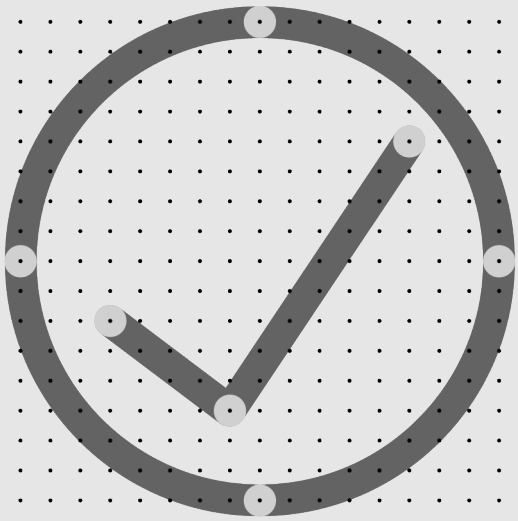
STANDARDS DOCUMENT

MCS 012 ISSUE 3.0

The Solar Mounting Standard

(Product)



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ABOUT MCS

Giving you confidence in home-grown energy

With energy costs constantly rising and climate change affecting us all, low-carbon technology has a bigger and bigger role to play in the future of UK energy.

We're here to ensure it's a positive one.

Working with industry we define, maintain and improve quality – certifying products and installers so people can have confidence in the low-carbon technology they invest in. From solar and wind, to heat pumps, biomass and battery storage, we want to inspire a new generation of home-grown energy, fit for the needs of every UK home and community.

About

The Microgeneration Certification Scheme Service Company Ltd (MCSSCo Ltd) trades as MCS and is wholly owned by the non-profit MCS Charitable Foundation. Since 2007, MCS has become the recognised Standard for UK products and their installation in the small-scale renewables sector.

We create and maintain standards that allow for the certification of products, installers and their installations. Associated with these standards is the certification scheme, run on behalf of MCS by Certification Bodies who hold UKAS accreditation to ISO 17065.

MCS certifies low-carbon products and installations used to produce electricity and heat from renewable sources. It is a mark of quality. Membership of MCS demonstrates adherence to these recognised industry s tandards; highlighting quality, competency and compliance.

Vision

To see MCS certified products and installations in every UK home and community.

Mission

To give people confidence in low-carbon energy technology by defining, maintaining and improving quality.

Values

1. We are expert – ensuring quality through robust technical knowledge
2. We are inspiring – helping to reshape energy in UK homes and communities
3. We are collaborative – working with industry and government to create positive change
4. We are principled – operating in a way that's clear, open and fair
5. We are determined – supporting the UK's drive towards a clean energy future

CHANGES TO STANDARDS

When MCS Standards are revised, the issue number is also revised to indicate the nature of the changes. This can either be a whole new issue or an amendment to the current issue. Details will be posted on the website at www.mcscertified.com

Technical or other significant changes which affect the requirements for the approval or certification of the product or service will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, the addition of notes for clarification etc.) may be made as amendments.

The issue number is given on the left of the decimal point, and the amendment number on the right. For example, issue 3.2 indicates that it is the third significant version of the document which has had two sets of minor amendments.

Users of this Standard should ensure that they are using the latest issue.

Issue No.	Amendment Details	Date
1.0	First Publication	16/03/2012
2.0	A5.1.1 Alternative Methods for fire testing	02/11/2015
3.0	Significant Update to improve clarity, new format and other changes.	10/05/2023

FOREWORD

This document contains references to other documents which may be either normative or informative. At the time of publication any editions of those documents, where indicated, were valid. However, as all documents are subject to revision, any users of this document should apply the most recent editions of those referenced documents (unless a dated version is specified).

This issue 3.0 is a significant update to issue 2.4. It is available for reference from the date of publication 10/05/2023. Manufacturers or importers of microgeneration systems who have certificated products, or wish to have products certificated, in accordance with MCS 012 may start working in accordance with this update from the date of publication. Compliance with this update is mandatory for products to be certified in accordance with MCS 012 from the date of implementation 10/05/2025.

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1 INTRODUCTION & SCOPE

This Scheme document identifies the evaluation and assessment practices for the purposes of certification and listing of systems and individual components for the mounting of Solar PV modules and Solar Collectors to the roofs of buildings. Certification and listing of products is based on evidence acceptable to the Certification Body:

- that the product meets the appropriate requirements listed below;
- that the manufacturer has staff, processes, and systems in place to ensure that the product delivered meets the standard.

And on:

- periodic audits of the manufacturer, including testing as appropriate;
- compliance with the contract with the Certification Body for listing and approval including agreement to rectify faults as appropriate.

The scope of this Standard includes:

- Products which enable above roof installations of solar panels;
- Products which enable roof integrated installations of solar panels;
- Active solar products which become part of the roof covering in roof integrated installations. This includes PV tiles and other products where PV elements are bonded to roof coverings such as standing seam roof sheets. Such products would also require certification in accordance with MCS 005.

The scope of this Standard excludes:

- Products whose sole purpose is to flash around brackets and hooks in above roof installations;
- Products relying solely on site applied sealants to provide a weathertight seal.

2 DEFINITIONS

Solar panel - this document uses the term solar panels as a collective term for solar thermal collectors and PV modules.

Roof mounting system - a collection of parts or components designed to mount solar panels on the roof of a building. The system comprises all parts required to provide a structurally stable fixing and ensure the weathertightness, and fire performance of the roof meets the requirements of the building regulations.

Roof integrated installations - an installation where the solar panels or roof mounting system (or an individual component of a roof mounting system) replaces some or all of the roof covering.

Above roof installations - an installation where the solar panel is mounted above the roof covering and the installation system does not replace or significantly alter the roof covering beneath it.

Individual Component – a uniquely identifiable, individual part or sub-assembly which, when used in combination with other components, forms a mounting system for the attachment of solar panels to the roof of a building. Examples of individual components are:

- Roof brackets/hooks
- Rails/profiles
- Joiners
- Clamps
- Clips
- Rafter bolts (sometimes referred to as "hanger" bolts)

Complete system – all components necessary to mount a solar panel to a roof to achieve wind uplift, weathertightness and fire performance.

Mechanically attached systems – those that are screwed, bolted, clamped or bonded/welded to the roof structure or covering.

Non-mechanically attached system – those that rely on ballast and/or aerodynamic effects to remain in place.

3 APPLICATIONS TO JOIN THE SCHEME

Applications should be made to an Accredited Certification Body operating this Scheme, who will provide the appropriate application form and details of the applicable fees.

4 MANAGEMENT SYSTEMS CERTIFICATION

Manufacturers shall operate a documented manufacturing quality control system, certified in accordance with the requirements of MCS 010 – Generic Factory Production Control Requirements.

5 CERTIFICATION AND APPROVAL

5.1 Certification and approval is based on the following:

a) An assessment of the reports recording the results of the relevant tests as set out in Clause 7.

Note: see MCS 011 - Testing Acceptance Criteria.

b) Verification of the manufacturing company's quality management system in accordance with the requirements of MCS 010.

c) Review of the technical documentation relating to the material or product.

