Site visit worksheet

Instructions:

Workshop attendees will be visiting a grid-connected PV system site. Attendees will break into groups and inspecting the system. Only one worksheet is required to be completed per group.
Each group will first record the system design and system components, then assess the system against the checklist provided. Once workshop attendees have returned to the workshop room, each group will report on their findings, observations and comments.

PV System Inspections Checklist

Location of System	

Solar Array Information

Total Size of Array	kW
Total number of Modules	
Array Ground mounted or roof mounted?	
Array Configuration:	
Number of modules in series (one string)	
Number of these strings in parallel (total)	
Number of modules in series (if different string)	
Number of these strings in parallel (total)	

Solar Modules

Module Brand	
Module Model	
Module Quantity Installed	
Module Power Rating	
Module Voltage Open Circuit	
Module Current Short Circuit	
Do the modules meet the following standards:	Check the label on the back of the module. Tick if they meet the Standard or cross if they do not.
UL1703- Flat Plat Photovoltaic Modules and Panels	☐
UL (IEC) 61215 Terrestrial photovoltaic (PV) modules - Design qualification and type approval	☐
UL(IEC)61646 Thin-film terrestrial photovoltaic (PV) modules—Design qualification and type approval	☐

Inverters

Number of Inverters	
Are all Inverters the same?	
Number of different modules/brands of Inverter	
Duplicate the following for each different brand/model of inverter.	
Inverter Brand	
Inverter Model	
Does the inverter meet the following standards:	Check the label on the side of the inverter(s). Tick if they meet the Standard or cross if they do not.
UL 62109 Safety of power converter for use in photovoltaic power systems.	☐
UL Standard 1741 Standard for Inverter, converters, Controllers and Interconnection System Equipment for use with Distributed Energy Resources. **NEC 2017 Article 705.60** for Interactive Inverters	☐
Inverter ac Power Rating	
Inverter Nominal ac Current	
Inverter Ingress Protection Rating / NEMA rating	
Is the Inverter Galvanically Isolated	
Number of MPPTs	
Inverter MPPT 1 dc Voltage Range Lower limit	
Inverter MPPT 1 dc Voltage Range Upper limit	
Inverter dc Maximum Voltage	
MPPT 1 Maximum dc input current	
Number of parallel strings attached to MPPT 1	
Is maximum current from strings less than maximum input current of MPPT 1	
Number of modules in series in each string	
String Vmp is greater than the minimum MPPT 1 voltage window at 75 ^{O}C	
String Voc is less than the inverter maximum dc input voltage at 10 ^{O}C	
Inverter MPPT 2 dc Voltage Range Lower limit	
Inverter MPPT 2 dc Voltage Range Upper limit	
Inverter dc Maximum Voltage	
MPPT 2 Maximum dc input current	
Number of parallel strings attached to MPPT 2	
Maximum current from strings less than maximum input current of MPPT 2	
Number of modules in series in each string	
String Vmp is greater than the minimum MPPT 2 voltage window at 75 ^{O}C	
String Voc is less than the inverter maximum dc input voltage at 10 ^{O}C	
Inverter dc maximum input Current	
Maximum array current connected to inverter less than maximum dc input current of inverter	

Array Structure

Brand	
Model	
Meets Wind Loading Requirements for location	

The information on the isolators will be dependent on the actual system configuration.

DC Isolators

DC Isolator Voltage	
DC Isolator Current	
DC Isolator Location (circle)	Adjacent to Inverter/Elsewhere
DC Isolator Non-Polarised	☐

AC Isolators

AC Isolator Rating	
AC Isolator Inside Switchboard	☐
AC Isolator Next to Inverter	☐

String Cables

Cross Section Area of String Cables	AWG
Conductor Ampacity of String Cables	A
Maximum Current on each string	A

Array Cables- If String Cables join Combiner Box

Cross Section Area of Array Cables	AWG
Conductor Ampacity of Array Cables	A
Maximum Current from Array	A

Voltage Drop

Maximum Length of String cables	ft
Maximum Voltage Drop in string cables	V
String Vmp	V
Maximum voltage drop (string cables) as %	%
Maximum Length of array cables	ft
Maximum Voltage Drop in array cables	V
Array Vmp	V
Maximum voltage drop (array cable) as %	%
Total dc voltage drop from array to inverter	V
Total maximum voltage drop from array to inverter	V

