



GUIDANCE DOCUMENT
External Fire Exposure of
Roof Decks within a Roof Build-Up

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Overview

BS EN 13501-5:2016 defines the external fire exposure classification for the roof element regarding its exposure to external fire, tested in accordance with DD CEN/TS 1187:2012 and the relevant direct application. There are four test methods within 'TS 1187':

- TS 1187, Test 1 (Germany)
- TS 1187, Test 2 (Scandinavia)
- TS 1187, Test 3 (France)
- TS 1187, Test 4 (UK)

TS 1187, test 4 has been accepted by the UK and Republic of Ireland regulators as the recognised test method and has been incorporated into England's Approved Document B (ADB): Fire Safety, plus other appropriate technical guidance in the rest of the UK, via the inclusion of EN13501-5. The Test 4 method has two-stages incorporating burning brands (stage 1 and 2), wind (stage 2) and supplementary radiant heat (stage 2). The level of external fire exposure is evaluated on two criteria; the fire penetration and spread of flame. Roof systems will be classified into five categories depending on the performance of the system, these are $B_{\text{ROOF}}(t4)$, $C_{\text{ROOF}}(t4)$, $D_{\text{ROOF}}(t4)$, $E_{\text{ROOF}}(t4)$, and $F_{\text{ROOF}}(t4)$. Approved Document B states that a roof system achieving $B_{\text{ROOF}}(t4)$ can be used less than 6m from any point on a relevant boundary and therefore is effectively unrestricted in its use.

All $B_{\text{ROOF}}(t4)$ compliant systems meet the following criteria:

- No penetration from outside to in the roof system during the 60 minute penetration test (stage 2)
- In the preliminary test (stage 1), after withdrawal of the test flame (1 minute), specimens burn for less than 5 minutes
- In the preliminary test, flame spread is less than 0.38m across any region of burning and no penetration should occur

ADB Appendix B sets out alternative ways to demonstrate that a system or product can meet the relevant performance classification i.e. They should have been assessed by applying relevant test evidence, in lieu of carrying out a specific test, as being capable of meeting that performance classification. Any test evidence used to demonstrate the fire performance classification of a product or system should be carefully checked to ensure that it is applicable to the intended use. Tests and assessments should be carried out by organisations with the necessary expertise. Assessments should only be carried out where sufficient relevant test evidence is available. Organisations listed as 'notified bodies' in accordance with the European Construction Products Regulation or laboratories accredited by the United Kingdom Accreditation Service (UKAS) for the relevant test standard can be assumed to have the necessary expertise.

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External Fire Exposure of Roof Build Ups

DD CEN/TS 1187 : 2012, Test 4 assesses the fire spread across the external surface of the roof, the fire penetration and the production of flaming droplets or debris falling from the underside of the roof or from exposed surface.

An example of a full roof system is shown below:

- Roof Deck
- Air and Vapour Control Layer
- Insulation
- Waterproofing Membrane

Please note that TS 1187, Test 4 should not be confused with Euroclass (BS EN 13501-1) which looks at individual components such as insulation and their reaction to fire. BS EN 13501-5 should also not be confused with EN 13501-1. For clarity, BS EN 13501-1 is reaction to fire and EN 13501-5 is external fire exposure.

To meet the requirements of the Government Guidance, ADB, plus other appropriate devolved technical guidance for fire, you will need to demonstrate that the 'as installed' roof system has a valid classification report to BS EN 13501-5 or has been assessed in accordance with ADB Appendix B by an appropriate organisation using relevant test data. In reality, there are so many possible variations of roof deck, insulation types, thicknesses etc that a roofing system provider would be unlikely to be able to test all permutations needed to be tested, but all could have an impact on the external fire exposure test results of the system.

The elements that are most likely to have the biggest impact on the external fire exposure test results are the deck, the insulation and the waterproofing or exposed top surface, which are the responsibility of the system owner to test. To reduce the number of test permutations a study was commissioned, which started with establishing the fire exposure of the most commonly used roof decks.

