved or etched plastic, which can be riveted or adhered to the device."* This statement simply indicates that the most common type in use in 2008 was an engraved plate. For years, many inspectors and installers have interpreted this to mean that an etched plate is mandatory in order to pass inspection and have the marker last 20+ years.

In the NEC 2014 code, the code panel made a specific point of using the word "label" to better define the method of marking. Some examples from the NEC 2014 code include:

NEC 110.21(B): "Where required in this code, any field applied LABELS, warning(s) and marking shall comply with ANSI Z535.4."

INFORMATIONAL NOTE:

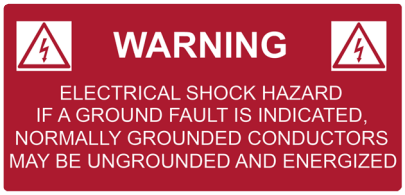
NEC 110.21(B)(1): "ANSI Z535.4 – 2011 Product Safety Signs and LABELS, provides guidelines for the design and durability of safety signs and labels for the application to electrical equipment."

The text is the same. The only difference is that the second label is designed based on the requirements of ANSI Z535.4.

The orange header color serves to satisfy the new code requirements when approving installations. On the one hand, this appears to make the work of labeling more complex. However, it also allows the market to now provide a variety of labeling packages that are pre-made for use by the installers, cutting time and costs out of the process.

All other warning and caution labels, unless otherwise specified, should meet the requirements of ANSI Z535.4 – 2011 per the Informational Note in Article 110.21(B) in NEC 2014. The ANSI standard requires that Danger, Warning and Caution signs use the standard header colors, header text, and safety alert symbol on each label. The ANSI standard requires a heading that is at least 50% taller than the body text. While not required in the NEC 2014, the message text should be at least .12" tall. If we compare this to Occupational Safety and Health Administration (OHSA)1910.145 and the American National Standard Institute (ANSI) Z535, it is specified that signs must be visible at a safe viewing distance from the hazard. They also recommend the use of safety alert symbols, where applicable.

In the NEC 2011 code, the following label would be and is currently acceptable.



In the NEC 2014 code, the format of this same label would look as follows:

There are some labels that are defined specifically within the standard that do not conform to the ANSI standard and follow IFC guidelines. These labels have specific warnings that require high visibility and, in some cases, require reflectivity. One new and very important requirement is found in NEC690.56(C) which specifies the need for a RAPID SHUTDOWN switch. This switch, when activated, is required to reduce voltage to 30vdc within 10 seconds inside the building and within 10 feet from the array.

PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN

< The Rapid Shutdown Switch is required to have a label that reads:

The label shall have 3/8" tall letters and be reflective with white text on a red background.

This label would be applied to a separate breaker or switch that comes after the utility meter and connects directly to the combiner boxes which would be used if the system has a battery backup system. If the installation does not include a battery backup system, the label will be applied to the MAIN AC Disconnect. Future equipment will most likely be designed that will enable the shut-down of the system as required in the new code. This label would be applied to that equipment.

As mentioned earlier, many inspectors and installers believe the use of an etched plate is required in order to pass inspection and that the marker must last for 20 years. In the NEC 2014 code, the language has been modified to include the word LABEL within the code.

NEC 110.21: "The LABEL shall be suitable for the environment where it is installed."

This means that the label should be designed to withstand the outdoor elements, but does not specify a time period. So, what does that mean for customers, designers or municipalities that seem fixed on having a 20-year rating for labels used on field marked equipment? First, there is no drawback to using an engraved plate, but the installer needs to be aware that most phenolics are not ultraviolet (UV) rated for outdoor use. Engraved plates can be costly and have limitations when it comes to meeting the requirements of the most recent standards (which now includes reflectivity). The new standards are written to allow the installer to pick from a variety of identification methods. For instance, IFC 2012 says that the materials used for marking shall be reflective, weather resistant, and suitable for the environment.

