

PV Solar Inspection Procedure

Documents:

- 1) Ensure the system was designed per the IRC or IBC and in accordance with IFC
 - a) IRC R324/IBC1509.7
 - b) IFC 605.11.3.1 – 605.11.3.3.3
 - c) IRC R324.4.4.2
 - d) Module manufacturer, make, model, and number of modules match the approved plans. IBC 107.4 - Amended Construction Documents
- 2) Review system permit for special notes from local AHJ
- 3) Review system design plans and specifications
- 4) Check components for proper labeling, Modules are properly marked and labeled per NEC 110.3, 690.4(B) & 690.51 or 690.52
- 5) All PV system conductors, conduit, raceways, and cables sized and installed per the approved plans are per permitted plans
- 6) Determine operating system (Grid-tied, Stand-alone, or hybrid)
- 1) Rapid shutdown initiation device per permitted plans; 1 and 2 family dwellings must be outside at a readily accessible location per 690.12(C). PV system disconnecting means labeled “PV SYSTEM DISCONNECT” and readily accessible per NEC 690.13(A) & (B). Disconnect may be an externally operable general-use switch or circuit breaker, or other approved means.
- 7) Proper diagrams or placards are provided at the building electric service equipment and other power source locations per NEC 706.11

System Support/Location Check List:

- 1) Is PV system Roof Top or Ground Mount type?
- 2) Is supporting structure adequate for system, showing signs of structural failure?
- 3) Slope of Roof is greater than 2:12? If so, need panel layout to include whether roof is:
 - a) Hips only Roof (IFC 605.11.3.2.1)
 - b) Hips/Valley Roof (IFC 605.11.3.2.3)
 - c) Single Ridge (IFC 605.11.3.2.2)
 - d) Multiple Ridge (IFC 605.11.3.2.4)
 - e) Access for Fire Fighters (IFC 605.11.3.2.1)
- 4) Roof system penetrations are flashed per IRC Chapter 9, section R903, R324.4.3
- 5) Racking/PV support structures installed and torqued per manufacturer requirements and permitted plans

System Access Check List:

- 1) Is PV system accessible from ground or requires additional access equipment (i.e. ladder)?
- 2) Roof access points, paths and clearances comply with (IFC 605.11.3.1 – 605.11.3.3.3)?
- 3) Does access place ladders/equipment over openings or at points conflicting with overhead obstructions (tree limbs, wires, etc.)?

Electrical System Review:

- 1) System has proper UL, NEC, IRC & IBC listings for all components?
- 2) Component UL ratings are:
 - a) PV Modules UL 1703, if AC modules also listed to UL 1741
 - b) Inverters UL 1741, grid-tied inverters need identification for use with interactive systems
 - c) 3+ strings are combined, a listed combiner box is used and fuses required per UL 1741
- 3) Component NEC ratings are:
 - a) PV Modules NEC 000.3, 690.4(B)
 - b) Inverter rating per NEC 690.4(B)
 - c) Residential 1 & 2 family dwellings limited to PV system voltage of 600 DC per NEC 690.7
 - d) Grounding electrode present and per NEC 690.8(A)(1)
 - e) Calculated maximum source circuit current is sum of parallel-connected module multiplied by 125% per NEC 690.8(A)(1).
 - f) Calculated maximum output circuit current is sum of combined source circuits per NEC 690.8(A)(2).
 - g) DC source circuit conductors are rated to 125% of ampacity when calculated above or with conditions of use applied (whichever is greater) per NEC 690.8(B)(1&2).
 - h) Inverter output circuit OPD (connected to AC system breaker) is sized based on maximum output current of inverter X 125% per NEC 690.8(A)(3), 690.8(B)(1), & 705.60(B).
 - i) OCP is required for:
 1. PV source circuit (modules/parallel) except for series string modules w/out source of overcurrent exceeding ampacity of conductors/modules per NEC 690.9(A)
 2. PV output circuit (conductors between source circuits and inverter)
 3. inverter output circuit
 4. Battery circuit conductors and equipment per NEC 690.9(A)
 5. OCP devices is not required for circuits with sufficient ampacity for the highest available current per NEC 690.9(A)
 - j) When DC source circuits are connected in parallel w/out fusing, the current through a failed circuit can be the sum of the current connected from other strings. Special considerations must be taken to ensure the sum of total number of strings less 1 does not exceed manufacturers series fuse rating or conductor ampacity per NEC 110.3(B) and 690.9(A); note special exception for higher series fuse rating and low current short circuit.
 - k) OCP devices shall be rated for 125% of the ampacity calculated or rated as an assembly for continuous duty per NEC 690.9(B)
 - l) PV source & output circuits, and must be in same polarity for all circuits, can have a single OCP device per circuit in either the + or – conductor
 - m) Disconnect for PV system shall disconnect from all other systems per NEC 690.13
 - n) Disconnect/isolation devices are required for all ungrounded conductors per NEC 240.15 & 690.15
 - o) Systems with Batteries must:
 1. Be listed per NEC 480.3
 2. Have disconnect for ungrounded conductors from batteries over 50V AC/60V DC per NEC 480.7 & 706.7
 3. Have been connected by qualified professional (licensed)
 4. Have high interrupt DC rated fuses or circuit breakers used in circuits (AIC of at least 20K amps) per NEC 706.21(C) & 110.9

