

# Photovoltaic Systems (Solar Panels)



## **CITY OF BEACHWOOD, OHIO**

### **BUILDING DEPARTMENT**

25325 Fairmount Blvd

216-292-1914

# GENERAL REQUIREMENTS

1. Photovoltaic Systems must comply with the **2019 Residential Code of Ohio Section 324—Solar Energy Systems**
2. Photovoltaic Systems must comply with the **2023 National Electric Code Section 690—Solar Photovoltaic (PV) Systems**
3. Photovoltaic Systems must comply with the **2017 Ohio Fire Code Section 605.11—Solar Photovoltaic (PV) Power Systems**
4. All submitted documents must be stamped by a design professional or PV professional
5. Structural analysis must be performed by a design professional for roof mounted array's.
6. If you belong to a Homeowner's Association, check with them to discuss their regulations prior to submitting plans to the Building Department.
7. Building Code and Codified Ordinance information available at:  
[www.BeachwoodOhio.com](http://www.BeachwoodOhio.com).
8. All Manufacture Installation Instructions must be followed.
9. All equipment and products used must be Listed by a recognized electrical testing agency and bare a Label.
10. This is not an all inclusive list of the requirements.
11. THIS DOCUMENT IS NOT INTENDED TO PRECLUDE THE USE OF OTHER CONSTRUCTION METHODS OR MATERIALS NOT SHOWN HEREIN.

# Checklist

## RACKING

1. Roof penetrations are flashed to prevent moisture from entering the roof. (2019 R.C.O. Chapter 9 & 324.4.3)
2. Racking and PV system support structures installed and torqued per manufacturers instructions and approved plans.

## WIRING METHODS CONDUCTORS

1. All PV system conductors are sized and identified per the approved plans.
2. Bonding fittings are used for ferrous metal conduits enclosing grounding electrode conductors. NEC 250.64(E)
3. Bonding fittings are used on concentric/eccentric knockouts with metal conduits for circuits over 250 volts to ground. NEC 250.97 (see also exceptions 1 through 4)
4. For underground conductor installations, the burial depth is appropriate. NEC 300.5(D) (3) & Table 300.5, 300.50 & Table 300.50
5. For conductors installed where ambient temperatures exceed 30°C conductor ampacities should be corrected for higher temperatures. 2017 NEC Table 690.31(A)
6. PV source and output circuits must be separated from non-PV system circuit conductors and inverter output circuit conductors. NEC 690.31(B)(1)
7. DC positive and negative conductors should not be identified with white or grey except for solidly grounded PV system conductors. NEC 690.31(B)(2)
8. Single conductor cables must be secured requirements. NEC 690.31(C)(1)
9. PV system conductors shall be grouped and identified. NEC 690.31(B)
10. Single conductor cables are secured by staples, cable ties, straps, hangers or similar fittings at intervals that do not exceed 24" for #8 or smaller and 54" for larger than #8. NEC 690.31(C)(1)
11. Exposed single conductor wiring is a 90°C, wet rated and sunlight resistant type USE-2 or listed PV wire. (NEC 690.31(C)) If the wiring is in a conduit, it is 90°C, wet-rated type RHW-2, THWN-2, or XHHW-2. NEC 310.15

## Checklist Cont.

12. DC conductors inside a building are in a metal raceway or MC metal-clad cable that complies with 250.118(10), or metal enclosures. NEC 690.31(D)(1)
13. Flexible metal conduit smaller than 3/4" or Type MC cable smaller than 1", where used, clo
14. Properly sized equipment grounding conductor is routed with the circuit conductors. NEC 690.45 & 250.122
15. Additional grounding electrodes shall be permitted to be installed in accordance with 250.52 and 250.54 and can be connect to the PV module frame or support structure. NEC 690.47

### CONDUIT, RACEWAYS, CABLE 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. NEC 110.14(A) & 110.3(B)
3. DC wiring in buildings is installed in metallic conduit or raceways. NEC 690.31(D)
4. The markings on the conduits, raceways and cable assemblies are every 10 feet with white lettering 3/8" tall and red background. Labels must be on every section of the system which is separated by walls, partitions, ceilings or floors and suitable for the environment which it is in. NEC 690.31(D)(2)
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. OFC 605.11
6. Expansion fittings must be installed where necessary to compensate for thermal expansion, deflection, and contraction. NEC 300.7(B)

# Checklist Cont.

## CONNECTORS

1. Connectors and terminals used for fine strand conductors are listed for use with such conductors. NEC 110.3(B) & 110.14(A)
2. Crimp on terminals are listed and installed using a listed tool specified for use in crimping those specific crimps. NEC 110.3(B) & 110.14
3. Pressure terminals are listed for the environment and tightened to manufacturer recommended torque specifications. NEC 110.3(B), 110.11, & 110.14(D)
4. Connectors are listed for the voltage of the system and have appropriate temperature and ampere ratings. NEC 110.3(B) & 110.14