Study Carried out by BRE & Warringtonfire on Behalf of the Flat Roofing Industry

Further to discussions at the BSI committee responsible for fire resistance tests for external fire exposure for roofs, the Liquid Roofing & Waterproofing Association (LRWA), National Federation of Roofing Contractors (NFRC) and Single Ply Roofing Association (SPRA) sponsored a study on behalf of the flat roofing industry, using the Building Research Establishment (BRE) and WarringtonFire as accredited test houses.

Aim of the Study

The study was commissioned to comply with the conditions of ADB Appendix B to establish, in lieu of carrying out a specific test, the 'worst case scenario' in relation to the resistance of decks to penetration when exposed to the penetration test element of the t4 test. In use, they would not be exposed and therefore there is no need to consider the spread of flame.

Objective

To establish fire penetration times (up to a maximum of 60 minutes as required for a B_{ROOF}(t4) classification) for:

- Profiled Steel 0.7mm thickness (unperforated)
- Plywood, to BS EN 636, Use Class 3.2, (external) 'S' (structural), 18mm thickness (not Fire Retarded grade - FR)
- Oriented Strand Board, to BS EN 300 type OSB3 18mm thickness (not FR)
- Calcium Silicate Board 11.5mm thickness (Calcium Silicate Board is used by fire test laboratories to replicate the performance of all commonly used thickness of structural concrete deck, cast in-situ or pre-cast, only for the purposes of fire testing)

Once confirmed, it would enable a system owner to be able to test their system on that deck and provide them; specifiers, regulators and building occupants, with the reassurance in the knowledge that any other deck type (included in the study) would actually perform better if subjected to the penetration element of the t4 test.

Roof Deck	Average Penetration Time (mins)	Observations
Profiled Steel 0.7mm	No penetration	Refer to BRE test report P118474-1000. See appendices
Plywood 18mm	41.44 mins	
Oriented Strand Board (OSB3) 18mm	Could not be established by this test equipment	
Calcium Silicate Board 11.5mm	No penetration	

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External Fire Exposure of Roof Decks within a Roof Build-Up

Summary of Warringtonfire Results

Roof Deck	Average Penetration Time (mins)	Observations
Oriented Strand Board (OSB3) 18mm (not FR grade)	16.41 mins	Refer to Warringtonfire test Report 20776A. See appendices

Conclusion

In accordance with the test results, and following the guidance set out in ADB Appendix B, it is our opinion that this indicates if you have tested a roof system in accordance with TS 1187 Test 4 using an 18mm plywood or OSB3 deck (non FR grade), a change to a 0.7mm or thicker non-perforated profiled steel or concrete deck it would be appropriate to consider that the change in deck would not have an impact on the penetration performance, for example OSB3 and plywood can be seen as worst case scenarios. It would therefore seem that the classification in accordance with BS EN 13501-5 of the originally tested system would be unaffected by the change in deck, for example, if the original system classified with an 18mm plywood or OSB3 (non FR grade) achieved $B_{ROOF}(t4)$ a change to a 0.7mm or thicker non-perforated profiled steel deck, or a concrete deck, would have no impact on this classification.

Notes:

1. This assumes that all other elements of the system remain as per the original classification report i.e. it is only the deck element of the system that has changed.
2. It is not possible to substitute a plywood deck with an OSB3 deck without further testing.
3. Any use should be carefully checked to ensure that it is applicable to the intended use i.e. it does not mean that you can use a combustible deck where ADB requires a non combustible deck.
4. We would recommend that written clarification be sought from the appropriate authority, prior to commencement of works as to what their requirements are. This would normally be the Building Control Authority responsible for the project and ideally included as part of the full plans Building Regulations application or equivalent.

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Appendix 1



24 August 2020
Your Ref. FSH 22 / - / 08
Our Ref. P118474-1000

Dear Sir/Madame

INDICATIVE TEST RESULTS – Penetration test trials on 4 types of substrate based on BS 476-3 & CEN/TS 1187 Test 4.

We are writing to report the results of the exploratory roof tests carried out on your samples from May to August 2018.