General Wiring and Installation Work

Item	Codes/Clause	Description	Compliant	Notes
1	NEC Article 690.4 (B)	**Is all the Equipment:** Inverters, PV modules, listed or field labelled for the PV application?		
2	NEC Article 690.4 (C)	Was the installation performed by a a **Qualified Personnel?** That is a person who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.		
3	NEC Article 690.4 (D)	If there are **Multiple Inverters:** and they are remotely located from each other, is there a directory in accordance with 705.10 provided at each PV system disconnecting means?		
4	NEC Article 690.4 (E)	The PV system equipment and disconnecting means are **NOT** installed in bathrooms.		

Compliance with Standards and Guidelines- Array Installation and dc Wiring

Item	Best Practices/Applicable codes	Description	Compliant	Notes
5	Best Practice	PV mounting systems and attachment to roof visually inspected and appears to be secure.		
6	Best Practice	Any freestanding PV structure was visually inspected and appears to be secure.		
7	Best Practice	All array supports, brackets, screws and other metal parts are either: (a) of similar material or stainless steel to minimise corrosion; or (b) where dissimilar metals that can have a galvanic reaction are used, they are galvanically isolated		
8	PPA/SEIAPI Guidelines	Roof penetrations and/or the roof top components used in the wiring system including secondary shields, isolator shrouds, conduits and conduit glands are suitably installed, sealed and waterproof		
9	PPA/SEIAPI Guidelines	The PV Array structure allows sufficient clearance to facilitate self-cleaning of the roof to prevent any build-up of leaves and other debris.		
10	PPA/SEIAPI Guidelines	Modules have sufficient ventilation space to minimise temperature rise.		
11	PPA/SEIAPI Guidelines	PV Wiring Losses are less than 3%.		
12	PPA/SEIAPI Guidelines	AC wiring losses are less than 1% between the inverter and the point of connection to the grid		
13	NEC 2017 Article 690 Part II	PV system dc circuits on or in one- and two-family dwellings have a maximum voltage of 600 volts or less		
14	NEC 2017 Article 690 Part II	The maximum voltage has been used to determine the voltage rating of conductors, cables, disconnects, overcurrent devices, and other equipment.		
15	NEC 2017 Article 690 Part III (B)	Each PV system Isolator indicates whether it is in the off or on position and is permanently marked “PV SYSTEM DISCONNECT”		

16	NEC 2017 Article 690 Part III (E)	The PV system Isolator has ratings sufficient for the maximum circuit current available short-circuit current, and voltage that is available at the terminals of the PV system disconnect.		
17	NEC 2017 Article 690.8 B	The current rating of all dc cables is equal to or greater than sum of parallel-connected PV module–rated short circuit currents multiplied by 125 percent or 1.25 x $I_{SC\ Array}$ if overcurrent protection not installed. OR The current rating of all dc cables is equal to the rating of Adjustable Electronic Overcurrent Protective Device if installed in accordance with 240.6		
18	NEC 2017 Article 690.9	Are PV system dc circuit and inverter output conductors and equipment protected against overcurrent where conductors do not have sufficient ampacity for highest available current?		
19	NEC 2017 Article 690.8 (B)	The overcurrent device rating is not less than 125 percent of the maximum currents calculated in 690.8(A).		
20	Best Practice	The entire PV array and associated wiring and protection have restricted access where the maximum voltage of the array exceeds 600 V dc in a non-domestic installation.		
21	Best Practice	Modules in the same string are installed in the same orientation within +/- 5 degrees		
22	NEC 2017 Article 690 Part IV (G3)	The following wiring methods and enclosures that contain PV system dc circuit conductors have been marked with the wording WARNING: PHOTOVOLTAIC POWER SOURCE: (1) Exposed raceways, cable trays, and other wiring methods (2) Covers or enclosures of pull boxes and junction boxes		
23	NEC 2017 Article 690 Part IV G(4)	The labels or markings are visible after installation. The labels are reflective, and all letters are capitalized and are of minimum height of 9.5 mm (3⁄8 in.) in white on a red background.		