Adhesive label manufacturers, in the label converting industry, will typically certify their label materials up to five years for outdoor durability in direct exposure to the elements. Many fully pre-printed labels have a nine-year rating, which is exceptional in the labeling market. Other manufacturers, like HellermannTyton, have tested their labels using Xenon Arc technology to 10,000+ hours with little or no degradation of the label. The key is to research the material specifications before selecting a label. The typical definition of "outdoor durability" is that the labels should show little or no degradation during a defined time period and then slowly degrade as the years go by. Labels in shade or protected from direct exposure to sun and the elements can last two or three times longer before starting to break down.

As mentioned, certain labels do not have to conform to the ANSI standards and some labels need to have reflective characteristics. The NEC and IFC actually go one step further in distinguishing critical labels needed to prevent a life-threatening hazard. It has become imperative that labels provide emergency responders with appropriate warning and guidance with respect to isolating the solar electric system. This includes identifying energized electrical lines that connect the solar modules to the inverter, as these should not be cut when venting smoke from a burning building. Cutting into a live conduit could result in a 520 volt jolt, so safety is a primary concern.

The International Fire Code and National Electrical Code both specify that electrical metallic tubing (EMT) conduit and raceways must be marked no less than every 10 feet, at every turn, above and below penetrations, and on all exposed raceways, cable trays, and other wiring methods. The labels also must be visible on the covers or enclosures of pull boxes and junction boxes as well as conduit bodies in which any of the available conduit openings are unused.

The NEC 2014 code finally bridges the gap between NEC 2011 and IFC 2012 in which NEC 2011 indicates that the required text should read as "PHOTOVOLTAIC POWER SOURCE" while the IFC states that the text should read as "WARNING: PHOTOVOLTAIC POWER SOURCE" and be reflective with 3/8" white characters on a red background. The NEC 2014 panel modified the code to support the IFC requirements so that both codes now agree on wording and format.

WARNING: PHOTOVOLTAIC POWER SOURCE

< Per NEC 2014, the label is to be printed with the following text: WARNING: PHOTOVOLTAIC POWER SOURCE. Further, the NEC and IFC require that these labels must have reflective properties so that they are clearly visible in the beam of a flashlight. The IFC is specifying that the markings must be detectable from a distance, which denotes that the minimum text height is 3/8" using white lettering on a red background.

MAIN PHOTOVOLTAIC
SYSTEM
AC DISCONNECT

< Also, printed labels must now spell out the word PHOTOVOLTAIC. The term PV is no longer acceptable on a printed label. In previous code revisions, the label to the left would have been acceptable:

< In the NEC 2014 code, that same label must be printed as:

The IFC would prefer to see labels that identify the main service disconnect or critical disconnects with reflective, red and white labels.

Finally, the California Department of Forestry and Fire Protection (CAL FIRE) code recommends that the markers meet UL969, an adhesive label specification, which is another added consideration for the installer when determining how best to label a system. If we examine the new requirements and compare and contrast those to the various environmental factors such as surface type, UV exposure and color, the installer has many things to consider in selecting a labeling solution. These include:

1. Is the marker reflective? Is reflectivity required?
2. Does the marker meet UL969 requirements?
3. Can the marker easily adhere to conduit?
4. Is the marker UV resistant?
5. Will the marker adhere to a variety of surfaces for the life of the product?
6. Is the printed wording correct?
7. Are the printed characters at least 3/8" tall, where required?
8. Are the colors correct?

WARNING
PHOTOVOLTAIC POWER SOURCE
DO NOT REMOVE UNLESS REPLACED IN EXACT LOCATION - PV POWER CIRCUIT DIRECTLY BELOW

< Also, in NEC690.31(G)(I), the installer must clearly mark circuits that are hidden under build up, laminate, or other membrane roofing materials that are not covered by PV modules. This typically can be a metal shingle label or something permanent that can be attached to both tar and composite shingles.

NEC 2014 and IFC 2012 offer new insights into the dynamics of labeling the PV installation. The updated standards open the door for the acceptable use of high-quality labeling products that are designed to meet the critical UV exposures. These suitable labels also offer a permanent marking on low-energy surfaces, such as powder coat paints found on many of the new breaker boxes and inverters. These updates come at an opportune time when the market is now capable of supplying label inks and adhesives that are UV stable and have the ability to adhere to various surfaces without losing adhesion due to temperature or environmental changes.

