



Government of **Western Australia**
Department of **Commerce**
EnergySafety

Electrical safety of grid-connected solar installations in Western Australia

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1. Background

As reported by the Clean Energy Council, 7.6% of Australians have solar systems installed in their homes. The total number of Australian households using solar energy saw a 60% increase in the period 2002 to 2009. Over 10,000 new domestic solar systems were installed in WA between July and December 2011 alone. Such escalation in demand for solar photo-voltaic (PV) systems underpins a need to ensure and monitor that solar PV installations are being properly installed.

In Western Australia, solar systems must be installed by licensed electrical contractors and the installations certified to be safe. All photo-voltaic system installers not holding an electrical contractor's licence are required to engage a licensed electrical contractor to carry out the electrical installing work.

All electrical installations, including solar installations in WA, are subject to sample inspections by the network operators (such as Western Power and Horizon Power) to ensure that they are safe and meet the relevant safety standards. Inspection rates vary from 10% to 100% based on the confidence that the network operators have in the electrician carrying out the work. On average, sixty new solar installations are inspected every week as part of the sample inspection regime.

In June 2011, in response to reports of potentially unsafe situations associated with installed solar panels, EnergySafety, in conjunction with the network operators, developed an inspection checklist to ensure that grid-connected solar installations in WA were being properly inspected. Network operators forwarded copies of all their completed checklists to EnergySafety for an initial period of three months, to assist with the collection of data on any trends of non-compliance in industry.

EnergySafety conducted a review on the inspection reports supplied by network operators. The purpose of this report is to inform all stakeholders of the outcomes of these inspections.

2. Review methodology

The main purpose of the review was to gauge the level of compliance of solar installations with applicable Australian Standards and Legislation. All inspections were carried out by electrical inspectors working for network operators and designated under the *Energy Coordination Act 1994*.

The inspections focused on the 26 items listed on the checklist¹. All of these items inspected related primarily to compliance with applicable Standards and Legislation pertaining to electrical safety. The inspections did not include any checks on the structural integrity of the installed systems.

Non-compliances were grouped under three distinct defect categories:

1. Category 1- Potential fire risk if switch operated at full load. Relates primarily to incorrect wiring of the DC circuit breaker.
2. Category 2 -Wiring Rules defects i.e. wrongly sized protective devices, inadequate mechanical protection of cables, IP index of equipment not suitable for environment.
3. Category 3 - Missing or incorrect warning labels.

¹ Refer to appendix A for a copy of the checklist used. The checklist is intended to provide guidance to electrical inspectors when performing inspections. Inspections are not limited to these items on the checklist.

3. Inspection results

- 260 inspection checklists were reviewed.
- 131 (50%) of the installations reviewed were defect-free.
- 129 (50%) of the installations inspected contained at least one defect, as detailed below. Inspector's Orders were issued requiring the relevant electrical contractor to correct all the defects identified.
 - 31 (12%) installations had a Category 1 defect.

A high percentage (12%) of installations inspected was found to have 'incorrect wiring of the DC isolating device'.

AS/NZS 5033:2005, the Australian Standard for photo-voltaic installations requires the use of a double-pole switch to disconnect the PV panels from the inverter and to isolate the solar cable from the panels. Installers can use either circuit breakers or isolators for this purpose. Many installers have been using double-pole DC circuit breakers instead of DC isolators. These DC circuit breakers can either be polarised or non-polarised.

Polarised breakers present a concern because if they are wired incorrectly, they are a potential fire hazard. Manually turning off an incorrectly installed DC circuit breaker while the inverter is still operating at full power may cause the circuit breaker to catch fire. However, if the shut down procedures are followed correctly and the AC power is turned off first, the inverter will turn off and remove any current from the solar panels. This will not present any risk with a DC circuit breaker, even if it is wired incorrectly. Having said this, it is a defect which warrants immediate rectification.

It is evident that a high percentage of electricians are not familiar with the wiring of polarised DC circuit breakers. In the July 2011 edition of the Energy Bulletin, industry was reminded that extra care should be undertaken when using polarised DC circuit breakers. Energy Safety recommended that electrical contractors refrain from using these devices if they were unsure how to wire them correctly.

- 29 (11%) installations had a Category 2 defect.

