A comparison of BS 8414-1 & -2, draft DIN 4102-20, ISO 13785-1 & -2, EN 13823 and EN ISO 11925-2

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Protecting People, Property and the Planet

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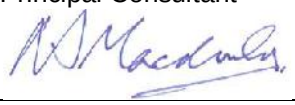
Signature 

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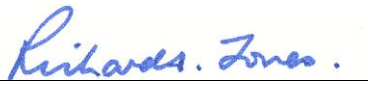
Signature 

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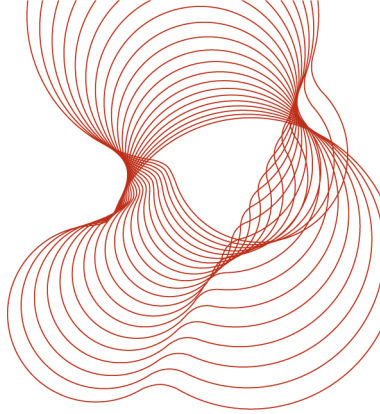


1 Introduction

External thermal insulation composite systems, ETICS, for use as decorative insulating systems secured to the outer face of the external cladding of buildings, are required to satisfy certain fire performance criteria. These criteria vary from one country to another and will depend on several factors including the height of the building, its proximity to other buildings and its use.

Two particular fire scenarios that must be considered are the types of fire that can occur as a result of an external fire in close proximity to the building envelope or fire breaking out from an opening in the external wall such as a window or a door. Various test standards have been developed to represent the action of such a fire impinging on the external surface of the cladding system. Other test standards are designed to cover exposure to radiant heat from a fire in an adjacent building or to assess the fire resistance characteristics of the system.

At the request of the European Mineral Wool Manufacturers Association, EURIMA, this report has compared the test standards BS 8414-1: 2002[1], DIN 4102-20[2] (draft), EN 13823[3], ISO 13785-1 & 2[4] and EN ISO 11925-2[5]. The report also considers the effects, if any, on variations of the design of the wall cladding system.

2 Scope

This report considers the test standards BS 8414-1: 2002[1], DIN 4102-20[2] (draft), EN 13823[3], ISO 13785-1 & 2[4] and EN ISO 11925-2[5] and compares the results from tests submitted by EURIMA.

3 Supporting Data

The test reports listed in Table 1 were submitted as examples of tests to BS 8414-1[1], DIN 4102-20[2] (draft), EN 13823[3], ISO 13785-1[4], and EN ISO 11925-2[5].

Results from tests to BS 8414-1[1] have been assessed against the criteria given in BR 135[6]. The performance criteria for draft DIN 4102-20[2] (January 2012) have been confirmed by Herr Sven Kühnen of MPA.

4 Comparison of test standards

The main points of each standard, including the performance criteria, are presented in Tables 2 & 3.

