Article 690. Article 690 is organized into 9 different parts:

Part I General
Part II Circuit Requirements
Part III Disconnecting means
Part IV Wiring Methods
Part V Grounding
Part VI Marking
Part VII Connection to other Sources
Part VIII Storage batteries
Part IX Systems over 600 Volts

690.1 Scope. This article applies to solar photovoltaic (PV) electrical energy systems, including the array circuit(s), inverter(s), and controller(s) for such systems .Solar photovoltaic systems covered by this article may be interactive with other electrical power production sources or standalone, with or without electrical energy storage such as batteries. These systems may have ac or dc output for utilization.

690.3 Other Articles. The 2011 code requires that wherever the requirements of other articles of this Code and Article 690 differ, the requirements of Article 690 shall apply and, if the system is operated in parallel with a primary source(s) of electricity, the requirements in 705.14, 705.16, 705.32, and 705.143 shall apply.

Exception: Solar photovoltaic systems, equipment, or wiring installed in a hazardous (classified) location shall also comply with the applicable portions of Articles 500 through 516.

690.4 (G) Bipolar Photovoltaic Systems. The 2011 code has added language which addresses bipolar photovoltaic systems. If the sum of two monopole subarrays voltages exceeds the rating of the conductors and connected equipment, the monopole subarrays in a bipolar PV system are required to be physically separated. The electrical output circuits from each monopole subarray are required to be installed in a separate raceway until connected to the inverter. The disconnect and overcurrent protective devices for each monopole subarray output shall be in separate enclosures. All conductors from each separate monopole subarray shall be routed in the same raceway.

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1) If looking for the grounding requirements for a photovoltaic (PV) electrical energy system, part _____ of 690 should be consulted.
A) V
B) VI
C) III
D) IV

2) To determine what type of disconnect to use for a PV system, part _____ should be referenced.
A) IV
B) III
C) I
D) VII

3) What part of article 690 should be referenced to determine the systems required to be marked for a PV system.
A) VI
B) IV
C) V
D) IX

4) To determine what voltage storage batteries can operate at in a residential application, part _____ of article 690 should be referenced.
A) IV
B) VI
C) V
D) VIII

5) Article 690 applies to PV systems including controllers, array circuits, and _____.
A) Collectors
B) Balancers
C) Inverters
D) Inversion cells

6) If a conflict between article 250 and article 690 with regards to the bonding of solar array frames occurs, the requirements of article _____ shall be followed.
A) 690
B) 250
C) 300
D) 450

7) A small solar array is installed at an oil refinery for a mobile communications system in a class 1 division 1 area of the plant. A grounding conflict is found between article 505 and 690 with regards to the installation. What article must be followed in this situation?
A) 690
B) 516
C) 500
D) 505

8) If the voltages of two monopole subarrays exceeds the rating of the conductors and connected equipment, the 2011 code requires them to be _____.
A) Paralleled
B) Physically separated
C) Insulated
D) Removed

9) True or False, the electrical output circuits from each monopole subarray are required to be installed in the same raceway until connected to an inverter.
A) True
B) False

690.4 (H) Multiple Inverters. This section addresses the requirements of having multiple PV inverters**.** A photovoltaic system is allowed to have multiple utility-interactive inverters installed in or on a single building or structure. If the inverters are remotely located from each other, a directory in accordance with 705.10 it is required to be installed at every dc PV system disconnect, ac disconnect, and at the main service disconnect. This directory is required to show the location of all ac and dc PV system disconnecting means in a building.

Exception: A directory shall not be required where all inverters and PV dc disconnecting means are grouped at the main service disconnecting means.

690.5 Ground-Fault Protection. Grounded dc photovoltaic arrays shall be provided with dc ground-fault protection meeting the requirements of 690.5(A) through (C) to reduce fire hazards. Ungrounded dc photovoltaic arrays shall comply with 690.35.

Exception No. 1: Ground-mounted or pole-mounted photovoltaic arrays with not more than two paralleled source circuits and with all dc source and dc output circuits isolated from buildings shall be permitted without groundfault protection.

Exception No. 2: Photovoltaic arrays installed at other than dwelling units shall be permitted without ground-fault protection if each equipment grounding conductor is sized in accordance with 690.45.

690.5 (A) Ground-Fault Detection and Interruption. Article 690 requires a ground-fault protection device or system to be capable of detecting a ground-fault current, interrupting the flow of fault current, and providing an indication of the fault. Automatically opening the grounded conductor of the faulted circuit to interrupt the ground-fault current path shall be permitted. If a grounded conductor is opened to interrupt the ground-fault current path, all conductors of the faulted circuit shall be automatically and simultaneously opened. Manual operation of the main PV dc disconnect shall not activate the ground-fault protection device or result in grounded conductors becoming ungrounded.

690.5 (C) Labels and Markings. The 2011 code requires that a warning label shall appear on the utility-interactive inverter or be applied by the installer near the ground-fault indicator at a visible location, stating the following:

WARNING ELECTRIC SHOCK HAZARD
IF A GROUND FAULT IS INDICATED,
NORMALLY GROUNDED CONDUCTORS
MAY BE UNGROUNDED AND ENERGIZED

When the photovoltaic system also has batteries, the same warning shall also be applied by the installer in a visible location at the batteries.