The electrical installations within solar systems are required to comply with the Wiring Rules. As such, it is a requirement for all components of the electrical installations to be properly selected and installed for the application i.e. correct current rating of circuit breakers, installation work practices according to the Wiring Rules. Non-compliance with the Wiring Rules does not necessarily indicate that the system is unsafe. However, the installation is deemed to be sub-standard and may pose a safety risk in the future, if the defect is not rectified.

The most common defect identified during the inspections was 'failure to provide adequate mechanical protection to cables'. Clause 3.9 of AS/NZS 3000:2007 requires that all wiring be adequately protected from mechanical damage i.e. in conduits and/or supported at fixed intervals where accessible e.g. in roof/ceiling space.



Figure 1: Typical case where cable is not properly secured

- 69 (27%) installations contained a Category 3 defect.

AS5033:2005, Installation of Photovoltaic Arrays prescribes the labelling requirements for solar installations. The Standard requires that switches, inverters and circuit breakers be identified by marking. Also signage should be affixed to indicate that solar power is installed so that electricians, emergency service workers or others know how to work on or shut down the system safely.

27% of solar installations either had no labelling or incorrect labelling. The majority of these omissions related to the mandatory affixing of a shut-down procedure. Again, while this issue does not pose an imminent safety hazard, the relevant installations do not comply with Australian Standards and should be rectified.

4. Conclusion

The review revealed an unacceptable level of sub-standard solar installations. Half of the systems inspected contained at least one defect ranging from incorrectly-wired DC isolating devices to labelling issues. While none of those installations posed an immediate electric shock or fire hazard, or was disconnected as a result of the inspections, the defects identified nevertheless require rectification. Inspector's Orders were issued by the attending inspectors to require the electrical contractors to rectify the defects.

5. The way forward

Energy Safety is working closely with network operators to ensure that the issues identified during the inspections are addressed. Network operators have been requested to review their inspection practices to treat incorrect wiring of DC circuit breakers, failure to provide adequate mechanical protection to cables, omission of labelling indicating presence of a second energy source and missing shut-down procedures as "serious defects". As such, once the rectification works are completed, network operators' inspectors will re-inspect all these installations, to ensure that the corrective work is adequate.

Additionally, once any one of the above-mentioned serious defects is found in an installation performed by an electrician, a greater sample of their future work will be inspected by the network operators i.e. the sampling rate will be reset to 1:1. Network

operators have also agreed to inspect retrospectively all installations done by a particular electrician once they encounter a serious defect in any of their installations.

EnergySafety will publish the findings of this review in the next edition of its Energy Bulletin. Electrical contractors will be advised that they may be in breach of the legislation if they had certified that a solar installation is safe when, in fact, it is not. Even if their work was not inspected at the time of completion, should an accident or a fire occur, in the future, and the subsequent investigation reveals a defect in their installations, they could still face serious penalties.

EnergySafety will write to all electrical contractors to remind them of their obligations and recommend that they retrospectively self-review their past work if in doubt.

6. APPENDIX A



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Solar photo-voltaic installations - Inspection Checklist / Report

This checklist/report is produced for use by network operator inspectors. The inspector will need to obtain a copy of the application / approval form prior to commencing the inspection.

Network Operator:	
Job ID / Number:	Date of inspection:
Site address where Solar PV system is installed:	Connection/commissioning date
Total generation capacity of system	Inspector's Orders issued: YES / NO

Item No.	Items to be inspected / reviewed	Criteria	Relevant Standard(s)	Requirement MET
1	Certification	Did the owner receive an "Electrical Safety Certificate"?	<i>Electricity (Licensing) Regulations 1991 (Reg 52B)</i>	YES / NO / Unable to provide
2	Application Form (Application to connect renewable energy system)	The installation and components are as listed in the Application Form	Refer to Application Form	YES / NO
3	Electrical Installation	All components of the electrical installation are properly selected and installed for the application i.e. Rating of circuit breakers (OC,SC), installation work practices according to the Wiring Rules	AS/NZS 3000:2007	YES / NO
4	DC Isolator (At array)	Weatherproof isolator is immediately adjacent to the array. (An AC rated isolator is not suitable for this application).	Recommended practice (Not mandatory)	YES / NO
5	DC Isolating Device (At inverter)	A double pole load break PV array isolator (switch) or a double pole DC rated circuit breaker is mounted near the inverter. (An AC rated isolator is not suitable for this application).	AS/NZS 5033 2.5	YES / NO
			Rating (A):	
6	Polarity of DC Isolating devices	If DC circuit breaker is polarised - Check to ensure that it is wired correctly.	Refer to SGES Guidelines provided by Department of Climate Change	YES / NO
7	DC cabling	LV DC cabling is clearly identified 'LV DC' or similar at least every 3m	AS/NZS 5033 3.5	YES / NO
8	DC cable Junction Box	PV cable junction boxes are labeled 'SOLAR DC'.	AS/NZS 5033 6.2	YES / NO

