[redacted] Job – String Rewiring

INTRODUCTION

The 2011 N.E.C. states in Article 200 "Grounded Conductors", section 200.7(C):

> ***Circuits of 50 Volts or More.*** *The use of insulation that is white or gray or that has three continuous white stripes for other than a grounded conductor for circuits of 50 volts or more shall be permitted only as in (1) and (2):*
>
> *(1) If part of a cable assembly... [does not apply]*
>
> *(2) A flexible cord... [does not apply]*

Currently, all Array String Wires are Black (Positive) and White (Negative). For the "NEGative ungrounded" Rows (#'s 4, 5, 6; 10, 11, 12; 16, 17, and 18), the "Negative" wires are colored white – however, they are ungrounded – so they must be replaced with wire having insulation colored other than white, gray, or green.

The Plan is to replace / redo the Array String Wires in the above "NEGative ungrounded" Rows, so that all the Negative (ungrounded) wires are black, and all the Positive (grounded) wires are white.

CAVEATS

WARNING: DURING DAYLIGHT, EACH ARRAY STRING GENERATES 500 VDC (TO GROUND). ARRAY CIRCUITS ARE "BACK FED" FROM THE OTHER COMBINERS, AND ALSO FROM THE UTILITY SUPPLY WHICH IS ENERGIZED CONTINUOUSLY. AT ALL TIMES, ALL CONDUCTORS MUST BE CONSIDERED LIVE 500 VDC – UNLESS YOU KNOW FOR CERTAIN OTHERWISE.

CAUTION: EVEN WITH THE COMBINER DISCONNECT AND ALL FUSEHOLDERS OPEN, THE MAIN OUTPUT WIRES CONNECTED TO THE DISCONNECT SWITCH WILL STILL BE LIVE 500 VDC (TO GROUND). MAKE SURE TO AVOID CONTACT WITH THIS TERMINAL AT ALL TIMES; AND, WHEN EXPOSED, COVER TEMPORARILY WITH SUITABLE INSULATION (TAPE OR EQUIVALENT).

PROCEDURE

Start at Row 10 (the 10th Row from the North), on the East half of the Row:

- Open ("turn off") the Disconnect on the front of Combiner # 10. Open the box; open all 36 of the String Cutouts (pull the "Mini-Fuse" Fuseholder toward you).
- Cut and remove all "Ty-Wraps" securing the wires to this half of the "Table" (structural Unistrut / Solar Panel support), discard in Trash Can.
- At all 36 "MC-4" Connectors coupling this half of the Solar Panels to the String Wires: unplug the Connectors; clip the Connectors from the 10-gauge String Wires, and discard in Trash Can.
- Pull all 36 String wires toward the Combiner, about 3 feet. Detach the top of the 2" "NMC" ("Non-Metallic Conduit"), which sleeves the wires entering the Combiner, from the Table. Straighten out the 2" NMC, and pull all 36 wires inside it, until there's about 2 feet more of each wire inside the Combiner. (This is so the Black wires will be long enough to reach all the Fuseholders.)
- If they won't all pull: try to pull them one at a time; or, pull another 6 feet of the String wires toward the Combiner, set the top of the 2" NMC on the ground and straighten it out, then try again to pull the wires through it.
- Pull 2 new White wires from the end of the Row, to the Combiner. Locate the 2 shortest White wires coming out of the 2" NMC at the Combiner – these will be

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labeled "19-" and "20-". Secure the ends of these to the 2 new wires, and pull the old ones out & the new ones through the 2" NMC, into the Combiner. Label the new wires "35+" and "36+" at each end.

