Checklists for Off-line Tests

Description

This Form contains the checklists required for verifying the off-line tests to be conducted on a PV System.

DC System Verification

Below is a checklist for verifying the DC part of a PV System.

Table 1 – Checklist for DC System Verification

Checklist for DC System Verification		
DC system – general		
Item to verify	**Result / Value**	**Notes**
The DC system has been designed, specified and installed to the requirements of IEC 60364 and IEC 62548	□ Yes□ No	
The maximum PV array voltage is suitable for the array location, except residential, (1000 Vdc on buildings, 1500 Vdc otherwise)	□ Yes□ No	
The maximum PV array voltage is suitable for residential location should not exceed 600V.	□ Yes□ No	
Roof fixings and cable entries are weatherproof (where applicable)	□ Yes □ No □ N/A	
The installation of modules, strings, inverters and equipment is according to the drawings	□ Yes □ No	
The PV modules do not have cracks and damages	□ Yes □ No	
The labelling, interconnection string cables are according to the design.	□ Yes □ No	
DC system – Protection against electric shock		
Item to verify	**Result / Value**	**Notes**
Protective measure provided by extra-low voltage (SELV / PELV)	□ Yes □ No (alternative to the next one)	
Protection by use of class II or equivalent insulation adopted on the DC side	□ Yes□ No (alternative to the previous one)	

Checklists for Off-line Tests

Checklist for DC System Verification		
DC system – Protection against the effects of insulation faults		
Item to verify	**Result / Value**	**Notes**
Galvanic separation in place inside the inverter or on the AC side	□ Yes□ No (informative)	
Functional earthing of any DC conductor	□ Yes□ No (Informative)	
PV Array Earth Insulation Resistance detection and alarm system is installed – to the requirements of IEC 62548	□ Yes□ No	
PV Array Earth Residual Current Monitoring detection and alarm system is installed – to the requirements of IEC 62548	□ Yes□ No	
DC system – Protection against overcurrent		
Item to verify	**Result / Value**	**Notes**
For systems without a string overcurrent protective device: IMOD_MAX_OCPR (the module maximum series fuse rating) is greater than the possible reverse current	□ Yes □ No □ N/A	
For systems without a string overcurrent protective device: string cables are sized to accommodate the maximum combined fault current from parallel strings	□ Yes □ No □ N/A	
For systems with string overcurrent protective device: string overcurrent protective devices are fitted and correctly specified to the requirements of IEC 62548	□ Yes □ No □ N/A	
For systems with array / sub-array overcurrent protective devices: overcurrent protective devices are fitted and correctly specified to the requirements of IEC 62548	□ Yes □ No □ N/A	
For systems where the inverter(s) can produce a DC back-feed into the PV array circuits: any back-feed current is lower than both the module maximum fuse rating and the string cable ampere rating	□ Yes □ No □ N/A	
All DC junction boxes (PV generator and PV array boxes) carry a warning label indicating that active parts inside the boxes are fed from a PV array and may still be energized after isolation from the PV	□ Yes □ No □ N/A	

Checklists for Off-line Tests

Checklist for DC System Verification		
inverter and public supply		
Are the IP ratings of outdoor and indoor junction boxes specified?	☐ Yes☐ No	
DC system – Earthing and bonding arrangements		
Item to verify	**Result / Value**	**Notes**
Where the PV system includes a functional earthing of one of the DC conductors: the functional earth connection has been specified and installed to the requirements of IEC 62548	☐ Yes ☐ No ☐ N/A	
Where a PV system has a direct connection to earth on the DC side: a functional earth fault interrupter is provided to the requirements of IEC 62548	☐ Yes ☐ No ☐ N/A	
Array frame bonding arrangements have been specified and installed to the requirements of IEC 62548	☐ Yes ☐ No ☐ N/A	
Where protective earthing and/or equipotential bonding conductors are installed: they are parallel to, and bundled with the DC cables	☐ Yes ☐ No ☐ N/A	
DC System – Protection against the effects of lightning and overvoltage		
Item to verify	**Result / Value**	**Notes**
To minimize voltages induced by lightning, the area of all wiring loops has been kept as small as possible	☐ Yes☐ No	
Measures are in place to protect long cables (e.g. screening or the use of SPDs)	☐ Yes☐ No	
Where SPDs are fitted, they have been installed to the requirements of IEC 62548	☐ Yes☐ No	
DC system – Selection and erection of electrical equipment		
Item to verify	**Result / Value**	**Notes**
The PV modules are rated for the maximum possible DC system voltage	☐ Yes☐ No	