24	Best Practice	Array wiring and wiring to the inverter is protected from mechanical damage. This requires a visual inspection of all cables related to the system and therefore might require checking on the roof.		
25	Best Practice	Array wiring and wiring to the inverter is protected from sunlight. This requires a visual inspection of all cables related to the system and therefore might require checking on the roof.		
26	NEC 2017 Article 690 Part IV A	Where PV source and output circuits operating at voltages greater than 30 volts are installed in readily accessible locations, circuit conductors have been guarded or installed in Type MC cable or in raceway.		
27	Best Practice	Double insulation has been maintained between any live conductor and any earthed or exposed conductive part		
28	Best Practice	All dc cable installed within the ceiling space, wall cavity or floor is enclosed in heavy duty [HD] conduit		
29	Best Practice	All dc connectors are of the same type/model from the same manufacturer where they are coupled at a connection point		
30	Best Practice	All cables/wiring in the installation are securely fixed in place to minimise any movement of the cable.		
31	Best Practice	Any conduit is installed such that they are protected from sunlight or the conduit is UV stabilised		
32	Best Practice	Array wiring and inverter wiring is protected from animals where deemed necessary.		

33	Best Practice	Array wiring and wiring to inverter is rated for the voltage and current.		
34	Best Practice	All joints in cables are enclosed e.g. in junction boxes.		
35	Best Practice	Double insulation has been maintained between the positive and negative conductors/terminations within all enclosures		
36	Best Practice	There is no evidence of mechanical damage to LV cables.		
37	Best Practice	Wiring from array to isolator/inverter is single conductor cable both insulated and sheathed.		
38	Best Practice	All array cables are (i) temperature rated to the application; or sunlight resistant if exposed to the environment; or (iii) flexible (multi-stranded) to allow for thermal/wind movement of arrays/modules		
39	Best Practice	LV array and inverter cables are not installed near building surfaces.		
40	NEC 2017 Article 690 Part IV G(4)	PV system dc circuit labels 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, is not more than 3 m (10 ft)		
41	ANSI/IEC 60529	The ingress protection provided by electrical enclosures is appropriate.		
42	Best Practice	PV cable junction boxes have an IP 54 rating [IP 55 if mounted on the array], and have been correctly installed to prevent water ingress		

43	Best Practice	Where there is a number of PV array strings, and could result in a potential fault current in any one string greater than reverse current of an individual module - appropriate string protection is provided. [e.g. Fuses or non-polarised circuit breakers]		
44	NEC 2017 Article 690.8 and 690.9	If string protection is installed, it is rated for dc application and applicable current. Minimum current rating is 1.56 x $I_{SC\ STRING}$ and maximum current is less than reverse current rating of string		
45	Best Practice	If string protection is installed, the fuse holders have a current rating equal to or greater than the corresponding fuse		
46	NEC 2017 Article 690.43	Exposed non– current-carrying metal parts of PV module frames, electrical equipment, and conductor enclosures of PV systems have been grounded in accordance with 250.134 or 250.136(A), regardless of voltage.		
47	NEC 2017 Article 690 Part IV	The PV array frame and/ module earthing connections and methods comply with code requirements		
48	NEC 2017 Article 690 Part IV	PV cable junction boxes are labelled 'WARNING: PHOTOVOLTAIC POWER SOURCE'		
49	Best Practice	If a transformer-less inverter (non-galvanically isolated) is installed, a functional earth is not connected to the DC positive or negative.		
50	Best Practice	If the PV array is functionally earthed an Earth Fault Interrupter is installed		
51	**PPA/SEIAPI Guidelines**	The dc cables connecting to the inverter are mechanically secured in such a manner that they cannot be inadvertently unplugged from the inverter.		
52	**NEC 2017 Article 690.41(B)**	The requirements for ground fault protection have been met as per NEC 2017		

53	**NEC 2017 Article 690.11**	Photovoltaic systems operating at 80 volts dc or greater between any two conductors have been protected by a listed PV arc-fault circuit interrupter or other system components listed to provide equivalent protection		
54	**NEC 2017 Article 690.46**	PV array equipment grounding conductors have been connected to the grounding electrode system of the building or structure supporting the PV array in accordance with Part VII of Article 250		