Test standard	Test report no.	Test date	Summary of test specimen				Test result	System type
			Insulation[1]	Fixing method	Render[2]	Fire barrier[3]		
Draft DIN 4102-20 (September 2009)	MPA NRW 230007546	05/07/2010	300mm EPS	Bonded and mechanical	3mm inorganic render + 2mm decorative finish	300mm thick x 200mm high, 3m above fire chamber	Pass Discoloured / molten insulation at top	1
	MPA NRW 230007586	30/08/2010	200mm EPS	Bonded and mechanical	3mm organic render + 2mm decorative finish	200mm thick x 200mm high, 3m above fire chamber	Fail Temperature at 3.5m over 500°C	2
	MPA NRW 230008038	20/05/2011	300mm EPS	Bonded only	3mm organic render + 2mm decorative finish	300mm thick x 200mm high, 0m + 2.7m above fire chamber	Pass Molten insulation at top	3
BS 8414-1: 2002	BRE 262211	17/06/2010	200mm EPS	Bonded and mechanical	5mm inorganic render + 2mm decorative finish	200mm thick x 300mm high, 3m above fire chamber	Pass (BR 135) Fail (LPS1581 - pool fire)	1
	BRE 264425	15/09/2010	200mm EPS	Bonded and mechanical	organic render (3 - 3kg/m²) + 2mm decorative finish	200mm thick x 200mm high, 3m above fire chamber	Non compliant (BR 135)[4] Fail (LPS1581) Test stopped before 30min	2
	BRE 266619	08/12/2010	300mm EPS	Bonded only	organic render (3 - 3kg/m²) + 2mm decorative finish	300mm thick x 200mm high, 0m + 3m above fire chamber	Non compliant (BR 135)[4] Fail (LPS1581) Test stopped before 30min	3
	BRE 269340	09/06/2011	300mm EPS	Bonded only	organic render (3 - 3kg/m²) + 2mm decorative finish	300mm thick x 500mm high, 0m + 3m above fire chamber	Fail (BR 135) Air temperature > 600°C within 15 min Fail (LPS1581) Test stopped before 30min	4
ISO 13785-1 (2002)	Pavus PR-11-1.153-En	09/09/2011	Specimen 1. 200mm EPS on blockwork	Bonded only	3mm organic render + 2mm decorative finish	200mm thick x 200mm high, located at bottom.	Pass[6]	
			Specimen 2. 200mm EPS (no blockwork)	n/a	3mm organic render + 2mm decorative finish	200mm thick x 200mm high, located at bottom.	Pass[6]	
			Specimen 3. 200mm EPS (no blockwork)	n/a	3mm organic render + 2mm decorative finish	200mm thick x 200mm high, located 2m above the bottom.	Fail[6] (Mean temperature on surface > 350°C)	
EN 13823: 2010	MPA NRW 230007856-3	02/02/2011	178mm EPS	Bonded to CaSi board	3mm organic render + 2mm decorative finish	n/a	See 5.1	2[5]
	MPA NRW 230007856-2	01/02/2011 & 02/02/2011	178mm EPS	Bonded to CaSi board	3mm inorganic render + finishing coat (2mm?)	n/a	See 5.1	1[5]
EN ISO 11925-2: 2010	MPA NRW 230007856-4	02/02/2011	55mm(?) EPS	n/a	3mm (?) inorganic render + finishing coat (2mm?)	n/a	See 5.1	
	MPA NRW 230007856-5	02/02/2011	55mm(?) EPS	n/a	3mm organic render + 2mm decorative finish	n/a	See 5.1	

NOTE 1: The insulation panel used in all the tests was the same EPS product, stated to be Euroclass E.

NOTE 2: All specimens used reinforcement mesh. The inorganic renders were all the same. The organic renders were all the same. All thicknesses and application rates are nominal.

NOTE 3: The fire barrier used in all tests was stated to be stone mineral wool with a Euroclass A1.

NOTE 4: Terminating the test before 30 minutes is not a specific failure criteria of BR 135. However, where a test is terminated for safety reasons due to a system collapse or excessive system combustion beyond the confines of the test rig prior to the full test duration required by BS 8414-1, a BR 135 classification cannot be issued and is therefore deemed 'non-compliant'.

NOTE 5: The test specimens were similar to systems 1 and 2 except the EPS thickness was only 178mm due to the requirements of the test standard. Also, the EPS was not mechanically fixed.

NOTE 6: Assessed against the Czech performance criteria given in the National Annex to ČSN ISO 13785-1

Table 1 Summary list of test reports and results

Test standard	Scope	Size of test specimen	Heat source	Performance criteria
EN ISO 11925-2	This part of EN ISO 11925 specifies a method of test for determining the ignitability of products by direct small flame impingement under zero impressed irradiance using vertically oriented test specimens.	Nominally 250mm long x 90mm wide. Maximum thickness 60mm. (Minimum of 6 samples for each exposure condition)	Gas burner	Test reports record a) whether ignition occurs, b)whether the flame tip reaches 150mm above the flame application point and the time at which this occurs, c) presence of flaming droplets/particles which cause ignition of the filter paper and d) observations of physical behaviour of the test specimen. Based on this performance, EN 13501-1 groups products into Classes.
EN 13823	This standard specifies a method of test for determining the reaction to fire performance of construction products when exposed to thermal attack by a single burning item (SBI).	Test specimen is L-shaped, 1500mm high, with one leg 1000mm long and the other leg 495mm long. Maximum specimen thickness 200mm.	Sandbox burner to give a heat output of 30.7 ± 2.0 kW	Test lasts for 20min and records heat production, smoke production, lateral (horizontal) flame spread and falling flaming droplets and particles. Based on this performance, EN 13501-1 groups products into Classes.