- If it will reach, attach the 2" NMC to the Table, reusing the old 2" "Minerallac" Strap. If it won't reach, strap it back where it was.
- Pull the slack out of all the wires, from the Combiner to the end of the Row. At the end of the Row, leave the 2 new White wires hanging down near where they will connect to the Panels. Make sure both are still labeled at each end.
- At the next connection point, 11 Panels from the end of the Row: locate the longest 2 Black wires (labeled "35+" and "36+"), leave them hang down where they will connect, and relabel them "35-" and "36-" near both ends. Also locate the 2 next-longest White wires (labeled "35-" and "36-"), leave them hang down there too, and relabel them "33+" and "34+". If the labels are missing at one or both ends: strip back a wire and hold it to the Table, while another worker identifies it with a DMM at the other end; then label it.
- At the next connection point, another 11 Panels down: locate the 2 next-longest Black wires (labeled "33+" and "34+"), leave them hang down where they will connect, and relabel them "33-" and "34-" near both ends. Also locate the 2 next-longest White wires (labeled "33-" and "34-"), leave them hang down there too, and relabel them "31+" and "32+".
- Continue this at each connection point, until you reach the Combiner. The 2 closest wires to the Combiner should be Black, and labeled "19-" and "20-".
- At the Combiner, secure the wires coming out of the 2" NMC to the "Table", with a large Ty-Wrap. Moving toward the end of the Row, pull out the slack and secure the wires neatly to the Table with a large Ty-Wrap, every 3 to 5 feet.
- At the Combiner, connect all the Black wires to the Fuseholders, starting with "19-" at the 19th Fuseholder from the top, moving down to "36-" at the bottom. Connect all the White wires to one side of the "Common Block", starting with "19+" at the top of the block, moving down to "36+" at the bottom.
- Install a MC-4 Connector on the Solar Panel end of each wire, making sure it's the correct "Polarity" to connect to the Panel (White will plug into Positive "+", and Black to Negative "-"). Make sure the wire is (still) labeled near the Connector. DO NOT CONNECT ("PLUG IN") ANY MC-4'S, UNLESS / UNTIL ALL STRING WIRES ON THIS HALF OF THE ARRAY, ARE CONNECTED INSIDE THE COMBINER.
- AFTER all wires have been connected inside the Combiner: plug in the MC-4 Connectors; secure wiring as needed with Cable Clips and/or Ty-Wraps.
- Using a DMM, connect its "Common" lead to the Common Block. With the other lead, verify presence of approx. "-500 VDC" at the wiring terminal of each fuse. If not, trace and repair as needed.
- Repeat similar to the above, for the West half of the Row.
- Carefully remove the temporary insulation from the Disconnect Terminal. Close all Combiner Fuseholders; secure the covers; close the Disconnect Switch.

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Two skilled, motivated electrical workers might be able to complete the above procedure in about 8 hours - parts, weather, and unexpected issues permitting.

MATERIALS NEEDED FOR ONE ROW

700'	10-gauge PV wire, Black (allowing 10% loss / breakage)
700'	10-gauge PV wire, White (")
40	MC-4 Connector, Male (")
40	MC-4 Connector, Female (")
200	Large Ty-Wrap (")
100	Cable Clips (leftover "Cooper B-Line" Clips are fine)

TOOLS NEEDED FOR EACH ROW

2	Cable Stand (for Rolls of 10-gauge PV wire)
1	5 - 10' piece of 1-1/2" HW Conduit (or equivalent - for Cable Stands)
1 or 2	Installation (Crimp) Tool for MC-4 Connectors
1 or 2	Wire Labeler, incl. sufficient Label Tape and Batteries
1 (?)	Gator

CONCLUSION

We will need the above parts and tools at 7 A.M., for each Row we intend to redo that day. If we want to start 2 Rows on Monday, we will need twice the above.

If you do not have this "on hand", we will need to get it "on hand" by 7 A.M. Monday. If your Supplier is open today, I suggest you call them, make sure they have this in stock, make sure they can ship TODAY via UPS / FedEx/ DHL OVERNIGHT.

If your Supplier is not open today, or if they cannot ship the above today via UPS / FedEx/ DHL overnight: I suggest you do an internet search, and find a Supplier that is open today, has the above, can ship the above TODAY via UPS / FedEx/ DHL OVERNIGHT, and accepts payment by credit card. I strongly suggest you do this right away, so they can make the overnight shipment cutoff time today.

Clearly, if we intend to get all 9 "NEGative ungrounded" Rows redone, we'll need 9 times the materials in above list, on site in a timely manner.

Four workers (you, me, Don, Peter) might be able to redo two complete Rows on Monday; two on Tuesday; two on Wednesday; two on Thursday; and the 9th Row on Friday. Parts, weather, and unexpected issues permitting.