690.5 (B) Isolating Faulted Circuits. Article 690 requires that PV circuits that become faulted are required to be isolated by one of the two following methods:

(1) The ungrounded conductors of the faulted circuit shall be automatically disconnected.

(2) The inverter or charge controller fed by the faulted circuit shall automatically cease to supply power to output circuits.

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10) If multiple PV inverters are to be installed remotely from one another, a _____ must be installed at all ac and dc disconnecting means showing their locations.
A) Indicator
B) Phenolic
C) Directory
D) Causeway

11) A PV array installed on the roof of a grocery store is required to size its equipment grounding conductor in accordance with _____.
A) 250.66
B) 690.45
C) 250.122
D) 690.1

12) A pole mounted PV array does not have to have ground fault protection if the DC source and output circuits are isolated from _____.
A) Equipment
B) Service equipment
C) No listed answers
D) Buildings

13) A ground-fault protection device must meet 3 criteria; must be capable of detecting a ground-fault current, Must provide an indication of the fault, and _____.
A) Must interrupt the flow of the fault current
B) Must convert the fault to current
C) Must divert the fault to the battery system
D) All listed answers

14) If operating a PV system disconnect, the disconnect must not activate the _____.
A) Inverter
B) Ground-fault protection
C) Rectifier
D) Array

15) Article 690 requires _____ methods for isolating PV circuits that experience a ground fault.
A) 5
B) 3
C) None
D) 2

16) A label warning of electric shock from a PV system ground fault is supposed to be located on the _____.
A) Utility-interactive inverter
B) Array
C) Disconnects
D) Cells

17) A PV battery system is required to have a _____ label posted.
A) Warning
B) Directory
C) Utility
D) All listed answers

690.6 (A) Photovoltaic Source Circuits. The requirements of Article 690 pertaining to photovoltaic source circuits shall not apply to ac modules. The photovoltaic source circuit, conductors, and inverters shall be considered as internal wiring of an ac module.

690.6 (B) Inverter Output Circuit. The output of an ac module shall be considered an inverter output circuit.

690.6 (C) Disconnecting Means. This code requires a single disconnecting means, in accordance with 690.15 and 690.17, shall be permitted for the combined ac output of one or more ac modules. Additionally, each ac module in a multiple ac module system shall be provided with a connector, bolted, or terminal type disconnecting means.
690.6 (D) Ground-Fault Detection. Article 690 allows alternating-current module systems to be permitted to use a single detection device to detect only ac ground faults and to disable the array by removing ac power to the ac module(s).

690.6 (E) Overcurrent Protection. The 2011 code requires the output circuits of ac modules shall be permitted to have overcurrent protection and conductor sizing in accordance with 240.5(B)(2).

690.7(A) Maximum Photovoltaic System Voltage. The 2011 code requires that in a dc photovoltaic source circuit or output circuit, the maximum photovoltaic system voltage for that circuit shall be calculated as the sum of the rated open-circuit voltage of the series-connected photovoltaic modules corrected for the lowest expected ambient temperature. For crystalline and multi-crystalline silicon modules, the rated open-circuit voltage shall be multiplied by the correction factor provided in Table 690.7. This voltage shall be used to determine the voltage rating of cables, disconnects, overcurrent devices, and other equipment. Where the lowest expected ambient temperature is below −40°C (−40°F), or where other than crystalline or multi-crystalline silicon photovoltaic modules are used, the system voltage adjustment shall be made in accordance with the manufacturer's instructions. When open-circuit voltage temperature coefficients are supplied in the instructions for listed PV modules, they shall be used to calculate the maximum photovoltaic system voltage as required by 110.3(B) instead of using Table 690.7.

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18) The requirements of photovoltaic source circuits _____ apply to ac modules.
A) Shall
B) Must
C) Shall not
D) Will

19) An AC modules output is consider by this code as an _____ output circuit.
A) Open
B) Exclusive
C) Inverter
D) Both A and C

20) Multiple AC modules are each required to have a _____.
A) Disconnect
B) Inverter
C) Ground Fault Indicator
D) All listed answers

21) Article 690 allows _____ different types of disconnecting means when using multiple AC modules.
A) 2
B) 4
C) 6
D) 3

22) Multiple alternating current module systems are allowed by this code to use _____ detection device for all AC ground faults.
A) One
B) An inverted
C) Harmonic
D) A resonance

23) AC modules output circuits are allowed to have their conductors sized based on article _____.
A) 310.16
B) 690.6
C) 240.5(B)(2)
D) 310(b)(2)

24) The maximum photovoltaic system voltage is required to be calculated as the sum of the rated _____ voltage of the series-connected photovoltaic modules corrected for the lowest expected ambient temperature.
A) Closed circuit
B) DC circuit
C) Listed circuit
D) Open circuit

25) The correction factors of table _____ are required to be used for crystalline silicon modules.
A) 690.7
B) 695.7
C) 690.4
D) 690.12

26) If a listed PV module has voltage temperature coefficients supplied, they are required to be used to calculate the _____ photovoltaic system voltage.
A) Maximum
B) Minimum
C) Listed
D) Rated

690.7 (C) Photovoltaic Source and Output Circuits. Article 690 requires that in one and two-family dwellings, photovoltaic source circuits and photovoltaic output circuits that do not include lampholders, fixtures, or receptacles shall be permitted to have a maximum photovoltaic system voltage up to 600 volts. Other installations with a maximum photovoltaic system voltage over 600 volts shall comply with Article 690, Part IX.

