

May 2021 #21-038

General

This bulletin is to clarify DC isolator test and certification criteria related to thermal currents with solar effects testing and degree of protection (IP code) testing.

It clarifies some requirements as there is a complex relationship between AS 60947.3:2018 Appendix ZZ and interrelationships with Annex D of AS 60947.3:2018, the main text of AS 60947.3:2018 and AS (IEC) 60947.1:2015. This clarification is required to ensure the unique Australian conditions and experience with DC isolators as identified and addressed in Appendix ZZ are adequately assessed, and the safety standards are applied in a manner to meet minimum criteria for the conditions as proven by tests.

This information bulletin explains the minimum expectation for certification to be issued for DC isolators related the requirements of Appendix ZZ of AS 60947.3:2018 for thermal current at 60°C ambient with solar effects, and IP56NW, as well as some general clarifications. This includes D.8.3.11 compliance requirements must be met, including Appendix ZZ (D.8.3.1.1) and Appendix ZZ table D.3 (Enclosed – Outdoor with solar effects) where relevant.

Requirement

Thermal currents with solar effects

1/ For dc isolators for outdoor location (enclosed outdoor DC isolator in dedicated individual enclosure – i.e. DC isolator for outdoor use, or a DC isolator in power conditioning equipment (PCE) such as solar inverters for mounting outdoor exposed to sunlight) the requirements of AS 60947.3:2018 for the $I_{the\ solar}$ current are explained below.

NOTE: The critical currents are:

- $I_{the\ solar} +40\ ^\circ\text{C}$
also known as:
 - $I_{the\ 40\ ^\circ\text{C}\ solar\ effect}$ or I_{the} at 40 °C shade ambient air temperature
 - $I_{the\ solar}$ at 40 °C shade ambient air temperature
 - I_{the} at 40 °C shade ambient air temperature outside the enclosure

- $I_{the\ solar} +60\ ^\circ\text{C}$
also known as:
 - $I_{the\ solar} +60\ ^\circ\text{C}$ shade ambient air temperature
 - $I_{the\ 60\ ^\circ\text{C}\ solar\ effect}$ or I_{the} solar current value outdoors at 60 °C
 - $I_{the\ solar}$ current value at 60 °C shade ambient air temperature with solar effects
 - $I_{the\ solar}$ current value at 60 °C shade ambient air temperature outside the enclosure

$I_{the\ solar} +40\ ^\circ\text{C}$ is not required to be reported in Appendix ZZ of AS 60947.3:2018, however it is required in the IEC standard in Annex D, and so will be in any test report to the IEC standard. It is included here for explanation as it will likely be in the test reports provided. If it is not provided the report may still be acceptable, so long as the $I_{the\ solar} +60\ ^\circ\text{C}$ is correctly assessed and reported.

- a) $I_{the\ solar} +40\ ^\circ\text{C}$ and $I_{the\ solar} +60\ ^\circ\text{C}$ values quoted must have test evidence of compliance to requirements, not just be values quoted or be values within datasheets.

- b) $I_{the\ solar} +40\ ^\circ C$ – requires, for any quoted current of $I_{the\ solar} +40\ ^\circ C$, test evidence in test report to show for D.8.3.11 the temperatures of terminals do not exceed $120\ ^\circ C$ maximum temperature when in $40\ ^\circ C$ ambient with solar effects applied. For temperature rise that is 80K at $40\ ^\circ C$ ambient.
- c) $I_{the\ solar} +60\ ^\circ C$ – requires, for any quoted current of $I_{the\ solar} +60\ ^\circ C$, test evidence in test report to show for D.8.3.11 the temperatures of terminals do not exceed $120\ ^\circ C$ maximum temperature when in $60\ ^\circ C$ ambient with solar effects applied. For temperature rise that is 60K at $60\ ^\circ C$ ambient.
- d) Test are conducted for D.8.3.11 at the shade ambient of the respective current rating ($I_{the\ solar} +40\ ^\circ C$ test is conducted at ambient $40\ ^\circ C$ and $I_{the\ solar} +60\ ^\circ C$ test is conducted at ambient $60\ ^\circ C$).
- e) Tests are conducted to requirements of AS 60947.3 Annex D and Annex ZZ and as explained in this bulletin. All requirements of D.8.3.11 compliance requirements for solar effects test must be met for all tests – including no damage shall be caused to adjacent parts of insulating materials.
- f) Test report shall include detail to enable certifier to verify and document test conducted in accordance with the requirements of the standard and as specified in instructions, including testing with smallest conductor sizes and termination method fitted into terminals.
- g) Test report shall include detail to enable certifier to verify and document test conducted for all configurations of pole/contact configurations to identify worst case
- h) Test report shall include detail to enable certifier to verify and document test conducted tested in actual enclosure switch disconnecter is to be used with (dedicated individual enclosure, enclosure of inverter if installed within inverter).
- i) No extrapolation of test results for use of switch disconnecter in other enclosures is permitted (as one criterion is no damage after test, all enclosures that will be used with the switch disconnecter must be tested).