5. Flexible battery cables do not leave the battery enclosure per NEC 400.12
6. Flexible, fine strand cables are only be used with terminals, lugs, devices, and connectors that are listed and marked for such use per NEC 110.3(B) & 110.14
7. Area is well ventilated and the batteries are not installed in living areas per NEC 408.10 & 706.10(A)
8. Live parts of battery systems are guarded to prevent accidental contact by persons or objects per NEC 706.10(B)
9. Working space and illumination are provided around the battery installation per NEC 706.10 (C),(D) & (E)

Wiring Methods:

- 1) Bonding fittings used for:
 - a) Ferrous metal conduits enclosing grounding conductors per NEC 250.64(E)
 - b) Concentric/eccentric knockouts with metal conduits for circuits over 250 volts to ground per NEC 250.97 (see also exceptions 1 through 4)
- 2) For underground conductor installations, the burial depth is appropriate per NEC 300.5(D)(3) & Table 300.5, 300.50 & Table 300.50
- 3) For conductors installed where ambient temperatures exceed 86°F (30°C) conductor ampacities should be corrected for higher temperatures per 2017 NEC Table 690.31(A)
- 4) PV source and output circuits must be separated from non-PV system circuit conductors and inverter output circuit conductors per NEC 690.31(B)
- 5) DC positive and negative conductors should not be identified with white or grey except for solidly grounded PV system conductors per 690.31(B)(1)
- 6) Single conductor cables are secured within 12 inches of each box, cabinet, conduit body or other termination per NEC 690.31(C); PV system conductors shall be grouped and identified per 2017 NEC 690.31
- 7) Single conductor cables are secured by staples, cable ties, straps, hangers or similar fittings at intervals that do not exceed 4.5 feet per NEC 690.31(C)
- 8) Exposed single conductor wire per NEC 690.31(C), if the wiring is in a conduit, it is 194°F (90°C), wet-rated type RHW-2, THWN-2, or XHHW-2 per NEC 310.15
- 9) DC conductors inside a building are in a metal raceway or MC metal-clad cable that complies with 250.118(10), or metal enclosures per NEC 690.31(G)
- 10) Flexible metal conduit smaller than 3/4" or Type MC cable smaller than 1", where used, closely follows the surface of the building finish or of the running boards per 2017 NEC 690.31(G)(2) & IFC 605.11.2
- 11) Properly sized equipment grounding conductor is routed with the circuit conductors per NEC 690.45, 250.134(B) & 300.3(B)
- 12) Separate grounding electrodes, if used, are bonded together per NEC 690.47, 250.50 & 250.58

Conductor Raceway/Conduit Assembly:

- 1) All conduit, raceways, and cables sized and installed per the approved plans.