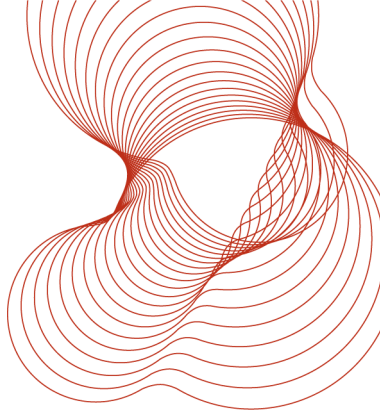
Table 2 Brief description of EN ISO 11925-2 and EN 13823

Test standard	Scope	Size of test specimen	Heat source	Performance criteria
				Criteria for BS 8414-1 & 2 given in separate document, BR135.
BS 8414-1	This test standard describes a method of assessing the behaviour of non-loadbearing external cladding systems, rainscreeen overcladding systems and external wall insulation systems when applied to the face of a building with a masonry wall and exposed to external fire under controlled conditions. The fire exposure is representative of an external fire source or a fully-developed (post flashover) fire in a room, venting through an opening such as a window aperture that exposes the cladding to the effects of external flames.	Test specimen is L-shaped, at least 8m high, with one leg forming the main test wall at least 2.6m long and the other leg at least 1.5m long.	Normally a timber crib of a standard size, located in a combustion chamber, nominally 2m wide, at the base of the main test wall. The size of the standard crib is nominally 1500mm x 1000mm x 1000mm high made up using 50mm x 50mm softwood sticks. Nominal weight 400kg. If another fuel source is used it must provide a mean heat flux within the range 45-95kW/m² over a 20min period, incident on the façade at specified locations.	External fire spread - failure is deemed to have occurred if the temperature rise of air 50mm from front face of specimen, 5m above combustion chamber, exceeds 600°C, for a period of at least 30sec, within 15min of the start time. Internal fire spread - failure is deemed to have occurred if the temperature rise at mid-depth of each combustible layer and any cavity, 5m above combustion chamber, exceeds 600°C, for a period of at least 30sec, within 15min of the start time. Mechanical performance - not a failure criterion but details of system collapse, spalling, delamination or flaming debris should be included in test report and should be considered as part of the overall risk assessment when specifying a system. These observations shall be taken for at least 30min or for the duration of any burning of material in the wall system, whichever is the shortest time, for a maximum time of 60min.
BS 8414-2	Same as BS 8414-1, except the substrate wall is steel-framed rather than masonry.	Same as BS 8414-1.	Same as BS 8414-1.	Same as BS 8414-1 plus continuous flaming in excess of 60 seconds is not permitted on the internal wall surface, i.e. on the surface on the non-fire side of the steel-framed main wall.
DIN 4102-20 (draft)	Same as BS 8414-1	Test specimen is L-shaped, at least 5.5m high, with one leg forming the main test wall at least 2m long (using burner) or 1.8m long (using crib) and the other leg at least 1.4m long (using burner) or 1.2m long (using crib).	Gas burners* or timber crib in combustion chamber, nominally 1m wide, located at base of the main test wall. The size of the standard crib is 500mm x 500mm x 480mm high made up using 40mm x 40mm softwood sticks. Nominal weight 25kg. *The writer was not able to determine the heat output requirements for the gas burner from the draft standard but it is assumed that it is equivalent to the heat output of the timber crib.	Burners turned off after 20 minutes for combustible facades, 30 minutes for non combustible facades. Data acquisition terminated when there is no further burning or developing of smoke or 60min, whichever is the shortest time. Performance criteria as follows: A. There should be no 'burned' damage (this excludes melting or sintering) to the specimen 3.5m or more above the fire chamber. B. The temperatures on the surface or under the surface of the insulation must not exceed 500°C, 3.5m or more above the chamber. C. There should be no continuous flaming for more than 30s, 3.5m or more above the combustion chamber. D. At no time must there be flames at the top of the test specimen. E. The duration of the falling of burning droplets and burning and non-burning debris and lateral flame spread must not exceed 90 seconds after the burners are turned off.
ISO 13785-1	Same as BS 8414-1. This part of ISO 13785 specifies a screening method for use by producers to reduce the burden of testing in Part 2 of ISO 13785 by eliminating those systems that fail the tests described in this part of the standard. If results from this test are successful the façade system must be tested to Part 2.	Test specimen is L-shaped, 2.4m high, with one leg forming the main test wall at least 1.2m long and the other leg at least 0.6m long (outside dimensions).	Sandbox burner located along bottom edge of main wall. Thermal output during the entire test must be 100 ±5 kW.	Test is terminated as soon as the top edge of the test specimen is extensively flaming or after a period of 30min, whichever occurs first. Performance criteria not known but the following observations are taken. A. Time, duration and size of any flaming. B. External surface temperatures at various locations at 5 heights. C. Temperatures at mid-depth into the insulation or at the centre of the test specimen's cavity, at a distance of 1.2m and 2.3m from the bottom. (In the test report submitted, temperatures were also measured 500mm above bottom). E. Damage to test specimen. F. Heat flux as a function of time measured at top of specimen. Rockwool International have stated that the performance criteria in the Czech Republic National Annex is that there is a maximum permissible temperature limit of 350°C(mean) inside the insulation and on the surface, 0.5m above the lintel.
ISO 13785-2	Same as BS 8414-1	Test specimen is L-shaped, at least 5.7m high, with one leg forming the main test wall at least 3m long and the other leg at least 1.2m long (outside dimensions).	The standard ignition source is gas burners, but liquid pool fires and timber cribs are also permitted.	Test duration is between 23min and 27min. Performance criteria not known but the following observations are taken. A. Heat flux 600mm, 1600mm and 3600mm above window. B. Surface temperatures measured 50mm and 4m above the window. C. Temperatures measured at each layer and in any cavity 4000mm above the window. D. General observations and other temperature measurements that are felt useful to determine fire spread.