2/ Test evidence required for verification of compliance is testing at actual $40\ ^\circ C$ or $60\ ^\circ C$ shade ambient temperature (this ambient temperature is defined as shaded temperature as measured within vicinity of, but external to, dedicated enclosure). In addition, the complete sample and all parts (including those inside the enclosure) must be pre-conditioned to be at ambient temperature of $40\ ^\circ C$ for $I_{the\ solar} +40\ ^\circ C$ or $60\ ^\circ C$ for $I_{the\ solar} +60\ ^\circ C$ prior to test being performed.

To verify the complete sample is correctly pre-conditioned prior to starting the test, there may need to be internal temperature probes to verify the parts are at the correct temperature.

3/ It is acceptable to use the current values of $I_{the\ solar} +40\ ^\circ C$ (when tested in $40\ ^\circ C$ ambient) to be current value at $I_{the\ solar} +60\ ^\circ C$ if the temperature values obtained for $I_{the\ solar} +40\ ^\circ C$ are less than the limits applied for $I_{the\ solar} +60\ ^\circ C$ after adjusting for the $60\ ^\circ C$ ambient (that is the temperature measured at terminals does not exceed $100\ ^\circ C$ when tested at $I_{the\ solar} +40\ ^\circ C$ at $40\ ^\circ C$ ambient, or in other words, temperature rise is not more than 60K when tested at $I_{the\ solar} +40\ ^\circ C$ at $40\ ^\circ C$ ambient – see examples for explanation of these limits). This is only valid where the cable sizes for installation, as stated in instructions provided with the equipment, are to be the same for the $I_{the\ solar} +40\ ^\circ C$ and $I_{the\ solar} +60\ ^\circ C$ current ratings.

Ingress Protection (IP56NW)

4/ for dc isolators in dedicated individual enclosures for outdoors requiring IP56NW (enclosed outdoor DC isolator in dedicated individual enclosure – i.e. DC isolator for outdoor use, but not including a DC isolator in a PCE) – Second numeral “IPX6NW” test shall be conducted, no claim of compliance from other results is permissible. Test shall be conducted on each enclosure to be used with the switch disconnecter. Test report must have detail to clearly show test facility has examined switch disconnecter and enclosure after test and

report includes a statement of the amount of water that has entered the enclosure – noting compliance criteria is that no water has entered enclosure.

5/ test report to clearly detail all aspects of dedicated individual enclosures used for testing, or inverter switch installed in for testing. Details at minimum must include: extensive photos of the enclosure from all angles - internal and external and reinforcing of enclosure, also showing any glands and securing mechanisms or other parts to enable IP rating, cable entry points, and methods of cable entry used, switch located within enclosure as per tests, cables used for test, (and as connected for tests), brand and model/part number of enclosure/PCE (inverter). Also included in test report is material composition and thickness of each part of enclosure, dimensions of enclosure.

General (applies to all tests)

6/ when assessing a switch disconnecter in a dedicated individual enclosure or inverter for compliance and certification the switch disconnecter must be fully tested and assessed by the test facility (have full test results) within the test report and be tested in the enclosure it is to be sold with – It is not permissible to use an ‘already certified’ switch disconnecter as a reason not to test the switch disconnecter (it is immaterial if the switch disconnecter is already certified, it must be tested in the enclosure, even if this means retesting).