- 2) Terminals containing more than one conductor are listed for multiple conductors per NEC 110.14(A) & 110.3(B)
- 3) DC wiring in buildings is installed in metallic conduit or raceways per IFC 605.11.2 & NEC 690.31(G)
- 4) The markings on the conduits, raceways and cable assemblies are every 10 feet, within one foot of all turns or bends and within one foot above and below all penetrations of roof/ceiling assemblies, walls and barriers per NEC 690.31(G)(4) IFC 605.11.1.4
- 5) Rooftop DC Conduits are located as close as possible to the ridge or hip or valley and from the hip or valley as directly as possible to an outside wall to reduce trip hazards and maximize ventilation opportunities per IFC 605.11.2
- 6) Conduit runs between sub arrays and to DC combiner boxes are installed in a manner that minimizes total amount of conduit on the roof by taking the shortest path from the array to the DC combiner box IFC 605.11.2
- 7) DC Combiner Boxes are located so that conduit runs are minimized in the pathways between arrays IFC 605.11.2
- 8) Expansion fittings must be installed where necessary to compensate for thermal expansion, deflection, and contraction per NEC 300.7(B)

Connectors:

- 1) Connectors and terminals used for fine strand conductors are listed for use per NEC 110.3(B) & 110.14(A)
- 2) Connectors are listed for the voltage of the system and have appropriate temperature and ampere ratings per NEC 110.3(B) & 110.14
- 3) Crimp on terminals are listed and installed using a listed tool specified for use in crimping those specific crimps per NEC 110.3(B) & 110.14, pressure terminals are listed for the environment and tightened to manufacturer recommended torque specifications per NEC 110.3(B), 110.11, & 110.14(D)
- 4) Twist on wire connectors are listed for the environment (i.e. wet, damp, direct burial, etc.) and installed per manufacturer's instructions per NEC 110.3(B), 110.11, 110.14 & 300.5(B)
- 5) Power distribution blocks are listed and rated for DC if used with DC PV circuits per 2017 NEC 314.28(E) & 376.56 690.4
- 6) Grounding - modules are bonded in accordance with manufacturer's installation instructions using the supplied hardware or listed equipment specified in the instructions and identified for the environment per NEC 110.3(B) & 690.43(A); racking systems used to bond the modules must be listed per UL 2703
- 7) PV circuits embedded in built-up (BUR), laminate, or membrane roofing materials (where not covered by modules /or associated equipment) shall be clearly marked per NEC 690.31(G)(1)

Modules:

- 1) Modules are attached to the mounting structure according to the manufacturer's instructions and the approved plans per NEC 110.3(B), 2009 & 2012 IBC 107.4

- 2) Module connectors are tight and secure per NEC 110.3(B) & 110.12
- 3) PV modules are in good condition (free of damage) per NEC 110.12(B)

Accessible Equipment (Ground Level):

- 1) Equipment locations, models, and specifications match the approved plans.
- 2) Connection from PV system to grounding electrode system made per the approved plans. (NEC 690.47)
- 3) Overcurrent devices in the PV DC circuits are listed for use in PV system and ratings match the approved plans. (NEC 110.3(A),(B), 690.9(B))
- 4) Disconnects used in PV systems must be rated for the maximum short circuit current and voltage. A DC PV system disconnecting means shall be marked for use in PV systems or be suitable for back-feed operation per NEC 110.3 & 690.13(E) and (F)
- 5) Isolating devices or disconnects are installed for the PV equipment, either integrated into the equipment or within 10' of the equipment per NEC 690.15
- 6) All interior and exterior DC conduit, enclosures, raceways, cable assemblies, junction boxes, combiner boxes, and disconnects on buildings are marked. "The markings say "WARNING: PHOTOVOLTAIC POWER SOURCE" and have 3/8-inch (9.5 mm) minimum-sized white letters on a red background. The signs are made of reflective weather resistant material per IFC 605.11.1.1, 605.11.1.2 & NEC 690.31(G)(3)
- 7) Connectors that are readily accessible and operating at over 30 volts DC or 15 volts AC require a tool for opening per NEC 690.33(C)
- 8) PV source and output circuits in readily accessible locations and operating over 30V must be guarded or in a raceway.