5.2 Applications for a range of common products (product families) will be dealt with on a case-by-case basis.

Note: for example, where one or more characteristics are the same for products with similar design, construction and functionality then the results of tests for these characteristics on one product may be applied to other similar products, as agreed between the manufacturer/supplier and the Certification Body.

5.3 A certificate is awarded following demonstration of satisfactory compliance with this Standard, taking into account any limitations imposed, other appropriate guidelines and satisfactory verification/assessment of the manufacturer's Factory Production Control (FPC) and technical documentation.

5.4 Certificates shall contain the name and address of the manufacturer, model and reference number of the product, a unique certificate reference number, and the issue number and date.

5.5 Certificates shall also include performance data established using the tests in this Standard and based upon the template given in Appendix B.

5.6 Certificates are valid from the date of issue and are maintained and held in force subject to satisfactory completion of the requirements for maintenance of certification (see clause 8) but remain the property of the issuing Certification Body.

5.7 Certain performance data contained in the certificate will be required to be uploaded to the MCS Installation Database (MID) by the Certification Body.

6 TECHNICAL DOCUMENTATION

6.1 A Technical file of documentation for the product must be submitted for review. This documentation shall be presented in English and shall be such that it can be assured that the products submitted for test are equivalent to those that are to be manufactured for normal production. The documentation must consist of the following as a minimum:

a) Details of intended use, application, classifications (if any), and restrictions (e.g., minimum roof pitch);
b) Manufacturing drawings and/or specifications including tolerances, issue and revision numbers;
c) The revision number of the product;
d) Raw material and components specifications;
e) Details of the quality plan applied during manufacture to ensure ongoing compliance;
f) Where pre-existing test data derived using different methodologies to those described in this Standard is requested to be considered for the application, the full test report and details of any existing approvals.

Note: each request to consider pre-existing test data will be dealt with on a case-by-case basis provided it is compliant with MCS 011.

g) Installation, use and maintenance instructions.

6.2 When individual components are to be offered for incorporation into a wide range of systems then they should be described as universally compatible with other manufacturers' components in the Technical file and the uses clearly described in the installation or user instructions.

7 PERFORMANCE AND TESTING CRITERIA

7.1 Performance shall be determined and declared for either whole systems tested or for individual components.

7.2 The objectives behind the tests are:

a) to establish the wind-uplift resistance of mounting systems or individual components intended for fixing solar panels to the roofs of buildings so that the mounting arrangements can be designed for individual installations and;
b) the fire performance classification of the roof can be known with the mounting systems or individual components in situ and;
c) to ensure those mounting systems and individual components do not degrade the ability of a roof to provide long-term weathertightness protection of the building interior.

7.3 The relevant tests which should be carried out are as set out in the following Table 1.

Note: this table is a guide only. For precise details of what should or should not be tested refer to the relevant appendix for each test.

System and Component				Required Tests		
Class	**Sub-class**	**Examples**	**Main considerations**	**Wind uplift resistance required?**	**Weathertightness required?**	**Fire performance?**
Attachment to Roof Covering	Penetrating a roof covering	Trapezoid brackets, mini-rail	Strength of attachment. Strength of the roof covering and its attachment to the sub-structure are limiting factors.	✓ See Note 1	✓ See Note 1	O See Note 3
	Non-Penetrating	Systems requiring bonding, gravity, friction or aerodynamic forces to remain secure. Also includes seam clamps.	With some systems the forces relied on can be adjusted during installation. Can testing provide the necessary limit information to inform the conclusions from field tests at installation?	✓ See Note 1		
Attachment to Substructure	Penetrating a roof covering	Hanger bolts	Strength of attachment to the substructure, resistance of the attachment to distortion. Affect on the weathertightness of the roof covering.	✓ See Note 1	✓ See Note 1	O See Note 3
	Inserted between gaps in discontinuous roof covering	Roof hooks	Strength of attachment to substructure. Affect on the weather tightness of the roof covering.	✓ See Note 1	✓ See Note 1	O See Note 3
	Forming part of the roof covering	Flashing systems/trays, PV Tiles, Integrated Brackets etc	Strength of the attachment to the substructure. Affect on the fire performance of the roof covering. Affect on the weather tightness of the roof covering.	✓ See Note 1	✓ See Note 1	✓ See Note 1
Connecting to the attachment	Frameworks	Constructions of rails attached above the roof covering including their nuts bolts, and angle brackets.	Resistance to distortion and/or breakage .	✓ See Note 2		
	Frames	Individual pieces for holding solar panels as a roof replacement	Resistance to distortion and/or breakage. Fire performance. Weathertightness.	✓ See Note 2	✓ See Note 2	✓ See Note 2
Attachment of solar panel to frames or frameworks		Clips, clamps etc	Resistance to distortion and/or breakage allowing solar panel to break free or slip.	✓ See Note 2		
Key	✓	Required				
	O	Option (check notes and relevant appendix)				
Notes						
1	Components used for attachment to a roof covering or substructure can be tested by themselves (i.e. not as part of a system)					
2	Components used for connecting to the attachment can only be tested as part of a complete system					
3	See Appendix A2 for details of when a test is or is not required					

Table 1

7.4 Solar panels may be required to facilitate testing of mounting systems or individual components.

7.5 RESISTANCE TO WIND UPLIFT

A Maximum Design Wind Uplift Resistance shall be determined and declared when assessed in accordance with Appendix A1. The value is declared in Kilopascals (kPa) for mounting systems, or Kilonewtons (kN) for individual components.

7.6 FIRE PERFORMANCE

A fire classification shall be determined and declared in accordance with Appendix A2.

7.7 WEATHERTIGHTNESS

7.7.1 The mounting of the solar panels on or in the roof shall not decrease the weather performance of the declared roof types when tested in accordance with Appendix A3.

7.7.2 Any roof brackets/hooks intended for use on frangible roof coverings (e.g., slate, clay or concrete tiles) shall meet one of the following criteria:

a) be designed to not transfer any load to the roof covering or;

b) be designed to transfer an evenly distributed load (see Note (i)) to the roof covering that does not cause damage.

If b) then this shall be demonstrated through a positive (snow/downward) load test using a load value no less than 1.0kN/m^2 (See Note (ii)) for a mounting system. Where testing an individual roof bracket/hook then the load value shall be no less than 0.25kN.

Notes:

(i) the load being considered is the combined static weight/load of the solar mounting system, solar panels, and snow. Manufacturers of brackets/hooks designed to evenly distribute such a load must make it clear in their installation instructions that the bracket/hook must not be climbed on or used as a means of support by installers.

(ii) the test load of 1.0kN/m^2 is derived using the calculations prescribed in BS EN 1991-1-3 and rounded up from the maximum calculated value for every snow zone in the UK at a site altitude above mean sea level of 200m.

7.7.3 Where the product relies upon seals (with or without additional site-applied sealant) then the means of providing a weathertight seal shall be durable for the lifetime of a typical solar installation.

Notes:

(i) products relying solely on site applied sealants to provide a weathertight seal (i.e., where the product does not incorporate a factory seal or gasket) are not eligible for certification under this Standard.

(ii) where some site-applied sealant is used to achieve a weathertight seal (in conjunction with a factory seal or gasket), the installation instructions shall specify the sealant by brand and/or its exact properties along with specific instructions regarding its application.