7/ details of each brand/model/switch disconnecter/enclosure combination must be included in test report or listed on a separate document endorsed by test facility who states they have viewed, assessed and tested each brand/model/switch disconnecter/enclosure combination, such listings shall include detailed photographs. The certifier shall ensure they have adequate information to verify the brand/model/switch disconnecters/enclosures combinations they have certified. A way of doing this may include the certifier to request representative samples of brand/model/switch disconnecter/enclosure combinations and review those samples, and record that review, against the test report to validate the switch disconnecter/enclosure being certified is the switch disconnecter/enclosure tested.

8/ It is noted test reports to AS 60947-3 can be lengthy and complex and cover many models and configurations. It is permissible (and preferable) for certifier to request a test report for the specific brand and model switch disconnecter with specific dedicated individual enclosure / PCE (inverter). A certifier can refuse test reports that are too complex or do not clearly indicate the test results of the particular switch disconnecter in configurations being certified and in specific dedicated individual enclosure or inverter. If test report is accepted by certifier the certifier must notate, document or otherwise clearly indicate which parts of test report (at a minimum that will require page number referencing) relate to the detail of the switch disconnecter and all ratings listed on the certificate.

9/ Other information bulletin and general guidance document requirements related to DC isolators also remain.

Examples

Example A:

I_{the solar} +40 °C = 25A and *I_{the solar}* +60 °C = 20A (tests conducted at both 40°C ambient and 60°C ambient) - PASS

Test of D.8.3.11 solar effects test conducted at 40°C ambient with current of 25A, and limit of terminals is stated as 80K rise.

- value recorded is stated as 63K – and this is a Pass (63K is <80K limit).
- Alternately value recorded is 103°C at 40°C ambient – and this is a Pass (103°C is <120°C limit)

Test of D.8.3.11 solar effects test is reconducted at 60°C ambient with current of 25A and limit of terminals is adjusted to account for new ambient and is stated as 60K rise*

- value recorded is stated as 63K, limit as 60K – and this is a Fail (63K is > 60K limit).

- Alternately value recorded is 123°C at 60°C ambient – and this is a FAIL (123°C is >120°C limit)

Test of D.8.3.11 solar effects test is reconducted at 60°C ambient with de-rated current of 20A and limit of terminals is adjusted to account for new ambient and is stated as 60K rise*

- value recorded is stated as 59K, limit as 60K – and this is a Pass (59K is < 60K limit).
- Alternately value recorded is 119°C at 60°C ambient – and this is a Pass (119°C is <120°C limit)

*NOTE: 60K rise calculated from difference between stated 40°C ambient with 80K rise which means there is 120°C limit (40 + 80 = 120). Taking the 120°C limit and applying new ambient of 60°C the temperature rise becomes 60K (120 – 60 = 60).

Alternately the difference between 40°C ambient and 60°C ambient is 20°C, so the 80K limit at 40°C ambient must be reduced by 20 for the 60°C ambient. That is 80K – 20K = 60K for a 60°C ambient.

Alternately the difference between 40°C ambient and 60°C ambient is 20°C, so the limit of 120°C at 40°C ambient must be reduced by 20°C to be valid for a 60°C ambient. That is 120°C – 20°C = 100°C at 40°C ambient – so measure value must be less than 100°C at 40°C ambient for the value to be acceptable as within the limit of 120°C at 60°C ambient.

The application of these adjustments to the temperature limit ensures the maximum temperature for the terminals is not exceeded irrespective of the ambient temperature.

Example B:

I_{the solar} +40 °C = 20A and *I_{the solar}* +60 °C = 20A (tests conducted at both 40°C ambient and 60°C ambient) - PASS

Test of D.8.3.11 solar effects test conducted at 40°C ambient with current of 20A, and limit of terminals is stated as 80K rise.