Checklists for Off-line Tests

Checklist for DC System Verification		
All DC components are rated for continuous operation at DC and at the maximum possible DC system voltage and current as defined in IEC 62548	☐ Yes ☐ No ☐ N/A	
Wiring systems have been selected and erected to withstand the expected external influences such as wind, temperature, UV and solar radiation	☐ Yes ☐ No ☐ N/A	
DC wirings are compliant and tested according to EN 50618	☐ Yes ☐ No ☐ N/A	
Means of isolation and disconnection have been provided for the PV array strings and PV sub-arrays – to the requirements of IEC 62548	☐ Yes ☐ No ☐ N/A	
A DC switch disconnector is fitted to the DC side of the inverter to the requirements of IEC 62548	☐ Yes ☐ No ☐ N/A	
If blocking diodes are fitted, their reverse voltage rating is at least 2 × Voc (STC) of the PV string in which they are fitted (see IEC 62548)	☐ Yes ☐ No ☐ N/A	
Plug and socket connectors mated together are of the same type and have similar specifications, and comply with the requirements of IEC 62548	☐ Yes ☐ No ☐ N/A	
Result	☐ **Accepted** ☐ **Not Accepted**	

Checklists for Off-line Tests

Labelling Verification

Below is a checklist for the labelling verification of a PV System.

Table 2 – Checklist for Labelling and Identification verification

Checklist for Labelling and Identification		
Labelling and identification		
Item to verify	**Result / Value**	**Notes**
All circuits, protective devices, switches and terminals are suitably labelled following IEC 60364 and IEC 62548 requirements	☐ Yes☐ No	
Means of isolation on the AC side are clearly labelled	☐ Yes☐ No	
Dual supply warning labels are fitted at the interconnection point	☐ Yes☐ No	
A single-line wiring diagram is displayed on the site	☐ Yes☐ No	
Installer details are displayed on the site	☐ Yes☐ No	
Shutdown procedures are displayed on the site	☐ Yes☐ No	
Emergency procedures are displayed on the site (where relevant)	☐ Yes ☐ No ☐ N/A	
All signs and labels are suitably affixed and durable	☐ Yes☐ No	
Result	☐ **Accepted** ☐ **Not Accepted**	

Checklists for Off-line Tests

Fire Protection Verification

Below are four checklists for verifying the fire protection of a PV System installed in houses and buildings according to the specified building type.

Table 3 – Checklist for verifying the Fire Protection – all PV Systems

Checklist for verifying the Fire Protection – all PV Systems		
Fire protection – Verifications common to all PV systems		
Item to verify	**Result / Value**	**Notes**
A manual emergency system for the disconnection of the PV modules from the internal electric PV System of the building is present and operates in one of the ways indicated	□ DC outside □ AC outside □ Fire-compartment □ No present	
When there is a passage of cables from PV modules inside the building before the disconnector, cables inside the building are placed in trunking with a fire-rated protection of at least one-and half-hour	□ Yes □ No □ N/A	
Except for One-and-Two-Family Dwellings, electrical disconnection is operated using a manual call point with all the following characteristics: • Installed at the height of 1.1 – 1.4 m above floor level in a plain, accessible, well-lit and free-hindrance place. • It is located close to external access to be easily operated by personnel or firefighters. • Following the NFPA 72 and a proper label indicate that it actuates the disconnection of the PV System.	□ Yes□ No	
Each PV array is equipped with an earth fault detector that preferably shuts down the array in case of failure	□ Yes □ No □ N/A	
A simplified site plan with the position of PV modules, cables and disconnectors is exposed close to the main energy meter. If a manual call point is present in the building, a further copy of the simplified site plan is exposed on the side.	□ Yes□ No	
The area where PV modules, cables and other equipment are located, if accessible, is marked by proper signs. They are also placed in correspondence	□ Yes□ No	

Checklists for Off-line Tests

Checklist for verifying the Fire Protection – all PV Systems		
of each access door to the PV System. The same signs indicate cables before disconnectors and are placed every 5 meters along the cable. These signs are UV resistant and indicate the DC voltage as the Open Circuit Voltage at STC of the PV array. Their minimum size is 200 ´ 200 mm (w ´ h).		
Result	☐ **Accepted**	☐ **Not Accepted**

Checklists for Off-line Tests

Table 4 – Checklist for verifying the Fire Protection for BAPV Systems

Checklist for Fire Protection Verification for BAPV		
Item to verify	**Result / Value**	**Notes**
Adoption of one of these measures when the PV system is installed on a rooftop	□ PV modules placed on a roof made of non-combustible material □ Interposition of a non-combustible layer between PV modules and the roof (at least ½ hour fire-rated) □ A new risk assessment is required □ None of the above	
PV modules, wirings and other equipment do not cover any possible ventilation systems on the roof, e.g. skylights, smoke extraction systems or chimneys	□ Yes□ No	
PV components and wirings are placed at a minimum distance of 1 m (top view) from the perimeter of the ventilation systems and following the manufacturer's prescriptions	□ Yes□ No	
PV components and wirings are placed at a minimum distance of 0.5 m (top view) from the perimeter of skylights, chimneys or other openings	□ Yes□ No	
Components and equipment installed internally or externally do not obstruct in any way the existing means of egress	□ Yes□ No	
Minimum elevation of the PV modules above the roof is 50 mm	□ Yes□ No	
Result	□ **Accepted** □ **Not Accepted**	