690.7 (D) Circuits over 150 Volts to Ground. Article 690 states that in one- and two family dwellings, live parts in photovoltaic source circuits and photovoltaic output circuits over 150 volts to ground shall not be accessible to other than qualified persons while energized.

690.8(A) (1) Photovoltaic Source Circuit Currents. Article 690 requires that the maximum PV source circuit current shall be the sum of parallel module rated short circuit currents multiplied by 125 percent.

690.8(A)(3) Inverter Output Circuit Current. Article 690 requires the maximum current shall be the inverter continuous output current rating.

690.8(A)(4) Stand-Alone Inverter Input Circuit Current. Article 690 requires the maximum current shall be the stand-alone continuous inverter input current rating when the inverter is producing rated power at the lowest input voltage.

690.8 (B) Ampacity and Overcurrent Device Ratings. The 2011 code requires Photovoltaic system currents to be considered as continuous.

690.8 (C) Systems with Multiple Direct-Current Voltages. Article 690 describes a photovoltaic power source that has multiple output circuit voltages and employs a common-return conductor, the ampacity of the common-return conductor shall not be less than the sum of the ampere ratings of the overcurrent devices of the individual output circuits.

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27) If a photovoltaic source circuit in a single family dwelling does not include receptacles, the maximum photovoltaic system voltage can be up to _____ volts.
A) 700
B) 800
C) 600
D) 1000

28) If a photovoltaic system operates at over 600 volts, it is required to comply with part _____ of Article 690.
A) X
B) V
C) VI
D) IX

29) A photovoltaic source circuit that operates at over _____ volts to ground is required to have its live parts accessible to only qualified personnel.
A) 120
B) 150
C) 100
D) 50

30) The maximum PV circuit current is required to be the sum of the parallel module rated short circuit currents multiplied by _____ percent.
A) 125
B) 100
C) 75
D) 50

31) An inverters maximum output current can be no more than the inverters _____ output current rating.
A) Load
B) Continuous
C) Initial
D) Stored

32) The input circuit current of a stand-alone inverter is required to be at its maximum when the inverter is producing rated power at the _____ input voltage.
A) Maximum
B) Rated
C) Array
D) Lowest

33) The current of a Photovoltaic system is required to be calculated as a _____ load.
A) Continuous
B) Intermittent
C) Maximum
D) Both A and C

34) A common-return conductor for a PV system that has multiple output circuit voltages cannot be less than the sum of the _____ ratings of the overcurrent devices of the individual output circuits.
A) Output
B) Input
C) Ampere
D) Array

690.8 (D) Sizing of Module Interconnection Conductors. Article 690 states where a single overcurrent device is used to protect a set of two or more parallel-connected module circuits, the ampacity of each of the module interconnection conductors shall not be less than the sum of the rating of the single fuse plus 125 percent of the short-circuit current from the other parallel-connected modules.

690.9 (A) Circuits and Equipment. This code requires a photovoltaic source circuit, photovoltaic output circuit, inverter output circuit, and storage battery circuit conductors and equipment shall be protected in accordance with the requirements of Article 240. Circuits connected to more than one electrical source shall have overcurrent devices located so as to provide overcurrent protection from all sources.

690.9 (B) Power Transformers. The overcurrent protection listed by this code for a transformer with a source(s) on each side shall be provided in accordance with 450.3 by considering first one side of the transformer, then the other side of the transformer, as the primary.

690.9 (D) Direct-Current Rating. 690 requires that overcurrent devices, either fuses or circuit breakers, used in any dc portion of a photovoltaic power system shall be listed for use in dc circuits and shall have the appropriate voltage, current, and interrupt ratings.

690.9 (E) Series Overcurrent Protection. The 2011 code allows In PV source circuits, a single overcurrent protection device shall be permitted to protect the PV modules and the interconnecting conductors.

690.10 (D) Energy Storage or Backup Power System Requirements. Article 690 states that energy storage or backup power supplies are not required.

690.10 (E) Back-fed Circuit Breakers. Plug-in type back-fed circuit breakers connected to a stand-alone inverter output in either stand-alone or utility-interactive systems shall be secured in accordance with 408.36(D). Circuit breakers that are marked "line" and "load" shall not be backfed.

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35) Would it be considered acceptable or a violation of this code for a single overcurrent device to be used to protect a set of two or more parallel-connected module circuits?
A) Acceptable
B) Violation

36) The overcurrent protection of article _____ is required to be used for all photovoltaic systems.
A) 250
B) 110
C) 240
D) 695

37) If using a transformer with a photovoltaic system, the over current protection is required to be provided as listed in _____.
A) 240.6
B) 240.3
C) 450.3
D) Both B and C

38) Over current devices used in dc photovoltaic power systems are required to be _____ for such use.
A) Installed
B) Listed
C) Separated
D) Fast acting

39) True or False, a single overcurrent protection device cannot be used to protect PV modules and their interconnecting conductors.
A) True
B) False

40) Energy storage or backup power supplies _____ required.
A) Are
B) Shall
C) Are not
D) Must be

41) Would it be considered acceptable or a violation of this code to backfeed a circuit breaker used for a PV system that is marked line and load.
A) Acceptable
B) Violation

690.11 Arc-Fault Circuit Protection (Direct Current). The 2011 code requires a photovoltaic system with either dc source or output circuits, or both that penetrates a building operating at a maximum system voltage of 80 volts or greater to be protected by a listed (dc) arc-fault circuit interrupter or other listed devise that provides equivalent protection. The PV arc-fault protection means shall comply with the following requirements:

(1) The system shall detect and interrupt arcing faults resulting from a failure in the intended continuity of a conductor, connection, module, or other system component in the dc PV source and output circuits.