Table 3 Brief description of BS 8414-1, prDIN 4102-20, and ISO 13785, Parts 1 & 2

Standard	Performance criteria
BR135: Annexes A & B (when tested to BS 8414-1: 2002 or BS 8414-2: 2005)	1. External fire spread - Air temperature rise 50mm in front of test specimen must not exceed 600°C fo 30s or more within 15min of start time, 5m above fire chamber .
	2. Internal fire spread - Temperature rise at mid-depth of each combustible layer and any cavity must not exceed 600°C for 30s or more within 15min of start time, 5m above fire chamber .
	3. Mechanical performance - Not a failure criterion but details of the collapse of the system , spalling, delamination or flaming debris is recorded and should be considered as part of the overall risk assessment when specifying the system.
	4. System burn through (only for steel-framed walls i.e. BS 8414-2) - Failure is deemed to have occurred if continuous flaming (more than 60s) is observed anywhere on the internal surface of the external wall at or above 0.5m above the fire chamber within the duration of the 60-min test.
LPS 1581 & 1582 (when tested to BS 8414-1: 2002 or BS 8414-2: 2005)	1. External fire spread - Air temperature rise 50mm in front of test specimen must not exceed 600°C fo 30s or more within 30min of start time, 5m above fire chamber .
	2. Internal fire spread - Temperature rise at mid-depth of each combustible layer and any cavity must not exceed 600°C for 30s or more within 30min of start time, 5m above fire chamber .
	3. Early test termination - Failure of the system is deemed to have occurred if the test is terminated within the duration of the full test period for any safety reason.
	4. Visible flaming - Failure of the system is deemed to have occirred if visible flaming (more than 60s) exceeds the confines of the test rig in any direction for the durtaion of the 60-minute test.
	5. Mechanical performance - Failure will be deemed to occur if there is collapse of the system or part thereof onto the floor outside the designated crib collapse zone within the duration of the 60-min test period.
	6. Burning debris and pool fires - Failure is deemed to have occurred if burning debris or a pool fire develops on the floor outside the designated crib collapse zone within the duration of the 60-min test period.
	7. Glowing combustion - Failure is deemed to have occurred if the area of system damage spreads vertically beyond 5m above the fire chamber or reaches the outer edge of the wing wall in the area between 2.5m and 5m above the fire chamber, within 24h of the termination of the 60-minute test.
	8. System burn through (only for steel-framed walls i.e. LPS 1582) - Failure is deemed to have occurred if continuous flaming (more than 60s) is observed anywhere on the internal surface of the external wall at or above 0.5m above the fire chamber within the duration of the 60-min test.

Table 4 Performance criteria for BR135 and LPS 1581 & 1582



5 Discussion

5.1 System types

Various ETICS systems were tested as listed in Table 1. The table identifies the systems as types 1 - 4 which are defined in Table 6.