These new and improved label materials also provide a cost advantage to the installer. For example, if a high-quality, UV stabilized, pre-printed or semi pre-printed label is used, the cost of labeling a typical installation goes from $60 to $70 per installation down to approximately $10 or $20 per installation. Not to mention, the installer is more likely to be truly compliant to the requirements of the NEC and IFC as well as applicable UL, OSHA and ANSI standards.

LOCAL REGULATIONS

The one caveat that installers must consider are the local regulations. Some communities mandate the use of an engraved plate, and in those instances the installer must comply. Yet, in most districts, there is no specific definition of what type of marker is required. This gives the installer more flexibility in selecting a labeling solution.

Again, there is no right or wrong answer on marker selection as long as the installer is meeting the requirements of the AHJ in all instances. The trend that we are seeing is that labeling products with specialized features, such as reflectivity, are the vanguard of the new era.

The market is evolving and like any other industry during growth, the players will seek to find the best solutions at the lowest cost. The cost of not passing an inspection is just as important as the cost of a marker. As the standards become more defined, additional solutions will become available to the designer, engineer and contractor.

Many adjustments are sure to come as the industry progresses and labeling grows with the changes to become a standard that everyone can define and implement now and in the future.

NEC 690 LABEL APPLICATION EXAMPLES

NEC690.31(G)(3)(4)

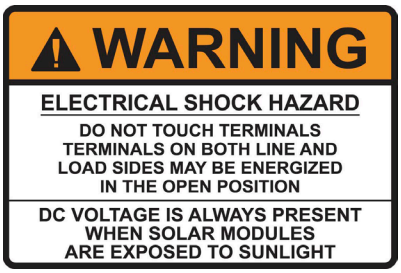
For use on EMT conduit, raceways, enclosures, and combiner boxes and disconnects.

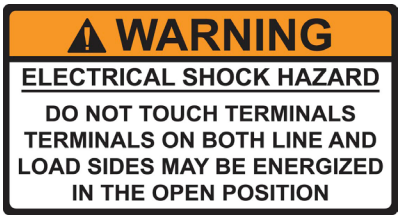
NEC690.31(G)(I)

For use on shingled roofs where circuits are embedded.

NEC690.35(F)
A PV power source shall be labeled at each junction box, combiner box or disconnect, and device where energized circuits may be exposed during service.

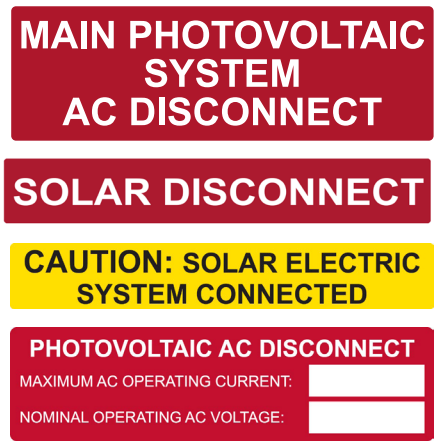
NEC690.5(C)
A label shall appear on the utility interactive inverter near or be applied by the installer close to the ground fault indicator at a visible location. This is typically only used on ungrounded systems.



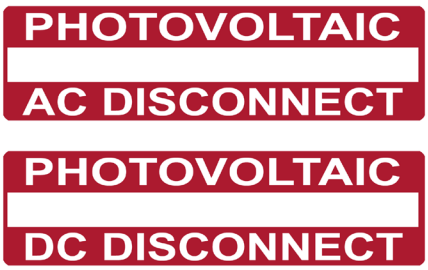


NEC690.17(E)
Where all terminals of the disconnecting means may be energized in the open position, a warning label shall be mounted adjacent to the disconnecting means. For use on AC/DC disconnects, junction boxes or the breaker panel.

NEC110.27(C) or OSHA 1910.145(f)(7)
Warning labels are used to represent a hazard. For use on the breaker panel, main disconnect, as well as junction and combiner boxes.