(2) The system shall disable or disconnect one of the following:
a. Inverters or charge controllers connected to the fault circuit when the fault is detected
b. System components within the arcing circuit

(3) The system shall require that the disabled or disconnected equipment be manually restarted.

(4) The system shall have an annunciator that provides a visual indication that the circuit interrupter has operated. This indication shall not reset automatically.

690.14 (B) Equipment. Article 690 allows equipment such as photovoltaic source circuit isolating switches, overcurrent devices, and blocking diodes to be permitted on the photovoltaic side of the photovoltaic disconnecting means.

690.14 (C) Requirements for Disconnecting Means. The 2011 Code requires a means to be provided to disconnect all conductors in a building or other structure from the photovoltaic system conductors.

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42) A photovoltaic system is required to have a _____ dc arc-fault circuit interrupter installed for protection if it enters a building and operates at a dc voltage of 80 volts or more.
A) Rated
B) Manufactured
C) Listed
D) Operating

43) The arc fault protection for a photovoltaic system is required to detect and _____any arcing faults.
A) Interrupt
B) Delay
C) Resolve
D) Open

44) A PV arc-fault circuit interrupter is required to disable or disconnect an arcing system circuit, _____or charge controller.
A) Diode
B) Transistor
C) Bridge
D) Inverter

45) If an arc fault system disables or disconnects a photovoltaic system or equipment, this code requires it to be _____ restarted.
A) Partially
B) Incrementally
C) Sequentially
D) Manually

46) The photovoltaic arc fault system is required to have a _____ indication that the circuit interrupter has operated.
A) Visual
B) Colored
C) Audible
D) Monitored

47) True or False, when an arc fault system has activated and detected a fault, the optical indicator will reset after 30 seconds automatically.
A) True
B) False

48) Blocking _____ shall be permitted on the photovoltaic side of the photovoltaic disconnect.
A) Diodes
B) Fuses
C) Breakers
D) Inhibitors

49) A _____ is required to separate all conductors in a building from the PV system conductors.
A) Fuse
B) Breaker
C) Switch
D) All listed answers

690.14 (C)(1) Location. The 2011 code requires a photovoltaic disconnecting means to be installed at a readily accessible location either on the outside of a building or structure or inside nearest the point of entrance of the system conductors.

690.14 (C)(2) Marking. Each photovoltaic system disconnecting means shall be permanently marked to identify it as a photovoltaic system disconnect.

690.14 (C)(4) Maximum Number of Disconnects. Article 690 requires a photovoltaic system disconnecting means to consist of not more than six switches or six circuit breakers mounted in a single enclosure, in a group of separate enclosures, or in or on a switchboard.
690.14 (C)(5) Grouping. Article 690 describes that the photovoltaic system disconnecting means shall be grouped with other disconnecting means for the system to comply with 690.14(C)(4). A photovoltaic disconnecting means shall not be required at the photovoltaic module or array location.

690.15 Disconnection of Photovoltaic Equipment. Article 690 states a means shall be provided to disconnect equipment, such as inverters, batteries, charge controllers, and the like, from all ungrounded conductors of all sources. If the equipment is energized from more than one source, the disconnecting means shall be grouped and identified.

690.16 (A) Disconnecting Means. As required by article 690, a disconnecting means shall be provided to disconnect a fuse from all sources of supply if the fuse is energized from both directions. Such a fuse in a photovoltaic source circuit shall be capable of being disconnected independently of fuses in other photovoltaic source circuits.

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50) A photovoltaic disconnect is required to be installed at a _____ location.
A) Accessible
B) Readily accessible
C) Marked
D) Fence

51) A photovoltaic disconnect is required to be permanently marked as a _____ disconnect.
A) Back fed
B) DC
C) Photovoltaic
D) No listed answer

52) What is the maximum number of PV disconnects allowed in a single enclosure?
A) 7
B) 8
C) 6
D) No limit

53) A photovoltaic disconnecting means _____ be required at the photovoltaic module or array location.
A) Shall not
B) Shall
C) Must
D) All listed answers

54) PV equipment is required to be disconnected from all _____ conductors.
A) Grounded
B) Grounding
C) Equipment grounding
D) Ungrounded

55) A photovoltaic source circuit is required to be capable of being disconnected independently of _____ in other photovoltaic source circuits.
A) Fuses
B) Inverters
C) Batteries
D) Arrays

690.16 (B) Fuse Servicing. The 2011 code requires a disconnecting means to be installed on PV output circuits where overcurrent devices (fuses) must be serviced that cannot be isolated from energized circuits. The disconnecting means shall be within sight of, and accessible to, the location of the fuse or integral with fuse holder and shall comply with 690.17. Where the disconnecting means are located more than 1.8 m (6 ft) from the overcurrent device, a directory showing the location of each disconnect shall be installed at the overcurrent device location. Non-load-break-rated disconnecting means shall be marked "Do not open under load."