7.8 INSTALLATION INSTRUCTIONS

Guidance shall be given on compatible solar panels and roof mounting systems. The information provided to the installer should clearly indicate how the product is installed with different solar panels and roof types including the type and number of fixings and maximum recommended spacing of brackets/rails.

In particular, the following information shall be clearly and prominently shown in the product installation instructions:

- The Maximum Design Wind Uplift Resistance the system achieved (in Pascals or Newtons as applicable) when assessed according to this document, using the standard procedure and fixing details as described in the manufacturer's instructions;
- For products that can be used with a variety of different solar panels these instructions should clearly describe the array design constraints (e.g., maximum panel size, maximum panel area, fixings per m^2 etc) that need to be met in order to achieve the stated wind load result.

8 MAINTENANCE OF CERTIFICATION AND LISTING

Certificates and listing are maintained and held in force subject to satisfactory completion of the following requirements for maintenance of certification:

8.1 FACTORY AUDITS

Certification is maintained through on-going FPC quality system audits in accordance with MCS 010 as appropriate, during which time a detailed check will be made that the product being manufactured is the same as the specification tested.

8.2 PRODUCT AUDITS

Product audits will be conducted as follows:

- Review of the product technical data files including materials.
- Review of end of line tests in accordance with the manufacturer's quality plan.
- Repeat testing of elements from the product standard as appropriate to confirm that the product continues to meet the requirements for certification and listing.

9 CERTIFICATION MARK AND LABELLING

All approved products listed under this Scheme shall be traceable to identify that they have been tested and certificated in accordance with the requirements of the test standard. See below for details.

The supplier shall use the Certification Mark(s) only in accordance with their Certification Body's instructions.

The Certification Mark(s) to be used for newly certified products under the scheme is as follows:

Certificate Number MCS "XXX"
"Description of the Technology certificated"

Where 'XXX' is the certificate number, and the logo of the Certification Body issuing the certification would sit on the right-hand side of the logo.

Companies shall only use the Mark whilst certification is maintained.

APPENDIX A – TEST PROCEDURES

Important note: all products shall be accompanied by manufacturer's installation instructions, and these shall be followed when preparing for all tests.

A1. RESISTANCE TO WIND UPLIFT

PRINCIPLES

A1.1 The test method shall follow the principles and, where appropriate, the details of BS EN 14437 (Determination of the uplift resistance of installed clay or concrete tiles for roofing — Roof system test method).

Note: a trial test, as specified in BS EN 14437: 2022, is not always necessary – this should be decided by the test laboratory, depending on the system. Figures A1 and A2 illustrate typical PV systems under test.

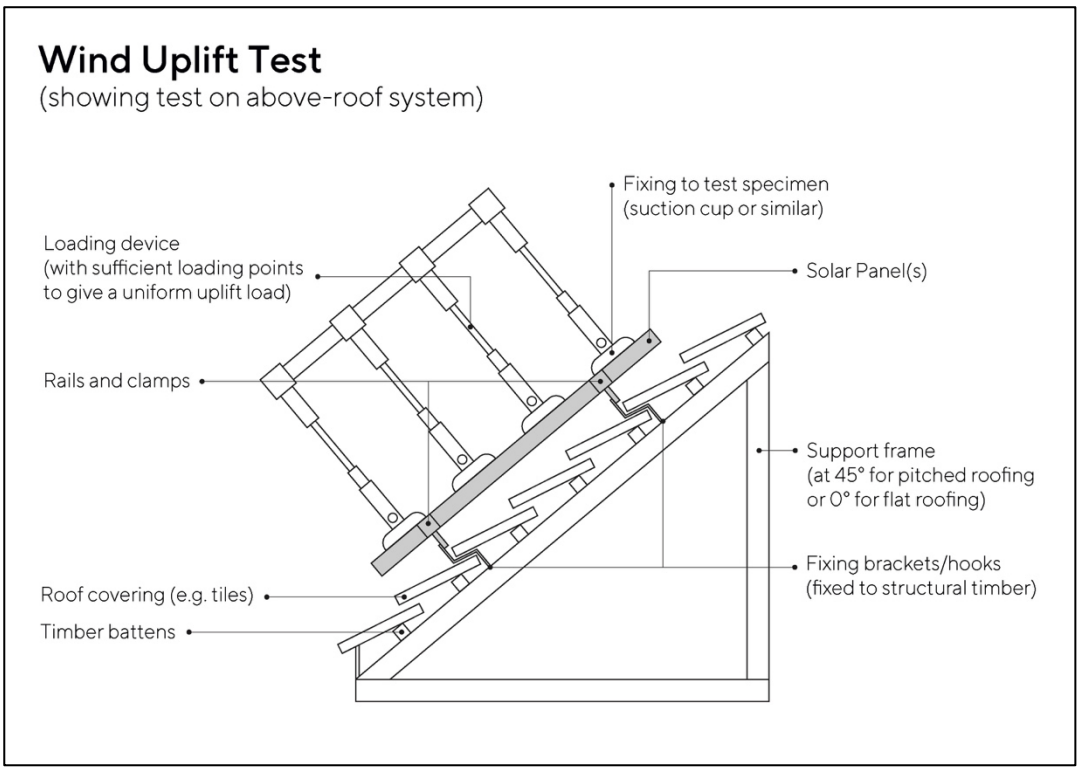

Figure A1: Schematic of pitched roof PV System undergoing a wind uplift test according to the principles of BS EN 14437: 2004