9	DC cable Junction Box	IP index of junction boxes is suitable for environment. The integrity of the IP rating is maintained and no moisture can enter the junction boxes.	AS/NZS 3000:2007	YES / NO
10	Cables and Wiring	All cables and wiring are sized in accordance with AS/NZS 3000 and AS/NZS 3008.1	AS/NZS 3000:2007 AS/NZS 3008.1	YES / NO
11	Cables and Wiring	All wiring is adequately protected from UV damage e.g. in conduits where exposed.	AS/NZS 3000:2007 3.3.2.11	YES / NO
12	Cables and Wiring	All wiring is adequately protected from mechanical damage i.e. in conduits and/or supported at fixed intervals where accessible e.g. in roof / ceiling space.	AS/NZS 3000:2007 3.9	YES / NO
13	Earthing	Check whether PV module frames are earthed. If the system includes a transformer less inverter with no galvanic isolation, then the PV module frames must be earthed.	Recommended practice (Not yet mandatory)	YES / NO
14	Inverter specifications	The inverter complies with the requirements of AS 4777 parts 2 and 3. Check details to confirm that inverter is on Clean Energy Council's list of approved inverters. http://www.solaraccreditation.com.au/acccec/approvedproducts/inverters/currentinverters.html .	AS 4777 5.2	YES / NO
15	Inverter specifications	Inverter details, including make, model, number connected, capacity and kVA rating matches those on "Application Form"	Refer to application form	YES / NO
16	Inverter Location	Inverter is outside building and accessible to fire & emergency crews.	Recommended practice (not yet mandatory)	YES / NO
17	Inverter Location	Inverter is IP rated for external use or in weatherproof enclosure with adequate space and ventilation	AS/NZS 3000:2007	YES / NO
18	AC isolator / Circuit Breaker (output of Inverter)	An AC isolator / circuit breaker is installed at the output of the inverter	AS/NZS 3000:2007 2.3.2	YES / NO
			Rating (A):	
19	Shutdown procedure	A shutdown procedure is permanently fixed at inverter and/or on main switchboard	AS/NZS 5033 Appendix G	YES / NO
20	Solar supply main switch (at main switchboard)	AC circuit breaker mounted within the switchboard to act as main switch for the inverter system.	AS/NZS 5033	YES / NO
			Rating (A):	
21	Labelling	AC circuit breaker (within switchboard) is labeled 'Solar Supply MAIN SWITCH'	AS/NZS 5033	YES / NO
22	Labelling	Grid supply main switch (from network) is labeled 'Normal Supply MAIN SWITCH'	AS/NZS 5033	YES / NO

23	Labelling	Sign – 'WARNING Dual Supply Isolate Both Normal and Solar Supplies before working on this switchboard'	AS/NZS 5033 Appendix G	YES / NO
24	Signage	Where the inverter is not adjacent to the main switchboard, inverter location information is provided	AS/NZS 5033 6.4	YES / NO
25	Signage	Fire Emergency information is permanently fixed on the main switchboard: 'SOLAR ARRAY ON ... ROOF ...' including PV array Voc and Isc ratings	AS/NZS 5033 6.4	YES / NO
26	Signage	If the solar system is connected to a distribution board the following sign is located on main switchboard & all intermediate distribution boards: WARNING DUAL SUPPLY ISOLATE SOLAR SUPPLY AT DISTRIBUTION BOARD	AS/NZS 5033 Appendix G	YES / NO