## MODULES

1. Module manufacturer, make, model, and number of modules match the approved plans. Modules are properly marked and labeled and Listed. NEC 110.3, 690.4(B)
2. Modules are attached to the mounting structure according to the manufacturer's instructions and the approved plans. NEC 110.3(B)
3. Module connectors are tight and secure. NEC 110.3(B) & 110.12
4. PV modules are in good condition (i.e., no broken glass or cells, no discoloration, frames not damaged, etc.). NEC 110.12(B)
5. Grounding and Bonding - modules and equipment 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 NEC 110.3(B) & 690.43
6. If the racking system is used to bond the modules, the module/rack assembly is listed to bonding attribute of UL 2703.
7. DC grounding configuration and fault detector-interrupter (GFDI) installed per NEC 690.41

# Checklist Cont.

## **INVERTER**

1. Inverter is properly secured with manufacturers required clearances NEC 110.3(B), 110.13
2. AC and DC terminations are properly torqued NEC 110.14(D)
3. Verify listed equipment provides DC Ground fault Detector-interrupter (GFDI) protection for the DC PV array NEC 690.41(B)
4. Required labels per Signage Requirements.

## **POINT OF UTILITY INTERCONNECTION**

1. Point of connection is either on the supply side of the service disconnecting means or at a new service. NEC 705.11
2. For load side source connections. NEC 705.12
3. Arc-Fault Circuit Protection—PV systems over 80 volts between any two conductors must detect arc-fault in all components of the system. NEC 690.11
4. Rapid Shut Down—PV systems require rapid shut down for firefighters. NEC 690.12
5. PV system disconnecting means, location and labeling. “PV SYSTEM DISCONNECT” label and must be a readily accessible disconnect. May be an externally operable general-use switch or circuit breaker, or other approved means. NEC 690.13
6. Required labels per Signage Requirements.

# Checklist Cont.

## **RAPID SHUTDOWN**

1. Rapid shutdown initiation device installed and located per approved plans. For one and two family dwellings device must be outside at a readily accessible location. NEC 690.12(C)
2. Installed rapid shutdown equipment, other than the initiation device, must be listed for the application NEC 690.12(D). Rapid shutdown equipment must control PV system conductors to within the limits of NEC 690.12(B)
3. Required labels per Signage Requirements. NEC 690.12(D)

## **ENERGY STORAGE SYSTEM BATTERIES**

1. ESS must be Listed and visible nameplate. NEC 706.4
2. Flexible, fine strand cables are only be used with terminals, lugs, devices, and connectors that are listed and marked for such use. NEC 110.3(B) & 110.14
3. Disconnecting means shall be provided to disconnect all power and equipment. Disconnect must be readily accessible, 10' from ESS and lockable. Disconnect must be labeled as ESS Disconnect with voltage. Maximum voltage for residential is 100vdc. NEC 706.15 (A)(B)(C) & 706.20(B)
4. Ventilation is required for any possible gases from the storage device. If present, to prevent accumulation of an explosive mixture. NEC 706.20(A)