5.2 General consideration of test standards

5.2.1 EN ISO 11925-2

EN ISO 11925-2[5] is a relatively small scale test that has been developed to determine the ignitability of products by impingement of a small flame (see Table 2). Test specimens do not include joints or framing and the thickness is limited to a maximum of 60mm. The single flame is applied to the outer surface. BS 8414-1[1] & -2[8], DIN 4102-20[2] (draft) and ISO 13785-1 & -2[4] are much larger scale tests (see Table 3) that are more representative of the complete wall system, including joints and framing and the fire exposure of these large-scale tests is more representative of an external fire source or a fully developed fire in a room venting through an opening such as a window aperture. Therefore EN ISO 11925-2[5] cannot be compared with the scope and aims of the standards listed in Table 3.

5.2.2 EN 13823

EN 13823[3] is also a relatively small scale test compared to BS 8414-1[1] & -2[8], DIN 4102-20[2] (draft) and ISO 13785-1 & -2[4] but the shape of the test specimen is similar, i.e. L-shaped, and can include a limited amount of joints and framing (see Table 2). However, the test specimen thickness is limited to a maximum of 200mm and the heat source is much smaller and more localised. Therefore because of the limited size of the test specimen and the heat source, this test cannot be compared with the scope and aims of the tests listed in Table 3.

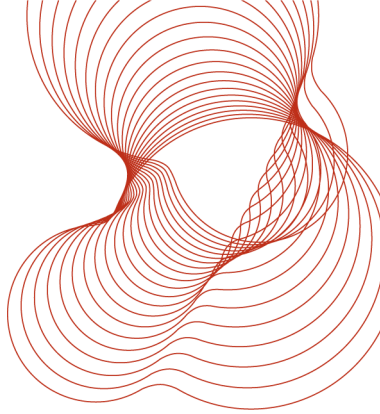
5.2.3 Classification to EN 13501-1

No classification reports to EN 13501-1[7] have been presented on the ETICs systems.

Small flame tests (EN 11925-2[5]) have been performed on the ETIC EPS system with organic and inorganic renders (see Table 1). Unfortunately the tests were not carried out in accordance with the standard as there were insufficient specimens tested with their edges exposed to the flame and the specimens were exposed on the EPS face but not the render face. SBI tests (EN 13823[3]) have also been performed on both systems (see Table 1). The SBI tests on the organic render are incomplete.

5.2.4 BS 8414-1 & 2, DIN 4102-20 and ISO 13785-1 and -2

BS 8414-1[1] & -2[8], DIN 4102-20[2] (draft) and ISO 13785-1 & -2[4] employ L-shaped test specimens and expose the specimen to fire and heat being emitted from the lower edge of the test specimen, although each standard uses a different level of heat. The different heating conditions are illustrated by the maximum temperatures measured on the face of the specimens at a height of 1.5m, i.e. 127-193^{0}C (ISO 13785-1[4]), 778-803^{0}C (DIN 4102-20[2] draft) and 720-930^{0}C (at 2.5m in BS 84141-1[1]).



The performance criteria are also similar. However the size of the test specimen varies as shown in Table 5 below.

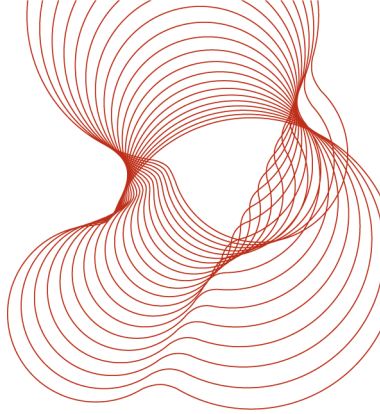
Standard	Minimum height of test specimen (m)	Minimum width of main wall (m)	Minimum width of smaller wall section (m)	Minimum area of test specimen (m^2)
BS 8414-1 & -2	8	2.6	1.5	32.8
DIN 4102-20 (draft)	5.5	2.0 (using gas burner) 1.8 (using crib)	1.4 (using gas burner) 1.2 (using crib)	18.7 (using gas burner) 16.5 (using crib)
ISO 13785-1	2.4	1.2	0.6	4.32
ISO 13785-2	5.7	3	1.2	23.94

Table 5 Size of test specimens

ISO 13785-1[4] is designed as a screening test in preparation of a test to ISO 13785-2[4] and therefore cannot be compared with the other tests listed in Table 3. In test specimen 1 of the ISO 13785-1 tests (see Table 1) the ETICS system was on blockwork and had a lintel to simulate the window frame, 150mm deeper than the external wall surface. The burner flames attacked the bottom edge of the original wall (substrate). We understand that this arrangement is required by ČSN ISO 13785-1, the Czech Republic National Annex. In specimen 2 there was no blockwork and the burner flames attacked the bottom surface of the ETICS, as required by ISO 13785-1. No test results have been presented on wall systems tested to ISO 13785-2[4].