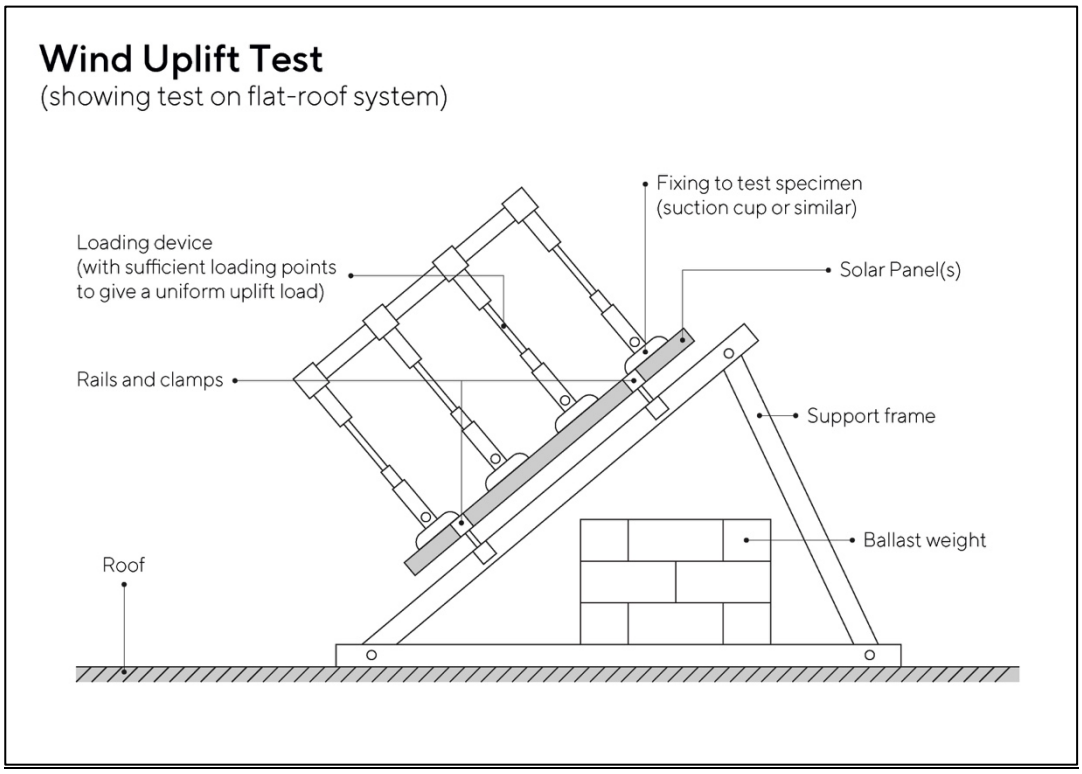

Figure A2: Schematic of ballasted flat roof PV System undergoing a wind uplift test

A1.2 The test preparation and procedures are given for complete systems and components in paragraphs A1.7 to A1.20 as appropriate.

A1.3 Individual components used for attachment to the roof covering or sub-structure (e.g., roof hooks) to be tested by themselves should be prepared in a manner determined appropriate by the Certification Body and tested as given in paragraphs A1.15 to A1.18.

A1.4 Individual components used for connecting to the attachment (e.g., clamps, rails etc) should be assembled into a complete system with other compatible components then prepared and tested as given in paragraphs A1.7 to A1.18.

A1.5 The preparation and procedures for the testing of complete systems mechanically attached to either the roof covering, or sub-structure, to resist wind uplift are given in paragraphs A1.7 to A1.18.

A1.6 The preparation and procedures for the testing of complete systems not mechanically attached to resist wind uplift are given in paragraphs A1.19 and A1.20.

PREPARATION OF SPECIMENS (MECHANICALLY ATTACHED COMPLETE SYSTEM TEST)

A1.7 The components to be tested shall be arranged with others to support a minimum of one solar panel.

Note: above roof mounting systems must include all components identified in the manufacturer's installation instructions as being required to mount one panel.

A1.8 Where the mounting system comprises components designed to attach more than one panel then the specimens shall be arranged to support a minimum of two solar panels.

Note: this would allow for the test to include components such as mid-clamps.

A1.9 Where any flashing or sealing products are designed to provide uplift resistance then these shall be included in the test.

PREPARATION OF APPARATUS (MECHANICALLY ATTACHED COMPLETE SYSTEM TEST)

A1.10 The detailed construction of the test rig in terms of the batten sizes, rafter spacing, and all fixings shall satisfy the minimum specification (worst case) of the manufacturer/supplier of the solar panel and all materials shall be of a quality typical of real construction. The minimum requirements of relevant standards should be satisfied (e.g., BS 5534: 2014+A1:2018 - Slating and tiling for pitched roofs and vertical cladding. Code of Practice).

A1.11 The test roof should include all components of typical construction, including the adjacent covering (e.g., tiles). Alternatively, technical justification shall be provided as to why these are omitted.

A1.12 The roof pitch shall be 45° (+/- 2°) or the maximum pitch declared by the manufacturer.

A1.13 The uplift load shall be applied using cables or equivalent methods to provide uniform loads. These may be fixed to the solar panel(s) by using suction cup devices attached to the upper surface, as shown in Figure A1 above. The uplift shall be applied perpendicular to the panels.

A1.14 Where there is a choice of fixing positions, the most onerous (weakest) shall be tested.

Note: for example, where the sole plate of a bracket or roof hook has a range of fixing holes then the outermost holes should be used where the load applies most leverage.

PROCEDURE – GENERAL TEST METHOD

A1.15 All tests shall be undertaken a minimum of three times.

A1.16 Determine the Characteristic Value Uplift Resistance from the measured failure loads as defined in Annex D of BS EN 14437: 2022 for a 95% confidence limit being attained.

A1.17 As written, the failure criteria specified in BS EN 14437: 2022 are not appropriate to solar systems so, for the purposes of this Standard, the failure criteria shall be taken as:

Ultimate Limit State (Failure)

a) Deformation of the system resulting in solar panel(s) coming free
b) Breakage of a mechanical component between the panel and the roof structure
c) Pulling out or breakage of the connection of the mechanical fixing to the roof
d) Breakage of elements of the solar panel

Note: if elements of the solar panel break before either of the failure states a), b) or c) occur then options are to either re-test using a stronger solar panel to attempt to achieve failure states a), b) or c), or accept the result as failure of the system or components under test.

Serviceability Limit State (Failure)

e) If the maximum displacement of any part of the roofing or solar systems exposes the under-roof OR exceeds 75 millimetres (mm)
f) After releasing the force to zero the remaining displacement of any roofing element exceeds 5mm. (When the 5mm limit is achieved, the test should be continued until the applied load is at least 1.5 times the load measured at the 5mm limit or until ultimate failure occurs. This is to ensure that the design resistance derived does not exceed the ultimate resistance divided by the appropriate partial factor)
g) Solar panel(s) becoming insecure (loose)

A1.18 Determine the Maximum Design Wind Uplift Resistance by dividing the Characteristic Value Uplift Resistance by the appropriate Partial Safety Factor given in table 2:

Failure Mode	Partial Safety Factor
Ultimate Limit State	
Deformation resulting in panels coming free	1.1
Failure in a metal component	1.1
Failure in a plastic component	1.25
Pull out from a metal component (e.g., self-tapping screw or rivet)	1.25
Failure in a timber component or pull out from a timber component	1.44
Serviceability Limit State (No ultimate failure but the system is no longer fit for purpose)	1.0

Table 2

Note: The IEC Code of Practice for Grid Connected Solar PV systems, Section 11.3.2, gives guidance on how to derive the wind load for a given site and location on a building, including the requirement to scale with wind load by a partial factor for the wind load of 1.35. The calculated wind load must not exceed the declared Maximum Design Wind Uplift Resistance for any system or component installed at that location.

PREPARATION OF SPECIMENS AND APARATUS FOR OTHER MOUNTING TYPES (NOT MECHANICALLY ATTACHED)

A1.19 Ballasted (including no or low ballast) systems should be tested to establish 3 characteristics (1 mandatory and 2 optional):

A1.19.1 Maximum Design Wind Uplift Resistance of the system attaching the solar panel to the ballast:

- The system should be restrained using ballast;
- Apply the uplift load until either a component breaks or the restraining force of the ballast is overcome (by the system sliding or overturning);
- Then either:
  - Determine the Maximum Design Wind Uplift Resistance as described in A1.16 to A1.18 above or
  - Increase the ballast and repeat the test (until the ballast cannot be reasonably increased any further).

A1.19.2 Resistance to sliding (Coefficient of Friction) by either:

- Declaring that the system shall always be mechanically restrained (e.g., by tethering or kerb)
- Declaring a default Coefficient of Friction of 0.3.
- Optional testing to determine the Coefficient of Friction on a range of substrate materials (see MIS 3002 Appendix D for test methodology).