## PHOTOVOLTAIC SYSTEM LABELING REQUIREMENTS

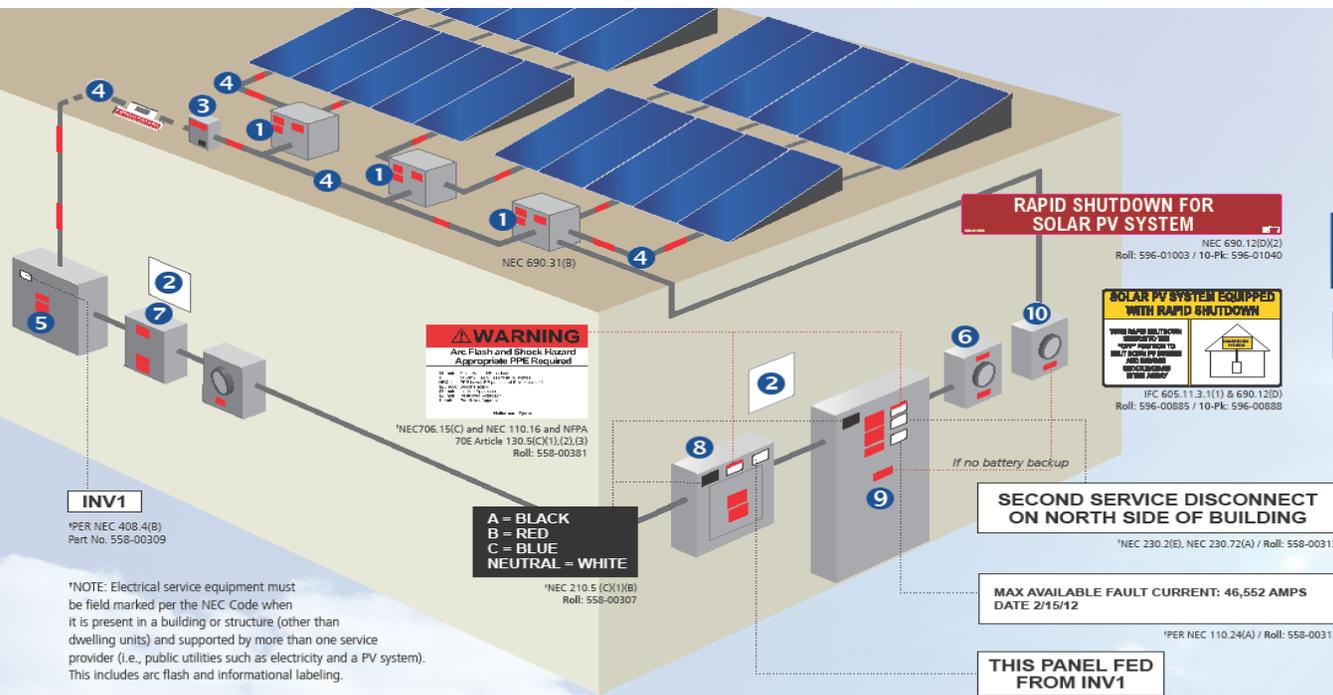
NEC 2023 Article 690

### Adhesive Fastened Signs

ANSI Z535.4-2011 Product Safety Signs and Labels, provides guidelines for suitable font sizes, words, colors, symbols, and location requirements for labels. **NEC 110.21(B)(1)**

The label shall be of sufficient durability to withstand the environment involved. **NEC 110.21(B)(3)**

Adhesive fastened signs may be acceptable if properly adhered. Vinyl signs shall be weather resistant. **IFC 605.11.1.3**



**INV1**

\*PER NEC 408.4(B) Part No. 558-0039

\*NOTE: Electrical service equipment must be field marked per the NEC Code when it is present in a building or structure (other than dwelling units) and supported by more than one service provider (i.e., public utilities such as electricity and a PV system). This includes arc flash and informational labeling.

**WARNING**  
Arc Flash and Shock Hazard  
Appropriate PPE Required

A = BLACK  
B = RED  
C = BLUE  
NEUTRAL = WHITE

The diagram shown in this poster is an illustration of one photovoltaic labeling scenario. The number and type of labels needed will vary based on the project scope and its related specifications. Check with AHJ for local requirements. UL1741 allows the use of either PV or Photovoltaic on the pre-printed label.

#### 1 Combiner Box / Circuits / Conduit Combiner Box / Enclosures / EMT Enclosures

**WARNING**  
ELECTRICAL SHOCK HAZARD.  
TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION

NEC 705.20(7) & NEC 690.13(B)  
Roll: 596-00878 / 10-Pk: 596-00893

**WARNING**  
TURN OFF PHOTOVOLTAIC AC DISCONNECT PRIOR TO WORKING INSIDE PANEL

NEC 110.27(C) & OSHA 1910.145(f)(7)  
Roll: 596-00499 / 10-Pk: 596-00664

#### 2 Building / Structure

THIS EQUIPMENT SUITABLE FOR ATTACHMENT TO FLOATING STRUCTURES, OR ATTACHED TO STRUCTURES FLOATING ON BODIES OF WATER.

NEC 690.4(G) / Roll: 558-00337

**CAUTION**  
MULTIPLE SOURCES OF POWER

NEC 705.10 & NEC 710.10  
Roll: 558-00358 OR 558-00346

#### 3 DC Disconnect / Breaker / Recombiner Box

**WARNING**  
ELECTRICAL SHOCK HAZARD  
TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION

DC VOLTAGE IS ALWAYS PRESENT WHEN SOLAR MODULES ARE EXPOSED TO SUNLIGHT

NEC 705.20(7) & NEC 690.13(B) / Roll: 596-00879 10-Pk: 596-00894

**PHOTOVOLTAIC DC DISCONNECT**

NEC 690.13(B)  
Roll: 596-00238 / 10-Pk: 596-00854

RATED AC OPERATING CURRENT  
MAX RATED AC OPERATING CURRENT  
RATED AC OPERATING VOLTAGE  
MAX RATED AC OPERATING VOLTAGE  
RATED SHORT CIRCUIT CURRENT  
MAXIMUM SYSTEM VOLTAGE