The test results relate to an investigation which utilised the test methodology given in BS 476: Part 3: 2004 / CEN/TS EN 1187-4:2012; the full requirements of the standard were not however complied with. The information is provided for the test sponsor's information only and should not be used to demonstrate performance against the standard nor compliance with a regulatory requirement. The test was not necessarily conducted under the requirements of UKAS accreditation.

The test samples were supplied by the client. BRE Global were not involved in the sample selection process and therefore cannot comment upon the relationship between samples supplied for test and the product supplied to market.

The purpose of these trials was to establish penetration times (up to a maximum of 60 minutes as required for an A/Broof-t4 classification) of four materials commonly used as substrate layers in roofing systems. The four materials tested were:-

Profiled steel 0.7mm thick.
Plywood 18mm thick
Oriented Strand Board (OSB) 18mm thick
Calcium Silicate board (Supalux) 11.5mm thick

All specimens were fully conditioned in accordance with the test standards and were tested in the flat position. All specimens were sealed around the edges with a sand/cement mixture as required by the test standards.

Penetration test- Profiled Steel 0.7mm thickness.

Tests conducted on 22nd May 2018.

Sample reference	Penetration min:s	Observations
E10979-1	None	No ignition or degradation of specimen visible.
E10979-2	None	No ignition or degradation of specimen visible.

Average penetration time- > 60 minutes.



Figure 1- test specimen 1 immediately prior to test.

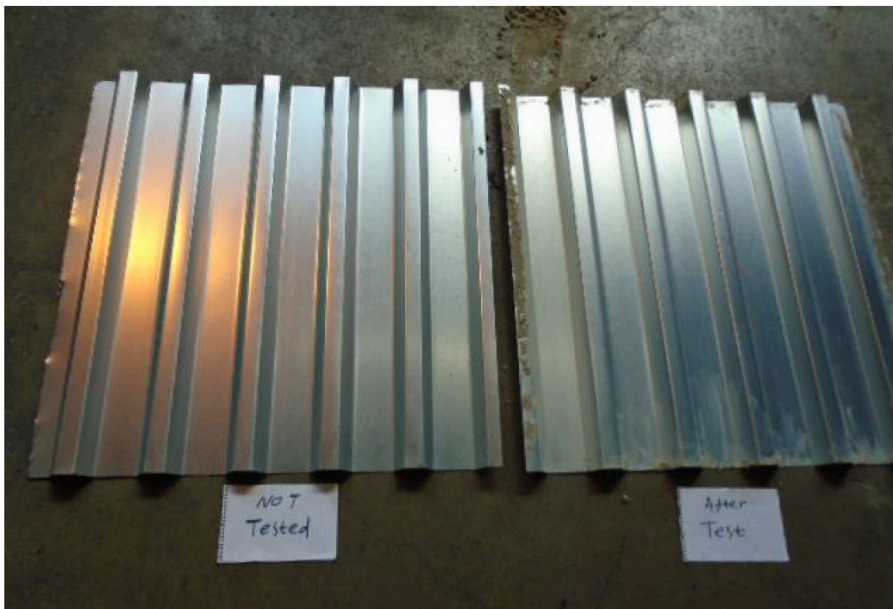


Figure 2- a comparison of specimen 2 before testing and specimen 1 after testing.

Penetration test- Plywood 18mm thickness.

Tests conducted on 17th August 2018.

Sample reference	Penetration min:s	Observations
E11180-1	40:05	Flexing of plywood was observed, sufficient to break the cement seal by 10 mins. Visible flaming ceased at 13:29 minutes. The specimen had visibly cracked open by 40:05 showing glowing on the edges and underside.
E11180-2	43:23	Flexing of plywood was observed, sufficient to break the cement seal by 8 mins. Visible flaming ceased at 12:20 minutes. Severe warping of the specimen occurred by 30 minutes. The specimen collapsed at 43:25 leaving visible glowing on the remaining edges and underside.

Averaged penetration time = 41:44 min:s.

Note:- the breaking of the edge seals would cause an X suffix to be added to any BS 476 classification, and observations of the same to be added to any EN 1187-t4 report.