Note: MIS 3002 allows Certified Contractors to do a bespoke test on a project-by-project basis. Some manufacturers may wish to provide contractors with a range of common scenarios (substrates and slip layers) where a coefficient of friction of greater than 0.3 can be used.

A1.19.3 Pressure coefficients (for use in wind uplift calculations) by either:

- Declaring the default pressure coefficients given in BRE Digest 489 apply to the system
- Optional wind tunnel testing or computation, in accordance with BS EN 1991-1-4 and the UK national annex, accounting for the edge and corner effects when the system is mounted on a building.

Note: where manufacturers believe that their product is designed in such a way that lower negative pressure coefficients should apply than the default values given in the BRE Digest 489 because of, for example, aerodynamic effects, this needs to be evidenced with appropriate testing in a wind tunnel (or

computation). Such testing should account for the turbulent airflow around buildings particularly at the edges and corners of a building.

ALTERNATIVE ASSESSMENT METHODS

A1.20 Where it can be demonstrated that alternative methods provide equivalent or conservative (safe) values for the resistance to wind uplift then these may be used. Alternative methods may be appropriate when testing individual components.

Depending upon the failure mode and the method of mounting other acceptable methods may include:

i) BS5534:2014+A2:2018 Slating and tiling for pitched roofs and vertical cladding. Code of practice;

Note: this test method may be appropriate for some designs of roof integrated systems. It is not suitable for above roof mounting systems.

ii) Validation by calculation alone.

Note: in some simple cases it may be possible to validate the system against wind loads by calculation only. However, this is often not possible because, for instance, a) the failure modes are not wholly predictable, b) tabulated fastener withdrawal loads from standards are often not applicable due to the fastener diameter/timber thickness ratio.

A2. FIRE PERFORMANCE

PRINCIPLES

A2.1 All roof integrated systems shall be tested.

A2.1.1 Where the panel forms part of the fire barrier for the fire test, the fire classification applies only to panels from the same product family to which the tested panel belongs (as determined by the certification against MCS 005). Systems that are intended for use with multiple product families must test and declare a fire classification for each product family it can be used with.

A2.1.2 Changes to the construction file for a PV module product family shall not invalidate the test provided those changes are permitted as given in Table 3.

Characteristic	Permitted Changes
Panel Area	No more than +/- 10%
Frame	Manufacturer
Coversheet	Manufacturer, thickness no more than +/- 5%
Cell	Power, size, manufacturer, crystal format
Bus bars	Number, width, colour
Encapsulant	Manufacturer, thickness no more than +/- 5%
Backsheet	Colour (lighter only), thickness no more than +/- 20%, manufacturer
Frame sealant	Manufacturer
Junction box	Any meeting requirements of IEC 61140:2016

Table 3

A2.2 Components or systems for mounting solar panels above roofs shall be tested where any of the following apply:

a) they increase the gaps in a discontinuous roof covering more than would be the case without the mounting system or;
b) they are made from an organic material and inserted through gaps in a discontinuous roof covering or;
c) they are made from an organic material and replace any part of the roof covering.

Any such testing needs to demonstrate the effect of the component(s) on the fire rating of the roof and may not necessarily require a full mounting system including the solar panels to be included in the test.

Notes:

(i) in the case of b) and c) above, components made from organic material are exempt from testing if they have a gross calorific value of ≤4MJ/m² or a mass of ≤200g/m² when set out on the roof. This can be determined when a sufficient number of those components are used to fix a single typical 1.6m² solar panel. In the case of integrated brackets where 4 brackets would be required for a single solar panel and each bracket has a mass of, say, 100g then the total mass would be 250g/m² (4 x 100 /1.6) and so would not be exempt and fire testing would be required.

(ii) Generally organic materials are defined as those containing carbon and therefore combustible such as wood and plastics. Metals, concrete, clay and slate are inorganic and therefore non-combustible.

A2.3 Research is ongoing to identify or develop appropriate test methodologies which can determine how the installation of solar panels above a wide range of roof types impacts the fire performance of those roofs. Once those methodologies become available then this section will be expanded as necessary to cover more installation scenarios.

PROCEDURE

A2.4 Testing shall be in accordance with BS 476-3: 2004 or CEN TS 1187:2012 Test 4, and the rating declared.

Notes:

(i) applying this test to solar systems is not without its problems and guidance is provided in Annex C (normative) of BS 476-3: 2004.

(ii) experience suggests that the flashings around and between solar panels often pose the greatest risk due to unprotected gaps.

(iii) for large systems it may be necessary to test more than one section to ensure the most vulnerable areas are all tested.

A3. WEATHERTIGHTNESS

PRINCIPLES

A3.1 Products intended for use on membrane roofs of a pitch ≤10° which penetrate the waterproofing layer shall be tested using method A given in BS EN 1928.

A3.2 Products bonded to the surface of membrane roofs of a pitch ≤10° which DO NOT penetrate the waterproofing layer need not be tested for weathertightness.

A3.3 For products for use on roofs of a pitch >10°, the wind driven rain test methods for roofs PD CEN/TR 15601:2012 shall be used to determine wind driven rain performance as set out in the following clauses A3.4 to A3.34 inclusive.

A3.4 PD CEN/TR 15601 specifies 4 different wind-rain sub-tests (A – D), covering a range of severe UK coastal conditions (referred to as N. European coastal). Only sub-tests B and D are required for this Standard.

A3.5 All roof integrated systems shall be tested.

A3.6 Products for mounting solar panels above roofs requiring the penetration of continuous roof coverings shall be tested.

A3.7 Products for mounting solar panels above roofs requiring insertion between the gaps of discontinuous roof coverings shall be tested.

A3.8 The manufacturer/supplier shall declare which generic classes of roof covering their system can be used with i.e.:

- Single lapped Pantiles or Plain tiles
- Double lapped Plain tiles
- Double lapped slates (natural or synthetic)
- Profiled, corrugated or standing seam metal sheet
- Any other generic roof covering type

A3.9 Where a single flashing system is specified for use with more than one generic class of roof covering, then the class representing the worst case shall be tested. If the worst class is not clear, then all classes that could be the worst shall be tested.

Note: based on experience the biggest risks of water entry are as follows:

Roof integrated systems:

(i) the risk of water entry over the flashing system which is around, between and, in some cases, under the panels. This water entry can be, for instance, at the

interface with the roof covering, at the interface with the panels, or through joints in the flashings;

(ii) water entry through the roof covering related to increased gapping of the roofing elements due to the presence of the solar panel system, including its fixing system.

Above roof mounting systems:

(iii) water entry via the penetrations through the outer roof covering;

(iv) spray entry through any gaps in the outer-roof covering created by the mounting arrangement.

Both types of system:

(v) Penetrations through the underlay can also pose a risk. Such penetrations must not jeopardise the role of the underlay, as specified in BS 5534:2014 + A2:2018 (Sections 4.9 and 6.2) and should therefore be sealed in an appropriate and durable manner, preferably with a purpose designed product.