- value recorded is stated as 50K – and this is a Pass (50K is <80K limit).
- Alternately value recorded is 90°C at 40°C ambient – and this is a Pass (90°C is <120°C limit)

Test of D.8.3.11 solar effects test is reconducted at 60°C ambient with current of 20A and limit of terminals is adjusted to account for new ambient and is stated as 60K rise*

- value recorded is stated as 50K, limit as 60K – and this is a Pass (50K is < 60K limit).
- Alternately value recorded is 110°C at 60°C ambient – and this is a Pass (110°C is <120°C limit)

*60K limit as per note to Example A

Example C:

I_{the solar} +40 °C = 20A and *I_{the solar}* +60 °C = 20A (tests conducted only at 40°C ambient) - PASS

Test of D.8.3.11 solar effects test conducted at 40°C ambient with current of 20A, and limit of terminals is stated as 80K rise.

- value recorded is stated as 53K – and this is a Pass (53K is <80K limit).
- Alternately value recorded is stated as 93°C at 40°C ambient – and this is a Pass (93°C is <120°C limit)

Test of D.8.3.11 solar effects test temperature measured value at 40°C for 20A is corrected for 60°C ambient and limit of terminals is adjusted to account for new ambient and is stated as 60K rise*

- value is stated as 53K, limit as 60K for 60°C ambient – and this is a Pass (53 is < 60K limit).

- Alternately value is stated as 113°C at 60°C ambient (measured value corrected for 60°C ambient) – and this is a Pass (113°C is <120°C limit)

*60K limit as per note to Example A

Example D:

$I_{the\ solar} +40\ ^\circ C = 25A$ and $I_{the\ solar} +60\ ^\circ C = 25A$ (tests conducted only at 40°C ambient) - FAIL

Test of D.8.3.11 solar effects test conducted at 40°C ambient with current of 25A, and limit of terminals is stated as 80K rise.

- value recorded is stated as 66K – and this is a Pass (65K is <80K limit).
- Alternately value recorded is stated as 106°C at 40°C ambient – and this is a Pass (106°C is <120°C limit)

Test of D.8.3.11 solar effects test temperature measured value at 40°C for 25A is corrected for 60°C ambient and limit of terminals is adjusted to account for new ambient and is stated as 60K rise*

- value is stated as 66K, limit as 60K – and this is a FAIL (66K is > 60K limit).
- Alternately value is stated as 126°C at 60°C ambient (measured value corrected for 60°C ambient) – and this is a FAIL (126°C is >120°C limit)

*60K limit as per note to Example A

Example E:

$I_{the\ solar} +40\ ^\circ C = 25A$ and $I_{the\ solar} +60\ ^\circ C = 25A$ (tests conducted at 60°C ambient only)

Test of D.8.3.11 solar effects test is conducted at 60°C ambient with current of 25A and limit of terminals is adjusted to account for 60°C ambient and is stated as 60K rise*

- value recorded is stated as 59K, limit as 60K – and this is a Pass (59K is < 60K limit).
- Alternately value recorded is stated as 119°C at 60°C ambient – and this is a Pass (119°C is <120°C limit)

Test of D.8.3.11 solar effects test at 40°C ambient with current of 25A does not need to be conducted as current (25A) passes as 60°C ambient and measured temperature of terminal at that value is 59K which is lower than the 40°C ambient limit of 80K on terminals.

- value recorded is stated as 59K at 40°C ambient – and this is a Pass (59K is <80K limit).
- Alternately value recorded is stated as 119°C at 40°C ambient – and this is a Pass (119°C is <120°C limit)

Note it is likely the actual measured value at 40°C ambient will be lower than 119°C / 59K rise, however the test isn't required – so the actual value is not determined - as the values at 60°C ambient is within the limit)

*60K limit as per note to Example A

Background

AS 60947.3:2018 is identified as a complex safety standard to apply, and while work is undertaken to address that complexity and provide clarification within the standard, regulators may issue information bulletins to assist in the agreed understanding of requirements.

It is critical any values stated by manufacturer are verified by appropriate test evidence, in the particular enclosure that it will be used within in the PV installation. All combinations of switch configuration and enclosures must be able to be verified by test/assessment evidence within the test report.