Inverter

- 1) Inverter is properly secured with manufacturers required clearances per NEC 110.3(B), 110.13)
- 2) Verify listed equipment
 - a. provides DC ground-fault protection for DC PV array per NEC 690.41(B)
 - b. provides DC arc-fault protection for PV system operating over 80V per NEC 690.11

Utility Interconnection & Rapid Shutdown

- 1) Point of connection is either on the supply side of the service disconnecting means or at a dedicated breaker or disconnect on the load side of the service disconnecting means per 2017 NEC 705.12(A) & (B)(1)
- 2) For load side connections, total rating of the overcurrent devices supplying a panelboard plus 125% of the inverter output current does not exceed 120% of the rating of the panelboard busbars per NEC 705.12(B)(2)(3)(a)
- 3) For load side connections, PV interconnect breaker is located at the opposite end of the bus from the feeder connection, unless the bus assembly has ampacity rating equal to or greater than the sum of 125% of the inverter output current and the rating of the overcurrent device protecting the panelboard per NEC 705.12(B)(3)
- 4) For supply-side connections, the sum of the ratings of all OCPDs connected to the power source must not exceed the rating of the service per NEC 705.12(A). OCP for supply-side connected power source conductors must be provided within 3m (10') of the point of interconnection to the service per NEC 705.31
- 5) Installed rapid shutdown equipment, other than the initiation device, must be listed for the application per NEC 690.12(D)
- 6) Rapid shutdown equipment must control PV system conductors to within limits of NEC 690.12(B)

Labels are phenolic where exposed to sunlight. Labels required on conduit are permanent, weather resistant and suitable for the environment. Labels have a red background with white lettering. The following labels are required as applicable:

SIGNAGE REQUIREMENTS FOR PV SYSTEMS

Code Section	Location of Label	Text
NEC 690.13(B)	On the PV system disconnect as Identified in Figure 690.1(B)	PV SYSTEM DISCONNECT
NEC 690.13(B)	Disconnects with power on line and load terminals when in the open position	WARNING ELECTRIC SHOCK HAZARD TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION
NEC 690.53	On the DC disconnects	(1) Maximum voltage Informational Note to (1): See 690.7 for voltage. (2) Maximum circuit current Informational Note to (2): See 690.8(A) for calculation of maximum circuit current. (3) Maximum rated output current of the charge controller or dc-to-dc converter (if installed)
NEC 690.54	At interactive points of inter-connection, usually the main service	RATED AC OUTPUT CURRENT ____ AMPS NORMAL OPERATING AC VOLTAGE ____ VOLTS
NEC 690.56(B) 705.10	At the electrical service and at the PV inverter if not at the same location	A directory providing the location of the service disconnecting means and the photovoltaic system disconnecting means
NEC 690.56(C)	At the service disconnecting means	RAPID SHUTDOWN LABELS FOR TYPE OF SYSTEM INSTALLED
NEC 705.12(B)(2) (3)(b)	Inverter output OCPD	WARNING:POWER SOURCE OUT PUT CONNECTION — DO NOT RELOCATE THIS OVERCURRENT DEVICE.
NEC 690.55	Battery enclosure	MAXIMUM OPERATING VOLTAGE, EQUALIZATION VOLTAGE POLARITY OF GROUNDED CONDUCTORS
IFC 605.11.1.4	On conduit, raceways, and enclosures, mark every 10 feet, at turns, above/below penetrations	WARNING: PHOTOVOLTAIC POWER SOURCE
NEC 705.12(B)(3)	Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.	