A3.10 A specimen solar system is fitted into the appropriate test apparatus, the external surface of the specimen is exposed to wind and continuously sprayed with water and run-off water is continuously applied at the top of the specimen. At the same time an air pressure difference between the upper and lower sides of the test specimen is increased or decreased in specific steps. Water leakage through the test specimen which may occur at certain air pressure differences is observed and measured.

PREPARATION – SPECIMENS

A3.11 Samples for the test specimen shall comply with the product specifications and be representative of normal production.

A3.12 The dimensions of the test specimen shall be as large as necessary to be representative of the intended use. The test specimen shall include at least one of every type of joint between it and the surrounding roof surface (where appropriate). In some cases, with large solar systems, it might not be possible to test all of the joints simultaneously in the same test. In such cases the testing shall be repeated to ensure that each joint is fully tested. The minimum number of tests shall be one. The test specimen shall include all representative joints, where this is not possible then additional tests will be required to test each joint separately.

A3.13 Construct the test specimen according to the manufacturer/supplier's specification representative of its intended use (such as roof pitch, fixing systems, etc). The test specimen may be built in a surrounding frame to facilitate transport and fitting to the

opening of the driving rain test apparatus. The joint between test specimen and surrounding frame shall be sealed to prevent water leakage during the test, without disturbance to the normal occurring gaps in the specimen. If a frame is used, it shall be able to resist the pressures applied during the test without deflecting to an extent to influence the test results. The surround shall be prepared and installed so that any water penetration through the test specimen is readily detectable.

Note (applicable to A3.12 and A3.13): due to the complexity and size of solar systems, it can be difficult to get a whole panel or panels onto the test rig for test. It is often necessary to make up special samples which ensure the most vulnerable parts of the solar array are tested. It is necessary to ensure that all joints and other vulnerable parts of the test sample are representative of normal production. Alternatively, more than one configuration should be tested in order to ensure that one of each joint and interface type is tested.

A3.14 The test shall be carried out at the minimum pitch of the roof covering/solar panel combination.

PREPARATION - APPARATUS

A3.15 In order to test under sub-tests B and D, the test apparatus shall consist of:

- a pressure chamber sealed to the underside of the test specimen and connected to a pressure generator, as specified in A3.16;
- a fan system to create wind on the outside of the test specimen, as specified in A3.17;
- a facility for generating rain, as specified in A3.20;
- provisions for creating run-off water as specified in A3.22; and
- a facility for observation and measurement of leakage as specified in A3.23.

Notes:

(i) apparatus of different design may produce different wind driven rain test results but can produce consistent comparisons of performance between different roof covering products.

(ii) where only sub-test D is to be undertaken (see A3.29 and A3.32) then neither the pressure chamber, suction device nor fan system are required.

A3.16 The pressure generator connected to the pressure chamber shall be capable of creating a stable negative or positive pressure difference, maintained for five minutes ±10 seconds, across the test specimen. The pressure difference shall be measured to a maximum inaccuracy of 1% or 2.5Pa, whichever is greater. The volume of the pressure chamber shall be sufficient to ensure uniform pressure conditions. A water collector

shall be provided connected to the pressure chamber capable of recording the amount of leakage water during any pressure step in the test to a maximum inaccuracy of 2% or 1 gram, whichever is greater. The surfaces of the pressure chamber shall allow leakage water to flow freely into the water collector.

A3.17 The fan system shall be capable of generating wind directed parallel to the longitudinal axis of the test specimen. The wind flow may be horizontal or parallel to the surface of the test specimen. The spatial variation of the wind speed shall be not more than 10% over the test specimen. Calibrate the fan system for spatial variation of the wind speed, by taking measurements at not less than 9 positions uniformly distributed at a height of 200 ±10mm over a flat boarded area which replaces the test specimen, at the relevant roof pitch. The calibration wind speed shall be 10 ±0.5 metre per second (m/s) at the centre of the test specimen.

A3.18 The wind speed (V_i) shall be measured to a maximum inaccuracy of 0.5m/s.

A3.19 The turbulence intensity (t) in the oncoming wind shall be less than 10%.

Note: the turbulence intensity t (%) is expressed as t = 100u/U, where u and U are the RMS and mean wind speeds respectively, measured over a duration of not less than 5 minutes for this purpose.

RMS (root mean square) wind speed $$u = \sqrt{\frac{\sum_{i=1}^{n}(V_i^2 - U)}{n-1}}$$

Mean wind speed $$U = \frac{\sum_{i=1}^{n} V_i}{n}$$

Where:

V_i is the individual wind speed;

n is the number of measurements

A3.20 The rain generation facility shall be capable of supplying a stable rain rate. The spatial variation shall be not more than ±35% over the area of the test specimen during a time period of 5 min ±10s. During the same time period of 5min ±10s the rainfall rate shall vary by not more than ±2%. The rain droplet size shall be representative of natural rain, predominantly in the range of 0.6mm to 2.5mm diameter.

A3.21 The variation of rainfall over the specimen can be measured using rain collectors with an area of 0.10 square metre (m^2) to 0.20 m^2 in area and arranged so that they do not collect any run-off water during calibration. To calibrate the rain falling directly on the test specimen, replace the test specimen with a flat board which incorporates the rain collectors in its upper surface. The calibration should be carried out for each wind-rain

combination used. The rain shall be measured to a maximum inaccuracy of 3% or 0.2 mm/h, whichever is larger.

Notes:

(iii) water droplets introduced into a high velocity air stream tend to break up over distance. Accordingly, it is recommended that the droplets are introduced far enough above the test specimen for this process to be completed and for the droplets to achieve the required velocity prior to impact with the test specimen.

(iv) a variation of ±35% in wind driven rain distribution when combined with run-off water results in a combined variation of not more than 10%.

A3.22 Run-off water shall be evenly distributed across the top of the test specimen. The run-off rate shall not vary by more than 10% over the width of the test specimen. The quantity of run-off water shall be measured to a maximum inaccuracy of 3%.

The run-off rate R_{ro} shall be calculated by the formula:

$$R_{ro} = R_{test}\ W\ L\ /\ 60$$

Where:
R_{ro} is the run-off rate, in litres per minute (l/m);
R_{test} is the rainfall on the roof surface in mm/h;
W is the effective width of the test specimen, in m;
L is the simulated additional rafter length above the test specimen, in m. Unless otherwise specified, L shall be not less than 5 m.

A3.23 The pressure chamber shall be provided with:

a) a transparent under-surface for clear visual observation of the nature and position of leakages which may appear on the underside of the test specimen during the test.

b) an apparatus to continuously collect and measure the amount (by weight or by volume) of leakage water which may fall from the test specimen into the pressure chamber during the test.

A3.24 To minimise surface tension, absorption and retention of water on the internal surfaces of the pressure chamber, the surfaces shall be smooth, non-absorbent and inclined at a vertical angle of not less than 15° from the horizontal towards the lower collecting apparatus during testing.

A3.25 Carry out the test in an environment with a temperature of between 5 degrees Celsius (°C) to 35°C with the test specimen installed in the apparatus at the specified roof pitch. Seal the edges of the test specimen as appropriate to prevent leakage of water

or air into or out of the pressure chamber. The test specimen shall be surface dry before each test.

PROCEDURE - GENERAL

A3.26 Select and continuously apply the relevant wind speed, rain-fall rate, and amount of run-off water for each wind-rain combination as specified in table 4.