Figure 3- plywood specimen as installed prior to testing.



Figure 4- showing edge detail prior to testing.



Figure 5- flaming shortly after ignition with pilot flame at 5-6 minutes.



Figure 6- flaming subsiding at 10 minutes.



Figure 7- showing edge seal failure.



Figure 9- showing the failure at 40 minutes.



Figure 10- showing severe warping of test specimen 2 at approximately 36 minutes.



Figure 11- showing failure due to collapse of specimen 2 at 43 minutes.

Penetration test- Oriented Strand Board (OSB) 18mm thickness.

Tests conducted on 17th August 2018.

Sample reference	Penetration min:s	Observations
E11181-1	N/A	Specimen ignited with test pilot flame at 5 minutes and flames grew until they threatened to envelop the gap pipes above the test rig. The test therefore had to be terminated by extinguishing with a hose at 6:30 minutes.
E11181-2	N/A	Specimen ignited with test pilot flame at 5 minutes and flames grew until they threatened to envelop the gap pipes above the test rig. The test therefore had to be terminated by extinguishing with a hose at 7:00 minutes.

Average penetration time- Could not be established due to material too flammable to test by this method.



Figure 12- OSB board test 1 as installed prior to testing.



Figure 13- Flaming of test 1 as seen at approximately 6:15 minutes.



Figure 14- Test 1 immediately before test stopped at 6:30 minutes due to flames threatening gas pipes above test rig.



Figure 15- Test specimen at 4:25 minutes, prior to ignition.



Figure 16- Flaming of test 2 as seen at 6:22 minutes.



Figure 17- Test 2 immediately before test stopped at 7:00 minutes due to flames threatening gas pipes above test rig.

Penetration test- Calcium Silicate board (Supalux) 11.5mm thickness.

Marked as "Supalux. ETA 07/0176 08/0129-"

Tests conducted on 20th August 2018.

Sample reference	Penetration min:s	Observations
E11179-1	None	No ignition or degradation of specimen visible.
E11179-2	None	No ignition or degradation of specimen visible.

Average penetration time- > 60 minutes



Figure 18- Test specimen 1 immediately prior to testing.



Figure 19- Test specimen 1 at end of 60 minute test.



Figure 20- Test specimen 2 immediately prior to testing.



Figure 21- Test specimen 2 at end of 60 minute test.

Conclusion

The steel (0.7 mm) and calcium silicate (11.5 mm) both achieved the highest rating (A or Brooft4), with no penetration occurring after the full 1 hour exposure. The performance of the wood-based substrates inferior. The plywood 18 mm exhibited penetration at 40 – 43 minutes. However, a penetration time could not be established for the OSB 18 mm, because this exhibited excessive flaming which threatened to engulf the gas supply pipes above the apparatus and the test had to be terminated early (6 to 7 minutes) on safety grounds.

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This letter is written on behalf of BRE Global. By receiving the letter and action on it, the client accepts that no individual is personally liable in contract, tort or breach of statutory duty (including negligence). No third party has any right to rely on this report.

If you have any queries, please do not hesitate to contact us.

Yours sincerely

P Potter
Senior Technician
For and on behalf of BRE Global

J Hunter
Reaction Leader, Reaction to Fire
For and on behalf of BREGlobal

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Appendix 2



Test Report

Indicative test Report No. 20776A

Sponsor

LRWA / SPRA / NRFC
Roofing House 31, Worship street
EC2A 2DY London
UNITED KINGDOM

Trade name of the roof covering

OSB 3 non-fire retarded grade

Manufacturer of the roof covering

LIQUID ROOFING & WATERPROOFING ASSOCIATION
Roofing House 31, Worship street
EC2A 2DY London
UNITED KINGDOM

Supplier of the roof covering

LIQUID ROOFING & WATERPROOFING ASSOCIATION
Roofing House 31, Worship street
EC2A 2DY London
UNITED KINGDOM

Nature of the tests

Test methods for external fire exposure to roofs: Test 4: Method with two stages incorporating burning brands, wind and supplementary radiant heat, according to CEN/TS 1187:2012: Test 4.

