

WRENCH



REALITIES

Bob-O Schultze (aka the Wrench)

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A “Wrench” is someone who is actually involved in the installation of RE systems. In other words, them what’s doin’ as opposed to them what’s talkin’. IPP members, folks that have installed their own systems to Code, and many others are mostly wrenches. The time has come for us to share our experiences and views about the National Electric Code (NEC), electrical inspectors, installation techniques, and the RE installation business in general.

Let’s get one thing straight. This Wrench is not anti-NEC. As a working electrician, I use it nearly every day. I am not ashamed to say that I’ve learned more about the correct way to do my job from reading the NEC than we have from any other single source.

The NEC® and You

The NEC is a codified record of wiring techniques whose purpose, in the authors’ words, is the “practical safeguarding of persons and property from hazards arising from the use of electricity.” The key word there is “practical.” The NEC can not protect anyone or anything from poor workmanship or the improper use of electricity by the end user. Perhaps this is why, in spite of 100 years of NEC rule making, electrical fires are still one of the leading causes of property loss. You can’t protect people from themselves. Neither should you attempt to regulate or codify emerging technologies. We can certainly build on and use existing techniques

where they apply, but some leeway is necessary in order for learning to take place. Stifling the learning process by attempting to enforce the letter of the Code in new or untested situations goes beyond the Code’s scope or intent.

The NEC itself recognizes this in Article 90-1(b). “This Code contains provisions considered necessary for safety. Compliance therewith and proper maintenance will result in an installation essentially free from hazard but not necessarily efficient, convenient, or adequate for good service or future expansion of electrical use.” While the authors apparently intended that “adequate for ... future expansion of electrical use” to mean the addition of a second garage, I believe it applies to situations where new electrical generating technologies and methods are used as well. If it doesn’t, then 90-2(b)(5) applies to any RE installation not actually on or in a building intended for uses other than as a shelter for the generation equipment. In plain American, 90-2(b)(5) says that if you are an electric utility, the NEC does not apply to your generation facilities. It doesn’t say public utility, just utility. Reading strictly the letter of the article, one can easily interpret the words to apply to a private utility with a customer base of one: you. Is that the intent of the NEC? I don’t believe so, but therein lies the difference between Code Corner’s ideas and the rest of us. Mr. Wiles seems not to grasp that where the letter of the NEC is inadequate or unclear in a new situation, the intent of the words take precedence over the words themselves.

Liquidtight Conduit in Wet Locations

Mr. Wiles, in Code Corner, puts forth the argument that because the sheltered underside of PV modules is considered by the NEC to be a “Wet Location,” the 60°C Wet rating of the nonmetallic flexible conduit (nfc) applies and the “conduits may not be used at the higher dry temperature ratings when used outdoors.” He builds an impressive hypothetical scenario around that statement. It’s wrong. Let’s take a look at the facts.

The Carlon Electrical Products data sheet on their Carflex® brand liquidtight conduit states the following:

- *UL listed for outdoor use.*
- *Suitable for use at conduit temperatures of 80°C dry, 60°C Wet and 60°C oil resistant as required by section 15-6 of ANSI/NFPA 79-1985 and UL 1660.*

Liquidtight flexible conduits, metallic and nonmetallic, in contrast to rigid PVC conduit and electrical nonmetallic tubing, does not have wire temperature limitations. Any temperature rated wire (for example, 90°C wire) can be used as long as the temperature conditions marked on the conduit are not exceeded. UL listed conduits that are not marked are limited to maximum temperatures of 60° wet or dry.

It seems very clear to me. Conduit temperature means conduit temperature, not conduit location. Of course, this Wrench is not an expert, just a working electrician trying to do the right thing. By the way, I found this data sheet at my local electrical wholesaler. It's there for the asking.

Mr. Wiles writes that he's seen professionally installed PV systems with water in the J-boxes and array-wiring conduits days after any rain. While we Wrenches don't doubt this, we do question the workmanlike manner of the installation and the quality of the PV J-box design. We wonder if Mr. Wiles has seen any nice, clean, dry installations as well? Well installed liquidtight conduit does not leak. Hence the name, "Liquidtight!" Shall we try to formulate policy based on poor workmanship or module design? Neither is covered by the NEC nor can they be. If there are any indicators here, they are that one should use good equipment and hire competent installers.

The Test vs the Test

The Code Corner test procedure for determining the temperature inside of a piece of fnc is flawed. Granted it was an "informal test," but is it scientific? Still, I felt the need to test the premise, so I did a little test of my own. Regretfully, it's mid-October here in the Northwest and temperatures aren't high enough to give us really meaningful hot weather data. On the other hand, the data I did get was significant as to the relationships between temperatures taken at various places in, out, and around the fnc. Here it is, draw your own conclusions.