FOR MARKING DC BACKUP SYSTEMS / Roll: 596-00240

**MAXIMUM DC VOLTAGE OF PV SYSTEM**

NEC 690.53 / Roll: 596-01001 / 10-Pk: 596-01009

#### 4 EMT / Conduit Raceways

**SOLAR PV DC CIRCUIT**

NEC 690.31(D)(2) / Roll: 596-00998 / 10-Pk: 596-01006

**PHOTOVOLTAIC POWER SOURCE**

NEC 690.31(D)(2) / Roll: 596-00999 / 10-Pk: 596-01007

#### 5 Inverter

**WARNING**  
THE DISCONNECTION OF THE GROUNDED CONDUCTOR(S) MAY RESULT IN OVERVOLTAGE ON THE EQUIPMENT

NEC 690.31(E) / Roll: 596-09323 10-Pk: 596-09324

#### 6 Production / Net Meter (Bi-directional)

**WARNING DUAL POWER SOURCE**  
SECOND SOURCE IS PHOTOVOLTAIC SYSTEM

NEC 705.30(C) & NEC 690.59 / Roll: 596-00495 10-Pk: 596-09665

#### 7 AC Disconnect / Breaker / Points of Connection

**WARNING**  
ELECTRICAL SHOCK HAZARD.  
TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION

NEC 706.20(7) & NEC 690.13(B)  
Roll: 596-00878 / 10-Pk: 596-00893

**WARNING**  
THIS EQUIPMENT FED BY MULTIPLE SOURCES: TOTAL RATING OF ALL OVERCURRENT DEVICES EXCLUDING MAIN POWER SUPPLY SHALL NOT EXCEED CAPACITY OF BUSBAR

NEC 705.12(B)(3) / Roll: 596-01000 10-Pk: 596-01008

#### 8 Breaker Panel / Pull Boxes

**WARNING**  
ELECTRICAL SHOCK HAZARD  
TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION

NEC 705.20(7) & NEC 690.13(B)  
Roll: 596-00878 / 10-Pk: 596-00893

**WARNING**  
TURN OFF PHOTOVOLTAIC AC DISCONNECT PRIOR TO WORKING INSIDE PANEL.

NEC 110.27(C) & OSHA 1910.145(f)(7)  
Roll: 596-00499 / 10-Pk: 596-00664

#### 9 Main Service Disconnect

**WARNING**  
ELECTRICAL SHOCK HAZARD  
TERMINALS ON THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION

NEC 690.13(B) & NEC 690.13(B)  
Roll: 596-00878 / 10-Pk: 596-00893

**WARNING**  
TURN OFF PHOTOVOLTAIC AC DISCONNECT PRIOR TO WORKING INSIDE PANEL

NEC 110.27(C) & OSHA 1910.145(f)(7)  
Roll: 596-00499 / 10-Pk: 596-00664

**WARNING**  
SINGLE 120-VOLT SUPPLY DO NOT CONNECT MULTIWIRE BRANCH CIRCUITS

NEC 705.82 & NEC 710.15(C) / Roll: 596-00591 10-Pk: 596-00699

**DO NOT DISCONNECT UNDER LOAD**

NEC 690.15 (B) & NEC 690.33(D)(2)  
Roll: 596-00244 / 10-Pk: 596-00671

**CAUTION**  
PHOTOVOLTAIC SYSTEM CIRCUIT IS BACKFED

NEC 705.30(D) & NEC 690.59  
Roll: 596-00587 / 10-Pk: 596-00666

**WARNING DUAL POWER SOURCE**  
SECOND SOURCE IS PHOTOVOLTAIC SYSTEM

NEC 705.30(C) & NEC 690.59 / Roll: 596-00495 10-Pk: 596-09665

**WARNING**  
POWER SOURCE OUTPUT CONNECTION DO NOT RELOCATE THIS OVERCURRENT DEVICE.

NEC 705.12 (B)(3) / Roll: 596-00893 10-Pk: 596-00894

**MAIN PHOTOVOLTAIC SYSTEM DISCONNECT**

NEC 690.13(B) / Roll: 596-00243 10-Pk: 596-00675

#### 10 Main Service Disconnect / Utility Meter

**MAIN PHOTOVOLTAIC SYSTEM DISCONNECT**

NEC 690.13(B) / Roll: 596-00243 10-Pk: 596-00675

#### 11 Energy Storage Systems

NOMINAL ESS AC VOLTAGE: \_\_\_\_\_  
MAXIMUM ESS DC VOLTAGE: \_\_\_\_\_  
AVAILABLE FAULT CURRENT DERIVED FROM THE ESS: \_\_\_\_\_  
DATE CALCULATION PERFORMED: \_\_\_\_\_

**WARNING**  
FUEL CELL POWER SYSTEM CONTAINS ELECTRICAL ENERGY STORAGE DEVICES

NEC 692.52 / Roll: 596-01002 / 10-Pk: 596-01010

**ENERGY STORAGE SYSTEM DISCONNECT**

NEC 706.15(C) / Roll: 596-01004 / 10-Pk: 596-01041