Deviations of the test standard


On the following points the test procedure deviated from the prescriptions of the standard: the number of specimens.
Therefore these results are of an indicative nature only and no classification can be given on only their basis.

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This report consists of 4 pages including 1 annex

This document is the original version of this test report and is written in English.
This report may be used only literally and completely for publications. - For publications of certain texts, in which this report is mentioned, our permission must be obtained in advance.
The authenticity of the electronic signatures is assured by Belgium Root CA.

1. DATA CONCERNING THE TEST SPECIMENS

Type of specimen: OSB 3 non-fire retarded grade board

The testing laboratory provided the OSB 3 non-fire retarded grade substrate. This roof specimens was conform to the prescriptions of the above-mentioned standard.

Sampling by : N/A
Sampling date : N/A
Sample ID : N/A
Production place : N/A
Production line : N/A
Production date : N/A
Identification within the quality system : N/A

2. DESCRIPTION OF THE TEST ROOF DECK

This description is based on information given by the sponsor (LRWA, SPRA & NRFC) and testing laboratory.

Nominal value (1)	
SUPPORTING DECK	
Material	OSB 3 non-fire retarded grade
Thickness (mm)	18
Density (kg/m ³)	680±10%

(1) Known by the laboratory

Position of the specimen:

The specimen was tested in the flat position.

Conditioning, according to EN 13238, § 4.2 to constant mass.

Start of conditioning : 22/10/2020

End of conditioning : 27/10/2020

3. TEST RESULTS AND OBSERVATIONS

a) Calibration

Calibration date: 27/10/2020

Burner No:	1	2	3	4
Heatflux (kW/m ²)	11,3	12,2	12,0	11,1
Criterion (kW/m ²)	12±1,5	12±1,5	12±1,5	12±1,5

b) Test results

Test date: 27/10/2020

Room temperature at start of test (°C): 18

Roof pitch: 0°

PENETRATION TEST WITH BURNING BRANDS, WIND AND SUPPLEMENTARY RADIANT HEAT (STAGE 2)

Specimen No:	1	Average
Time to fire penetration (min:sec)	16:41	N/A
Nature of the penetration	glowing	N/A
Additional observations: panel ignited, flame out after 16:41, glowing in the corners, corners curl upwards, carbonization		

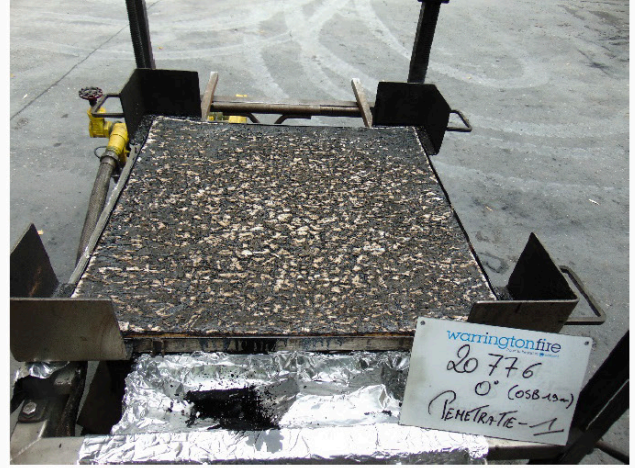
Photo of the test specimen before and after the test: annex 1.

Photo of the test specimen before and after the test

Specimen 1: Before



After



Extra detail: 1



Extra detail: 2



For More Information:



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National Federation of Roofing Contractors

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Single Ply Roofing Association

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Registered Office: Roofing House, 31 Worship Street, London, EC2A 2DY

Disclaimer

LRWA/NFRC/SPRA and any contributors believe that the guidance and information contained in this guide is correct. All parties must rely on their own skill and judgement when making use of it.

This guide is not exhaustive and building designers will be required to check constructions against guidance for a number of functional standards. It is recommended that project specifics are discussed with the local authority and a qualified fire engineer, particularly when following alternative guidance or a fire safety engineered approach.

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