Compliance with Standards and Guidelines- Inverter , ac cabling and dc and ac Switchgear

Item	Best Practice /Codes	Description	Compliant	Notes
55	Best Practice	Inverter is of appropriate IP rating for its location or has appropriate NEMA rating.		
56	Best Practice	Inverter (or any heavy part of system) is installed/mounted safely and there appears no imminent risk of the item falling.		
57	Best Practice	Inverter has been installed in a location that has safe access and adequate working space		
58	Best Practice	There is adequate clearance around the inverter in accordance with inverter manufacturer's recommendation with adequate space and ventilation.		
59	**NEC 2017 Article 690.8 (3)**	Is the inverter continuous output current rating equal to the maximum current in the circuit?		
	The following relates to dc isolator beside inverter-it can be part of the inverter as per PPA/SEIAPI guidelines, NEC 2017 and IEC standards			
60	NEC 2017 Article 690 Part III	Means have been provided to disconnect the PV system from all wiring systems including power systems, energy storage systems, and utilization equipment and its associated premises wiring.		
61	Best Practice	The Isolator [or C/B] at the inverter, connected to the array, is dc rated.		

62	Best Practice	The dc isolator [or dc C/B] is mounted close to inverter input and the inverter is not in sight or more than three metres from the array.		
63	Best Practice	The dc Isolator [or dc C/B] is lockable in the off position.		
64	Best Practice	The dc Isolator at the inverter is correctly wired.		
65	Best Practice	The dc isolator at the inverter is not polarised and activates in all active conductors		
66	NEC 2017 Part III A	The dc isolator/s at the inverter are readily available		
67	NEC 2017 Part III D	Each PV system disconnecting means consists of not more than six switches or six sets of circuit breakers, or a combination of not more than six switches and sets of circuit breakers, mounted in a single enclosure, or in a group of separate enclosures		
68	NEC 2017 Part III F	The PV system disconnecting means simultaneously disconnects the PV system conductors of the circuit from all conductors of other wiring systems		
69	**ac isolator, ac cabling and signage**			
	Best Practice	If there is not a clear line of sight between the switchboard connected to the inverter and any person working on the inverter, an AC isolator is provided at the inverter		
70	Best Practice	AC Circuit Breaker on switchboard is lockable.		
71	Best Practice	An AC circuit breaker is mounted within the switchboard to act as a main switch for the PV/inverter system and to protect the cable from the switchboard to the inverter.		
72	Best Practice	The AC circuit breaker is correctly rated to protect the AC cable installed between the inverter and switchboard to which it is connected		
73	NEC 2017 Article 690.8	The AC cables installed between the inverter and the switchboard to which it is connected are rated as per 690.8		
74	Best Practice	Inverter cables are not installed near building surfaces		

75	Best Practice	Connection of AC and DC components in same enclosure are segregated i.e. there must be physical separation between AC and DC in an enclosure where wiring from both components are terminated.		
77	Best Practice	Shutdown procedure is correct and is permanently fixed at inverter and/or on main switchboard.		
78	NEC 2017 Article 690.12	PV systems dc wiring installed on or in buildings includes a rapid shutdown device.		
79	NEC 2017 Article 690 Part IV C	Buildings with Rapid Shutdown have permanent labels.		
80	Best Practice	The AC circuit breaker in the switchboard from PV side is labelled: 'MAIN SWITCH Solar Supply' or similar.		
81	NEC 705.12(B)(3)	Sign – 'WARNING Dual Power Supply' has been displayed on backfed panelboard		
82	Best Practice	Where the inverter is not adjacent to the main switchboard, inverter location information has been displayed on the switchboard to which the inverter system is directly connected.		
83	Best Practice	Fire Emergency information is correct and is permanently fixed within the building's main switchboard.		
84	Best Practice	dc isolator near inverter is appropriately labelled.		
85	Best Practice	Grid supply main switch is labelled 'MAIN SWITCH Normal Supply' or similar.		
86	Best Practice	Signage "WARNING HAZRADOUS VOLTAGE - AUTHORIZED ACCESS ONLY" or similar is installed if the system voltage is greater than 600V dc on a non-domestic installation		