690.17 Switch or Circuit Breaker. A PV system requirement for the disconnecting means for ungrounded conductors shall consist of a manually operable switch(es) or circuit breaker(s) complying with all of the following requirements:

(1) Located where readily accessible

(2) Externally operable without exposing the operator to contact with live parts

(3) Plainly indicating whether in the open or closed position

(4) Having an interrupting rating sufficient for the nominal circuit voltage and the current that is available at the line terminals of the equipment

690.31 (E)(1) Beneath Roofs. The 2011 code has added this new subdivision to address photovoltaic dc systems installed under roofs. Wiring methods for PV systems shall not be installed within 25 cm (10 in.) of the roof decking or sheathing except where directly below the roof surface covered by PV modules and associated equipment. Circuits shall be run perpendicular to the roof penetration point to supports a minimum of 25 cm (10 in.) below the roof decking.

Informational Note: The 25 cm (10 in.) requirement is to prevent accidental damage from saws used by fire fighters for roof ventilation during a structure fire.

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56) A disconnect is required to service fuses for photovoltaic systems if they cannot be _____from energized parts.
A) Closed
B) Open
C) Isolated
D) Verified

57) A disconnect used to service fuses for a PV system are required to comply with the installation provisions of_____.
A) 690.(A)(2)
B) 250.46
C) 240.6
D) 690.17

58) If a disconnect is installed more than _____ from the fuses or fuse holder it disconnects in a photovoltaic system, then a directory showing the location of all disconnects is required where fuses or fuse holder are located.
A) 6 ft
B) 2 ft
C) 4 ft
D) 44 inches

59) A Non-load-break-rated disconnect used to disconnect a PV system is required by this code to be marked on its cover "_____."
A) Do not reset load
B) Open Here
C) Do not open under load
D) Open with other loads

60) A PV disconnect is required to be _____.
A) Accessible
B) Polyphase
C) Oversized
D) Readily accessible

61) A PV disconnect must be plainly marked indicating whether it is in the _____ position.
A) Tripped
B) Open
C) Closed
D) Both B and C

62) What section of the 2011 code addresses the minimum distances from roof decking PV dc wiring methods can be installed.
A) 690.31 (E)(1)
B) 690.31 (E)(2)
C) 690.31 (E)(3)
D) 680.31 (E)(1)

63) PV systems are required to be installed below _____ of a structures roof decking or sheathing.
A) 8 inches
B) 6 inches
C) 9 inches
D) 10 inches

64) PV circuits are required to be run _____to the roof penetration point.
A) Perpendicular
B) Parallel
C) Next
D) Concealed

65) The minimum distance requirement from roof decking or sheathing to PV systems came about due to concerns from the _____.
A) Utility
B) Fire Department
C) General Contractor
D) Electrical Contractor

690.31 (E)(2) Flexible Wiring Methods. This new subdivision was added to the 2011 code to address flexible wiring systems that contain photovoltaic dc systems. Where flexible metal conduit (FMC) smaller than metric designator 21 (trade size 3⁄4) or Type MC cable smaller than 25 mm (1 in.) in diameter containing PV power circuit conductors is installed across ceilings or floor joists, the raceway or cable shall be protected by substantial guard strips that are at least as high as the raceway or cable. Where run exposed, other than within 1.8 m (6 ft) of their connection to equipment, these wiring methods shall closely follow the building surface or be protected from physical damage by an approved means.

690.31 (E)(3) Marking or Labeling Required. The 2011 Code has added this new subdivision to address the marking and labeling requirements of dc photovoltaic systems. The following wiring methods and enclosures that contain PV power source conductors shall be marked with the wording "Photovoltaic Power Source" by means of permanently affixed labels or other approved permanent marking:

(1) Exposed raceways, cable trays, and other wiring methods
(2) Covers or enclosures of pull boxes and junction boxes

(3) Conduit bodies in which any of the available conduit openings are unused

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66) A flexible metal conduit that has a 1/2" diameter and is installed across ceiling floor joists that contains PV conductors is required to be protected by _____.
A) 3/8" mesh
B) ¼" particle board
C) Mesh weave
D) Guard Strips

67) A metal clad cable that has a 3/4" diameter and is installed across ceiling floor joists that contains PV circuits is required to be protected by _____.
A) Guard Strips
B) 1/8" mesh
C) 3/16" particle board
D) Mesh Stripping

68) True or False, PV cables are not required to closely follow the building surface or be protected from physical damage by an approved means if limited access to the cables is provided.
A) True
B) False

69) According to the 2011 code, a flexible wiring method installed for a PV system is not required to be protected within _____ of their connection to equipment.
A) 6 ft
B) 7 ft
C) 8 ft

D) 9 ft

70) Any conduit or cable tray system that contains dc circuits for a photovoltaic system are required to be _____.
A) Painted
B) Dedicated
C) Labeled
D) Rigid