Checklists for Off-line Tests

Table 5 – Checklist for verifying the Fire Protection for BIPV Systems

Checklist for Fire Protection Verification for BIPV		
Item to verify	**Result / Value**	**Notes**
In case of BIPV is not installed in fire compartmented areas, at least one of these further measures is adopted	☐ The manual call point also disconnects or short-circuits PV modules having an open circuit voltage not greater than 120 VDC ☐ An AFCI to protect the DC side from series arcs following NEC Section 690.11 and UL 1699B is installed ☐ None of the above	
Where applicable, PV modules, wirings, switchboard assemblies and other equipment do not cover any possible ventilation systems on the roof, e.g., skylights, smoke extraction systems or chimneys	☐ Yes ☐ No ☐ N/A	
Where applicable, PV components and wirings are placed at a minimum distance of 1 m (top view) from the perimeter of the ventilation systems and in accordance with the manufacturer's prescriptions	☐ Yes ☐ No ☐ N/A	
Where applicable, PV components and wirings are placed at a minimum distance of 0.5 m (top view) from the perimeter of skylights, chimneys or other openings	☐ Yes ☐ No ☐ N/A	
Where applicable, components and equipment installed internally or externally do not obstruct in any way the existing means of egress	☐ Yes ☐ No ☐ N/A	
Result	☐ **Accepted** ☐ **Not Accepted**	

Checklists for Off-line Tests

Table 6 – Checklist for verifying the Fire Protection in Households

Checklist for verifying the Fire Protection in Household		
Special Requirements for Households		
Item to verify	**Result / Value**	**Notes**
The back sheet, the junction box and the wiring of each PV module are compliant with at least one of these conditions	☐ Not reachable without a proper provisional tool (stair, scaffold, etc.) ☐ Protected with at least IP67 degree (the back of the hand) ☐ None of the above ☐ N/A	
When the spacing between rows of supporting structures is greater than 0.5 m, the connections are placed on the floor, not higher than 50 mm, without sharp edges and clearly visible. They withstand the weight of a person (100 kg).	☐ Yes ☐ No ☐ N/A	
Module mounting structure (MMS)/Ballasts and their arrangements are clearly visible and without sharp edges MMS	☐ Yes ☐ No ☐ N/A	
Electrical connections between the PV array and combiner boxes or inverters preferably do not interfere with existing passages for people. In the case of passage crossing, the connections are placed on the floor, not higher than 50 mm, without sharp edges and visible. The top of the trunking and the floor surface is matched with sloped surfaces to avoid the step. This trunking withstands the weight of a person (100 kg).	☐ Yes ☐ No ☐ N/A	
Result	☐ **Accepted** ☐ **Not Accepted**	

Checklists for Off-line Tests

PV Array Tests

Below there is the checklist for verifying the tests conducted on PV Arrays.

Table 7 – Checklist for Verification of the PV Array Tests

Checklist for Verification of the PV Array Tests						
PV Array number: **Sheet number:** **PV array test report**						
String	*String reference*	1	2	3	4	5
	PV module					
	Quantity					
Array parameters (as specified)	*$V_{oc\text{-}stc}$ [V]*					
	Isc-stc [A]					
String overcurrent protective device	*Type*					
	Rating [A]					
	DC rating [V]					
	Capacity [kA]					
String wiring	*Type*					
	Cross-sect [mm^2]					
String test	*Voc [V]*					
	Isc [A]					
	Irradiance [W/m2]					
Polarity check OK		□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No
Array insulation resistance	*Test voltage [V]*					
	Pos – Earth [M□]					
	Neg – Earth [M□]					
Earth continuity (where fitted) □ N/A		□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No
Array isolator	*Rating [A]*					
	Rating [V]					
	Location					
	Functional check					

Checklists for Off-line Tests

Checklist for Verification of the PV Array Tests						
Inverter	*Manuf. and model*					
	Serial number					
	Functioning OK					
Result		☐ **Accepted** ☐ **Not Accepted**				

An analysis of the measured data shall be made to check the following:

- All checkboxes are checked Y or N/A
- String overcurrent protection devices fit the specific application
- Array isolators fit the specific application
- String wiring fits the specific application
- V_{oc} reading matches the expected value
- The array insulation resistance is higher than the minimum value required

Checklists for Off-line Tests

Final Result of Off-Line Tests

Below is the checklist for the final acceptance (or not) of the off-line tests conducted on the PV System.

Table 8 – Final Result of the Off-line Test

Off-line Test Final Result		
Participants		
Role	**Name**	**Signature**
Test engineer (mandatory)		
Installer (mandatory)		
Designer (if present)		
Inspector (if present)		
Inspector (if present)		
Inspector (if present)		
Notes		
Result	☐ **Accepted** ☐ **Not Accepted**	