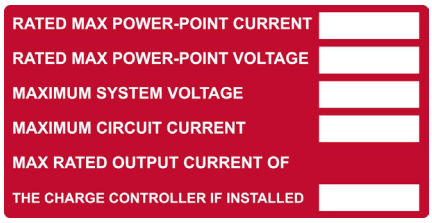


NEC690.15 and NEC690.13(B)



NEC690.15 and NEC690.13(B)

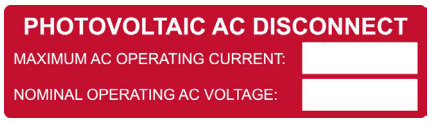
If equipment is energized from more than one source, the disconnecting means must be grouped and identified. In this case of the labels shown left, a printer can be used to print the breaker series or disconnect means in the white middle portion of each label.



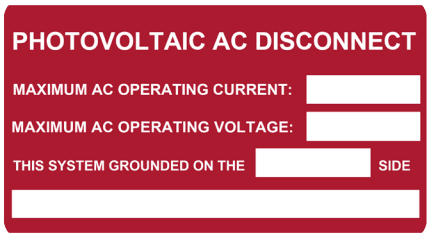
NEC690.53

NEC690.16(B)
Non-load, break-rated disconnect mean shall be marked "Do Not Open Under Load."

NEC690.33(E)(2)
Interruption current – a type that requires the use of a tool to open will be marked "Do Not Disconnect Under Load."



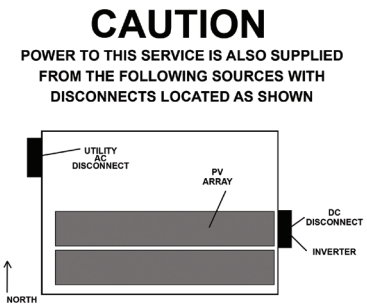
NEC690.54
All interactive points of interconnection with other sources shall be marked at an accessible location at the disconnecting means as the power source with the rated AC output current and nominal AC operating voltage.

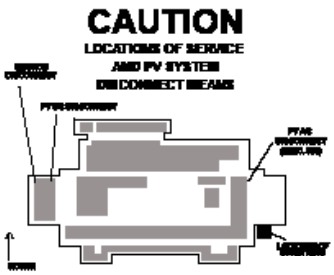


NEC690.55
PV power systems employing energy storage shall also be marked with the maximum operating voltage including any equalization voltage and the polarity of the grounded circuit conductor.

NEC705.12(D)(3)(4)
Equipment containing over current devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources. Typically used on the breaker panel.

Individual breakers should also be marked.





NEC690.15(A)(4), NEC690.56(A) and NEC690.16(B)

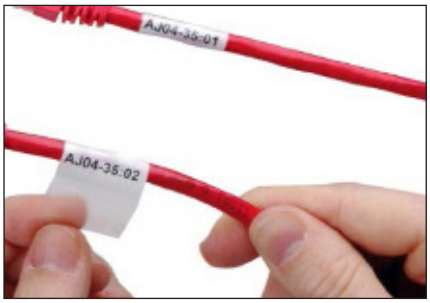
The use of a large 4" wide continuous vinyl roll, printed using a label printing program can be used to make directory labels or plaques for buildings and structures. Typical examples include:

NEC690.10(C)

Single 120 Volt supply label for panel breakers in a stand-alone PV system where only 120V service is installed.

NEC690.31(I)

Bipolar source and output circuits on all DC equipment typically found on most larger solar farms.



NEC690.4

Where conductors of more than one PV system occupy the same junction box, raceway or equipment, the conductors of each system shall be identified at all terminations and splice points. Cables can be marked using UL969 approved self-laminating vinyl labels.

Always check local codes before defining labeling formats.

About HellermannTyton

HellermannTyton is a global manufacturer of identification, cable management and connectivity solutions for the commercial data, telecommunications, electrical, and industrial markets. HellermannTyton offers an integrated approach to design, operation, and delivery to optimize service and solutions for local and global customers. The company's engineered solutions and innovative products are designed and constructed to meet the strictest quality standards while delivering reliable implementation at the lowest cost.

For more information, call HellermannTyton at 800.537.1512 or visit www.hellermann.tyton.com for published details.

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