71) A label that identifies dc conductors for a photovoltaic system are present is required to read "Photovoltaic _____".
A) Potential
B) Service
C) System
D) Power Source

72) True or False, a pull box that have pass through dc photovoltaic conductors contained are not required to have a label affixed.
A) True
B) False

73) The affixed labels used to identify that dc photovoltaic circuits are present is required to have an approved _____ marking.
A) Large
B) Open
C) Permanent
D) Fixed

690.31 (E)(4) Marking and Labeling Methods and Locations. When any wiring systems are used for photovoltaic direct current systems, they are required to be labeled or marked, and shall be visible after installation. Photovoltaic power circuit labels shall appear on every section of the wiring system that is separated by enclosures, walls, partitions, ceilings, or floors. Spacing between labels or markings, or between a label and a marking, shall not be more than 3 m (10 ft). Labels required by this section shall be suitable for the environment where they are installed.

690.32 Component Interconnections. Article 690 requires fittings and connectors that are intended to be concealed at the time of on-site assembly, where listed for such use, shall be permitted for on-site interconnection of modules or other array components. Such fittings and connectors shall be equal to the wiring method employed in insulation, temperature rise, and fault-current withstand, and shall be capable of resisting the effects of the environment in which they are used.

690.43 (C) Structure as Equipment Grounding Conductor. Article 690 describes devices listed and identified for grounding the metallic frames of PV modules or other equipment shall be permitted to bond the exposed metal surfaces or other equipment to mounting structures.

Metallic mounting structures, other than building steel, used for grounding purposes shall be identified as equipment-grounding conductors or shall have identified bonding jumpers or devices connected between the separate metallic sections and shall be bonded to the grounding system.

690.43 (D) Photovoltaic Mounting Systems and Devices. When devices and systems that are used for mounting PV modules are also used to provide grounding of the module frames, they are required be identified for the purpose of grounding the PV modules.

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74) Metal Clad cable used as a wiring method for a photovoltaic system is required to be _____.
A) Marked
B) Labeled
C) Identified
D) All listed answers

75) If using a flexible wiring method to install a PV system, the cable or system is required to be labeled at intervals not to exceed _____.
A) 5 ft
B) 15 ft
C) 10 ft
D) 20 ft

76) Labels used to mark PV systems cables are required to be _____ suitable.
A) Environmentally
B) Openly
C) Directly
D) Systematically

77) True or False, photovoltaic power circuit labels are required to be installed on every section of a wiring system that is separated by a wall.
A) True
B) False

78) Fittings used to connect PV equipment must be capable of resisting the effects of the _____in which they are used.
A) Environment
B) Voltage
C) Current
D) No listed answer

79) A device listed to ground the metallic frame of a photovoltaic module is allowed by this code to _____ equipment to the mounting structure.
A) Weld
B) Install

C) Bond
D) Attach

80) True or False, identified bonding jumpers connected between separate metallic sections for PV systems are required to be bonded to the grounding system.
A) True
B) False

81) If using the PV metallic mounting structures for grounding purposes, the 2011 code requires the mounting structures to be _____ as equipment-grounding conductors.
A) Identified
B) Marked
C) Labeled
D) All listed answers

82) If the frame of a photovoltaic module is also used for grounding the system, then the frame must be _____ for that purpose.
A) Added
B) Identified
C) Installed
D) All listed answers

690.45 (A) General. Article 690 requires equipment grounding conductors in photovoltaic source and photovoltaic output circuits shall be sized in accordance with Table 250.122. Where no overcurrent protective device is used in the circuit, an assumed overcurrent device rated at the photovoltaic rated short-circuit current shall be used in Table 250.122. Increases in equipment grounding conductor size to address voltage drop considerations shall not be required. The equipment grounding conductors shall be no smaller than 14 AWG.

690.45 (B) Ground-Fault Protection Not Provided. This section requires for other than dwelling units where ground-fault protection is not provided in accordance with 690.5(A) through (C), each equipment grounding conductor shall have an ampacity of at least two (2) times the temperature and conduit fill corrected circuit conductor ampacity.

690.46 Array Equipment Grounding Conductors. Article 690 requires equipment grounding conductors for photovoltaic modules smaller than 6 AWG shall comply with 250.120(C).

680.47(B) Direct-Current Systems. The grounding electrode system for a dc system is required to be installed in accordance with 250.166 for grounded systems or 250.169 for ungrounded systems. The grounding electrode conductor is required to be installed in accordance with 250.64. The 2011 Code allows a common dc grounding-electrode conductor to serve multiple inverters. The size of a common grounding electrode and tap conductors shall be in accordance with 250.166. Tap conductors are required to be connected to the common grounding-electrode conductor by exothermic welding or with connectors listed for such use. This connection is to be

made in such a manner that the common grounding electrode conductor remains without a splice or joint.