Methodology

I performed the testing on a actual working PV system with current flowing in the wires during the test. The test jig was ten Siemens PC4JF modules on a dual axis Wattsun tracker. The array wiring and the fnc interconnects are approximately two years old. There were a total of three 10 AWG wires inside the 1/2 inch (trade size) fnc. All of the wires carried between 4.1 and 4.4 Amps at 26 to 28VDC depending on the time of day and household uses.

I used a Fluke 87 DMM, Wavetek TC-253 Temperature/Voltage converter, and an assortment of Wavetek Type K temperature probes. One probe was placed inside the fnc approximately one inch from the module J-box, which I reckoned to be as close to as hot as it gets. Other probes measured ambient air temperature both in the sun and the shade, the temperature on the PV module's back, and the temperature on the outside of the fnc at the point where the sun shined on it through a 3/8 inch crack between modules. I could not measure direct sun on the fnc elsewhere, because the system was designed so that all the rest of the conduit is shaded at all times.

Data points were taken each hour starting two hours before solar noon and ending three hours after. The day was clear and bright with no clouds. The wind speed varied between 0 and 1.5 meters per second. All temperature measurements are in °C.

Results

See for yourself. For me, the interesting measurements are those taken inside the fnc in relation to the back of the PV, and the relationship between the interior and exterior fnc temperatures. In the PV / interior fnc relationship, the warmer the PV got the greater the difference in temperature between it and the inside of the fnc became. This would seem to indicate that the fnc has an insulating effect on the wires within, protecting them somewhat from high PV temperatures rather than the other way around. The temperature on the exterior of the fnc, while absorbing some radiation from the sun and increasing in temperature, seemed to have little effect on the interior fnc temperature.

Conclusions

Very few, really. There isn't enough data in either test to form a conclusion. Neither this test or Mr. Wiles' test is based on the scientific method. There are far too many vagaries and no controls of any kind. It is not good science. About all I can say in defense of my testing is that it attempts, at least, to simulate a real world RE situation using generally accepted test equipment and techniques.

Temperature and Carflex® conduit on a working PV array

Date: 18 October 97

WX: Clear, Bright

All temperature measurements °C

Wind: 0-1.5 meters/second

Time (Solar)	Amb./Shade	Amb./Sun	Carflex/IN	Carflex/Out	Back of PV
Minus 2 Hrs	16.5	18.5	34.4	19.8	34.7
Minus 1 Hrs	18.8	21.8	35.2	21.8	36.1
Solar Noon	19.5	23.0	35.2	24.0	36.5
Noon +1	20.7	24.8	36.5	24.5	38.4
Noon +2	22.0	29.7	37.8	32.0	44.0
Noon +3	23.3	25.3	35.9	31.3	43.3

I am not going to try to draw a conclusion. You can give the tests whatever value or discount you want. Mr. Wiles, on the other hand, seems to have made up his mind and is making recommendations based only on his single informal test. Is this wise?

Mr. Wiles and the 1999 NEC

I counted 67 proposed changes to Section 690 of the NEC. Of those Mr Wiles submitted 59. Of those, 55 were accepted either outright or in principle. Of the eight other submissions, only two were accepted! I'm very concerned that one person's opinion carries so much weight at the NEC, especially given Mr. Wiles' lack of homework on this fnc issue. In future Code Curveball columns we will take a hard look at some of the proposed changes that affect RE.

Want to see what's coming at you in 1999? Point your web browser at <http://roproc.nfpa.org/nec/>. All the proposed changes are there in pdf format. You can download them and view them with Adobe Acrobat Reader®. The reader is available online from lots of places including Home Power at www.homepower.com.

Calling All Wrenches

Look, here's the deal. By myself, this Wrench can easily be dismissed as just another California nutcase. Together, sharing our experience and techniques, we can have real influence.

We're the RE electricians, technicians, end users, and enthusiasts. We're the folks who are working toward RE replacing the power generating sources which are polluting our air, fouling our water, and emitting cancer-causing radiation. What we're not doing is burying RE under a morass of contrived, unreasonable restrictions. These restrictions keep RE beyond the reach of the common person and in control of groups like Sandia, the electric utilities, and the Department of Energy.

Think about this. In the absence of any real-world examples, an inspector, even the ones who think for themselves and follow a logical path, will apply the Code Corner doctrine by default. Let's give them another choice! A different and practical way to look at RE installations. The time is now. The place is here. We can hang together or (if these unreasonably restrictive Code interpretations continue for much longer), starve separately. What do you say?

Access

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