Climate zone	Wind-rain sub-test	Test conditions*	
		Approach Wind speed Vr (m/s)	Rainfall on horizontal Rh (mm/h)
Northern Europe Coastal	A	Not used in this Standard	
	B	13	60
	C	Not used in this Standard	
	D	0	225
** See PD CEN/TR 15601:2012 for the methodology to determine the wind and rain over the roof surface, as a function of roof pitch.*			

Table 4

In summary these sub-tests are:
Sub-test B: High wind speed with high rainfall rate
Sub-test D: Maximum rainfall rate with no wind (deluge)

A3.27 In sub-test B, measure initially the pressure difference with the pressure box closed and adopt this pressure difference as the reference zero for subsequent pressure changes during the test. Then reduce the pressure in the box in steps of not less than 5 Pa and maintain each pressure step for 5 minutes ±10 seconds, until leakage is observed. Measure the amount of leakage water at each pressure step, or continuously, up to the reference leakage rate (10grams per square metre per 5 minutes period) and note the suction pressure.

Notes:

(i) each sub-test may be continued at greater pressure differences to observe more leakage.

(ii) fine spray may leak through the joints in certain types of solar systems. Its occurrence should be recorded. Such fine spray may or may not be regarded as leakage depending on the leakage criterion adopted.

A3.28 In the deluge test, sub-test D, apply the rainfall and run-off without wind and with the pressure box open to the atmosphere, for 2 minutes ±10 seconds. Observe any leakage and measure the amount of leakage water.

PROCEDURE – ROOF INTEGRATED SYSTEMS

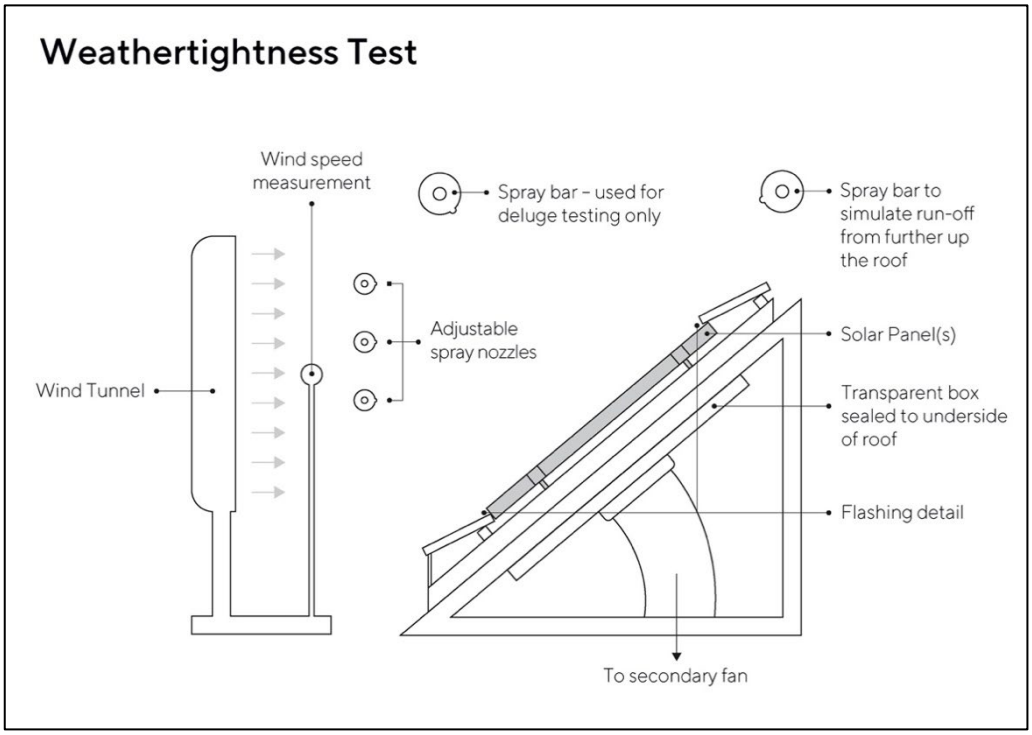

Figure A3: Roof Integrated PV system ready for weather tightness test

A3.29 Where the mounting and installation arrangement does **not** create unprotected gaps greater than those pre-existing in the roof covering before the installation of the solar panels, and there is no reason to believe the gapping will increase due to wind, conduct test under sub-test D.

Note: in this scenario tests according to sub-test *B is optional.*

A3.30 Where the mounting and installation arrangement **does** create unprotected gaps greater than those pre-existing in the roof covering, then conduct tests under sub-tests B and D.

A3.31 The quantity of water running onto the top of the solar panel ('run-off water') shall be adjusted to simulate the worst case (widest panel and longest rafter length of roof). The minimum simulated additional rafter length above the solar panel shall be 5 metres (m).

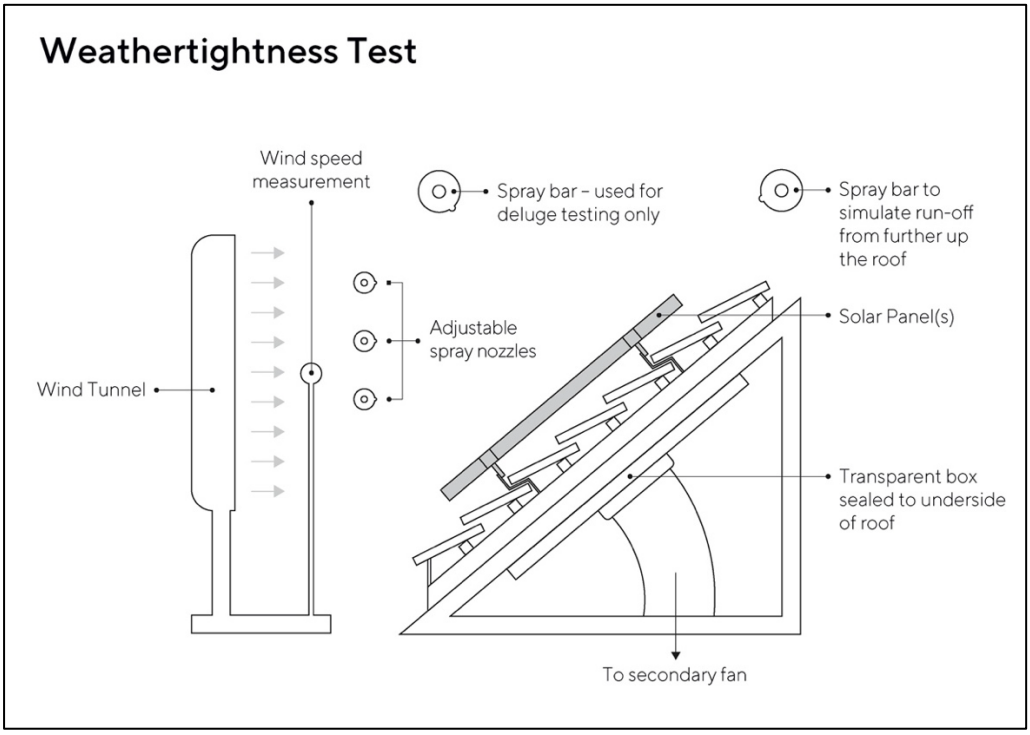

Figure A4: Above roof PV system ready for weather tightness test

A3.32 Where the mounting and installation arrangement does **not** create unprotected gaps greater than those pre-existing in the roof covering before the installation of the solar panels, conduct test under sub-test D using at least two fixing penetrations and **without** a solar panel in place.