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83) A PV equipment grounding conductor is required to be sized using _____.
A) 250.66
B) 690.3
C) 690.5
D) 250.122

84) What is the smallest equipment grounding conductor allowed by article 690?
A) 12 AWG
B) 10 AWG
C) 14 AWG
D) 1/0

85) If ground fault protection is not provided for a PV system, the equipment grounding conductor is required to have an ampacity of at least _____ the temperature and conduit fill corrected circuit conductor current.
A) 3 times
B) 4 times
C) 2 times
D) No requirement

86) An array equipment grounding conductor for PV modules smaller than _____ must follow the requirements of 250.120(C).
A) 4 AWG
B) 2 AWG
C) 6 AWG
D) 1/0

87) A dc grounding electrode system is required to be installed as specified in _____.
A) 250.169
B) 250.166
C) 250.66
D) 250.122

88) The 2011 Code requires a dc grounding electrode conductor to be installed as per _____.
A) 250.166
B) 250.64
C) 250.169
D) 250.122

89) True or False, the 2011 code does not allow a common dc grounding-electrode conductor to serve multiple inverters.
A) True
B) False

90) A common grounding electrode tap conductor is required to be sized as per section _____ for a dc system.
A) 250.196
B) 250.122
C) 250.166
D) 250.66

91) Would it be considered acceptable or a violation of this code for a dc tap conductor to connect directly to a common grounding-electrode conductor.
A) Acceptable
B) Violation

92) Connecting dc tap conductors to a common grounding electrode conductor must be made by _____.
A) Exothermic welding
B) Irreversible crimp
C) Listed Split Bolt
D) All listed answers

690.47(C) Systems with Alternating-Current and Direct-Current Grounding Requirements. A Photovoltaic system that has dc and ac circuits and having no direct connection between the dc grounded conductor and ac grounded conductor is required to have a dc grounding system. This dc grounding system is required to be bonded to the ac grounding system by one of the methods as specified in 690.47(C)(1), (2), or (3). This section does not apply to ac PV modules. When using the methods of (C)(2) or (C)(3), the existing ac grounding electrode system shall meet the applicable requirements of Article 250, Part III.
690.47 (C)(1) Separate Direct-Current Grounding Electrode System Bonded to the Alternating-Current Grounding Electrode System. The 2011 Code has added this new subdivision that requires a separate dc grounding electrode or system to be installed if there is no direct connection between the dc grounded conductor and ac grounded conductor for a photovoltaic (PV) system. This dc system is required to be bonded directly to the ac grounding electrode system. The size of any bonding jumper(s) between the ac and dc systems shall be based on the larger size of the existing ac grounding electrode conductor or the size of the dc grounding electrode conductor specified by 250.166. The dc grounding electrode system conductor(s) or the bonding jumpers to the ac grounding electrode system shall not be used as a substitute for any required ac equipment grounding conductors.

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93) A dc grounding system is not required for a Photovoltaic system that has a _____connection between the dc and ac grounded conductors.
A) Partial
B) Direct
C) Open
D) Nominal

94) A dc grounding system is required to bond directly with the _____ grounding system.
A) Utility
B) Network
C) AC
D) Telephone

95) True or False, alternating current photovoltaic modules are required to comply with 690.47(C)(1), (2), or (3).
A) True
B) False

96) To use the requirements of 690.47(C)(1), (2), or (3), the ac grounding electrode system is required to meet the applicable provisions of Article 250, Part _____.
A) III
B) II
C) IV
D) VII

97) True or False, a photovoltaic (PV) system does not require a separate dc grounding electrode or system if a current 200 amp AC service exists.
A) True
B) False

98) A photovoltaic grounding system is required to be connected the _____ grounding electrode system.
A) AC
B) Utility
C) District
D) CATV

99) The bonding jumper that connects a DC and AC system together of a photovoltaic system is required to be sized based on the _____ grounding electrode conductor of either the AC or DC system.
A) Utility
B) Service
C) smaller
D) Larger

100) To size a DC grounding electrode conductor, the 2011 code requires one to look in _____.
A) 250.122
B) 250.166
C) 250.66
D) 430.52

101) True or False, a DC grounding system may be used as a substitute for any required ac equipment grounding conductors.
A) True
B) False

690.47 (C)(2) Common Direct-Current and Alternating-Current Grounding Electrode. A photovoltaic (PV) system dc grounding electrode conductor of the size specified by 250.166 shall be run from the marked dc grounding electrode connection point to the ac grounding electrode. If an ac grounding electrode is not accessible, the dc grounding electrode conductor shall be connected to the ac grounding electrode conductor in accordance with 250.64(C)(1). This dc grounding electrode conductor shall not be used as a substitute for any required ac equipment grounding conductors.

690.48 Continuity of Equipment Grounding Systems. Article 690 requires for safety where the removal of equipment disconnects the bonding connection between the grounding electrode conductor and exposed conducting surfaces in the photovoltaic source or output circuit equipment, a bonding jumper shall be installed while the equipment is removed.

690.50 Equipment Bonding Jumpers. This code requires equipment bonding jumpers, if used, shall comply with 250.120(C).

690.54 Interactive System Point of Interconnection. This code requires all interactive system(s) points of interconnection with other sources shall be marked at an accessible location at the disconnecting means as a power source and with the rated ac output current and the nominal operating ac voltage.

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102) The DC grounding electrode conductor shall be run from the marked _____ grounding electrode connection point.
A) AC
B) Connected
C) DC
D) Listed

103) A dc grounding electrode conductor used for a PV system is required to be sized using the requirements of _____.
A) 250.66
B) 250.166
C) 250.122
D) 250.122(E)

104) The DC grounding electrode conductor for a PV system shall be run to the _____ grounding electrode.
A) DC
B) Listed
C) Sized
D) AC

105) If installing a PV system and the AC grounding electrode is not accessible, the DC grounding electrode conductor is allowed to be connected to the AC grounding electrode conductor as long as it complies with the requirements of _____.
A) 250.64(C)(1)
B) 250.166
C) 250.66
D) 250.122

106) Would it be considered acceptable or a violation of this code to substitute a DC grounding electrode conductor for any required AC equipment grounding conductors.
A) Acceptable
B) Violation

107) If removing equipment for repair in a PV system, a temporary _____ is required to be installed to the grounding electrode conductor and exposed conducting surfaces to maintain continuity.
A) Bonding jumper
B) Array
C) Block out
D) EGC

108) An equipment bonding jumper used in a PV system is required to meet the provisions of _____.
A) 250.122
B) 250.66
C) 250.120(C)
D) 690.3

109) All PV interactive system points of interconnection with other sources are required to be marked at an accessible location at the _____.
A) Disconnect
B) Existing service
C) Utility connection
D) Both B and C

690.55 Photovoltaic Power Systems Employing Energy Storage. Photovoltaic 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.

690.56 (A) Facilities with Stand-Alone Systems. Article 690 requires any structure or building with a photovoltaic power system that is not connected to a utility service source and is a stand-alone system shall have a permanent plaque or directory installed on the exterior of the building or structure at a readily visible location acceptable to the authority having jurisdiction. The plaque or directory shall indicate the location of system disconnecting means and that the structure contains a stand-alone electrical power system.

690.71 (A) General. Storage batteries in a solar photovoltaic system are required to be installed in accordance with the provisions of Article 480. The interconnected battery cells shall be considered grounded where the photovoltaic power source is installed in accordance with 690.41.

690.71 (B)(1) Operating Voltage. When installing storage batteries for dwellings, the cells are required to be connected to operate at less than 50 volts nominal. Lead-acid storage batteries for dwellings shall have no more than twenty-four 2-volt cells connected in series (48- volts nominal).

690.64 Point of Connection. Article 690 requires that the point of connection for a solar photovoltaic (PV) system shall be in accordance with 705.12.

690.63 Unbalanced Interconnections. As required by article 690, the unbalanced connections for solar photovoltaic (PV) systems shall be in accordance with 705.100.

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110) The equalization voltage and polarity of the grounded circuit conductor of a PV power system that uses an energy storage system is required to be marked with the _____ operating voltage.
A) Inversion
B) Rectified
C) Maximum
D) Minimum

111) A stand-alone PV system not connected to a utility service is required to have a permanent directory installed on the _____ of the structure.
A) Exterior
B) Interior
C) Meter base
D) Both B and C

112) Article _____ must be referenced when installing storage batteries for a PV system.
A) 250
B) 240
C) 110
D) 480

113) Lead-acid storage batteries used in dwellings shall have an operating voltage of no more than _____ volts.
A) 50
B) 60
C) 75
D) 48

114) The Point of connection for a solar photovoltaic (PV) system is required to be done in accordance with _____.
A) 705.10
B) 704.12
C) 705.12
D) 704.10

115) The Unbalanced connections for solar photovoltaic (PV) systems are required to be installed in accordance with _____.
A) 705.100
B) 705.10
C) 704.100
D) 704.10

690.72 (C) Buck/Boost Direct-Current Converters. The 2011 Code requires when buck/boost charge controllers and other dc power converters used in solar photovoltaic (PV) systems that increase or decrease the output current or output voltage with respect to the input current or input voltage are installed, the requirements of 690.72(C)(1) and (C)(2) shall be followed.

(1) The ampacity of the conductors in output circuits shall be based on the maximum rated continuous output current of the charge controller or converter for the selected output voltage range.

(2) The voltage rating of the output circuits shall be based on the maximum voltage output of the charge controller or converter for the selected output voltage range.

690.74 (A) Flexible Cables. Article 690 requires battery connections using flexible fine-stranded cables for solar photovoltaic (PV) systems must be terminated only with terminals, lugs, devices, or connectors in accordance with 110.14(A).

690.80 General. Any solar photovoltaic system with a maximum system voltage over 600 volts dc shall comply with Article 490 and other requirements applicable to installations rated over 600 volts.

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116) The 2011 Code lists _____ provision(s) to follow when using buck/boost charge controllers for photovoltaic (PV) systems.
A) 3
B) 1
C) 2
D) 4

117) The ampacity for conductors in output circuits using buck/boost charge controllers for PV systems shall be based on the _____ rated continuous output current of the charge controller.
A) Minimum
B) Load
C) Continuous
D) Maximum

118) The voltage for conductors in output circuits using buck/boost charge controllers for PV systems shall be based on the _____ rated continuous output voltage of the charge controller.
A) Maximum
B) Minimum
C) Load
D) Continuous

119) The requirements of _____ shall be used when making battery connections using fine stranded flexible cables.
A) 110.14(A)
B) 110.14
C) 110.13(A)
D) 110.13

120) A solar photovoltaic system with a maximum system voltage over _____ volts dc is required to comply with Article 490.
A) 480
B) 240
C) 600
D) 120