Note: in this scenario tests according to sub-test *B is optional.*

A3.33 Where the mounting and installation arrangement **does** create unprotected gaps greater than those pre-existing in the roof covering before the installation of the solar panels, conduct test under sub-tests B & D **with** a solar panel (and as many fixing penetrations as necessary to hold the solar panel in place).

Note applying to both A3.32 and A3.33: for some designs of penetration a simpler 'impermeability test' can be considered as equivalent and sufficient. This simple test should follow the principles of the water impermeability test in one of the following standards, or other test standard as appropriate: BS EN 490: 2011 or BS EN 491: 2011, European concrete tile standard and associated test methods, BS ISO 10904:2011, Fibre-cement corrugated sheets and fittings for roofing and cladding, BS EN 539-1:2005, Clay roofing tiles for discontinuous laying – Determination of physical characteristics - Part 1 Impermeability test, BS EN 1928, Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of watertightness. In some cases, it might be necessary to design a bespoke test enclosure to apply these tests.

PERFORMANCE CRITERIA

A3.34 The following performance criteria applies:

a) The performance of the surrounding roof covering elements which are unaffected by the presence of the solar panels shall be taken as a benchmark against which to judge the performance of the solar panels.
b) The system under test shall have a level of performance at least equal to that of the unaffected roofing elements, or equal to that of any other roofing element of known acceptable performance.

Note: if necessary, a reference test shall be carried out with the test roof constructed wholly of roofing elements. The reference test must be carried out at the same laboratory as the test on the solar panel system.

APPENDIX B – PERFORMANCE DATA TEMPLATE

The following data shall be incorporated or appended to the product certificate in accordance with clause 5.5.:

Manufacturer & Product Name	**Model or Reference No.**	**Type**
		Select one... Above roof: System/Component Roof Integrated: System/Component
If a system, list all components included in the certification and their part numbers.		
If an individual component, and not a complete mounting system, is it?		Select one... • For attachment to roof covering (penetrating) • For attachment to roof covering (non-penetrating) • For attachment to substructure (penetrating) • For attachment to substructure (inserted between gaps in discontinuous roof covering) • For attachment to substructure (forming part of the roof covering) • Connecting to the attachment (frameworks) • Connecting to the attachment (frames)
System/Component description (free text box to describe the system or component, its purpose, the material(s) it is made from etc)		*Example text:* *Profiled universal and adjustable roof hook made from steel and for use with discontinuous roof coverings such as concrete roof tiles. Sole plate with multiple holes to accept screw fixings to timber roof joists.*

Compatible roof coverings		Select all that apply...
		• Continuous:
		  o Sheet or profiled metal
		  o Bitumen/GRP
		  o Other (describe)
		• Discontinuous
		  o Profile concrete/clay tile
		  o Plain concrete/clay tile
		  o Slate (natural or synthetic)
		  o Other (describe)

Tests undertaken (see Section 7 for required tests)		
Resistance to wind uplift		Yes/No
Fire performance		Yes/No
Weather tightness		Yes/No

Test details and results			
Resistance to Wind Uplift			
Compatible substructures	Timber Steel Other (describe)		
Test preparation	2 Solar PV modules mounted… (*full description of test rig set up so that the installer knows under what conditions the maximum design wind uplift resistance was achieved and can use this to assist with onsite calculations*)		
Maximum Design Wind Uplift Resistance (given in kPa for full systems or kN for components)	XXXXX	Partial Safety Factor used	X.X
Failure Mode			
Where attachment to timber substructure, state minimum permitted timber dimensions (width & depth in mm).			

Weathertightness			
Reference roof covering (Type, pitch and head-lap)			
Maximum unprotected gap in reference roof covering (+/- 1mm)			
Maximum unprotected gap with mounting system/component (+/- 1mm)			
Minimum permissible roof pitch (°)			
Test	Test pitch (°)		Test Result (System)
B		Applied suction (kilopascal (kPa)) at leakage rate 10g/m^2/5min	
D		Leakage observed after 2 min	

Fire Performance	
Fire classification (where determined)	Where this is not determined then use the following default text: *The fire performance of this above roof mounting system is not currently required for MCS 012. Research is ongoing into any influence above roof solar panels could have on the fire classification of the roof mounting system.*
Where relevant, state the solar panel family name(s) used to achieve this classification.	

Notes:

(i) where the same system achieves different classifications with different solar panel families then duplicate the above table for each classification.

(ii) work is ongoing to define the module characteristics that would conserve the fire rating when substituting one type of module for another.

(iii) an alternative means for an installer to achieve a fire rating is to use a substrate with an independent fire rating (for example a barrier material with AA rating) beneath a roofing system/module combination that does not have a declared fire rating. It is important to be able to verify that the system achieves a sufficient rating as a whole.

APPENDIX C - REFERENCES

- BS EN 1928: 2000 Flexible sheets for waterproofing. Bitumen, plastic and rubber sheets for roof waterproofing. Determination of watertightness.
- BS EN 14437: 2004 Determination of the uplift resistance of installed concrete or clay tiles for roofing-roofing system test method.
- BS 5534:2014 + A2:2018 Slating and tiling for pitched roofs and vertical cladding – Code of practice.
- BS 476-3: 2004 Fire tests on building materials and structures — Classification and method of test for external fire exposure to roofs.
- BS EN 13501-1: 2018 Fire classification of construction products and building elements — Classification using test data from reaction to fire tests.
- BS EN 13501-5: 2016 Fire classification of construction products and building elements — Classification using data from external fire exposure to roofs tests.
- PD CEN/TR 15601:2012 Hygrothermal performance of buildings — Resistance to wind-driven rain of roof coverings with discontinuously laid small elements — Test Method.
- BS EN 490: 2011 Concrete roofing tiles and fittings for roof covering and wall cladding — Product specifications.
- BS EN 491: 2011 Concrete roofing tiles and fittings for roof covering and wall cladding — Test methods.
- *BS ISO 10904:2011, Fibre-cement corrugated sheets and fittings for roofing and cladding.*
- *BS EN 539-1:2005, Clay roofing tiles for discontinuous laying – Determination of physical characteristics - Part 1 Impermeability test.*
- *BS EN 1928, Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of watertightness.*
- DD CEN TS15087: 2005 Determination of the uplift resistance of installed clay and concrete interlocking tiles for roofing — Test method for mechanical fasteners.
- BS EN ISO 9806:2013 Solar Energy. Solar Thermal collectors. Test methods.
- DD CEN/TS 1187: 2012 Test methods for external fire exposure to roofs.
- BS EN 1991-1-4: 2005 Eurocode 1. Actions on Structures. General actions. Wind loads.
- BRE Digest 489 Wind loads on roof-based photovoltaic systems.
- IEC Code of Practice for Grid Connected Solar PV systems.