Parts 1 and 2 of BS 8414 are similar to each other, the only difference being that the substrate wall is masonry in Part 1 and steel-framed in Part 2. The required performance criteria for these two standards are given in BR 135[6], *Fire performance of external thermal insulation for walls of multi-storey buildings.* BR135[6] provides the performance criteria, as listed in Table 3 of this report. The criteria for the two types of substrate wall are the same except Part 2 does not permit sustained flaming on the non-fire side of the steel-framed substrate wall. BR 135[6] is referred to in guidance to UK national building regulations which is mainly concerned with life safety. Insurers may also be interested in property protection. If this is the case they may consider specifying systems that have been certified to LPS 1581[9] or LPS 1582[10]. The performance requirements of these standards are compared to those of BR 135[6] in Table 4.

Therefore in section 5.2 we have only considered the results from tests to the standards listed in Table 3, except for ISO 13785-2[4] for which there was no test results provided.



5.3 Performance criteria

The performance criteria for each standard are given in Tables 2, 3 and 4.

5.4 ISO 13785-1

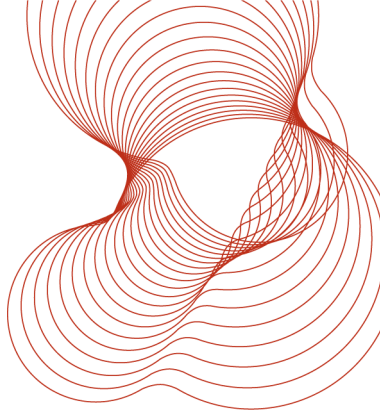
These tests were carried out in the Czech Republic. The three samples tested to ISO 13785-1[4] were all the same 200mm EPS product, stated to be Euroclass E. Two of the test specimens passed the Czech national performance criteria and one narrowly failed. Comparing these results with those of similar EPS specimens tested to BS 8414-1[1] and DIN 4102-20[2] (draft) it is clear that the ISO 13785-1[4] test is less onerous and results using this test standard should be treated with caution. As stated in the standard itself, it must only be regarded as a screening test before progressing to the ISO 13785-2[4] standard.

5.5 Detailed comparison of fire performance to DIN 4102-20 & BS 8414-1

The height of the BS 8414-1[1] test specimen is greater and the heat exposure in the BS 8414 standards is more severe than that in the draft DIN 4102-20[2] standard as discussed in section 5.1.4. However, the size of the tests specimens and the heating conditions in DIN 4102-20[2] (draft) and BS 8414-1[1] are more comparable than with the other standards discussed in this report. Therefore in this section we have only considered the results from tests to DIN 4102-20[2] (draft) and BS 8414-1[1].

To compare the test results some relevant information has been extracted from Table 1 and from the test reports and presented in Table 6.

For illustration of typical tests, photos from tests on the EPS system with inorganic render to BS 8414-1 and on the EPS system with organic render to BS 8414-1 and to draft DIN 4102-20 are given in Tables 7, 8 and 9 respectively.



	System Type 1[1]		System Type 2[1]		System Type 3[1]		System Type 4[1]
Test method	BS 8414-1	Draft DIN 4102-20	BS 8414-1	Draft DIN 4102-20	BS 8414-1	Draft DIN 4102-20	BS 8414-1
EPS insulation thickness	200mm	300mm	200mm	200mm	300mm	300mm	300mm
Position of fire barrier	3m above opening	3m above opening	3m above opening	3m above opening	0m & 2.7m above opening	0m & 3m above opening	0m & 3m above opening
Height of fire barrier	300mm	200mm	200mm	200mm	200mm	200mm	500mm
Adhesive	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Anchors	Yes	Yes	Yes	Yes	No	No	No
Mesh	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Render	Inorganic	Inorganic	Organic	Organic	Organic	Organic	Organic
Pass/fail[2]	Pass	Pass	Fail	Fail	Fail	Pass	Fail
Flaming on surface	None recorded	After 5:45min	After 4:15min	After 3:00min	After 5:44min	After 1:30min	After 3:55min
Droplets	After 6:57min	After 8:17min	After 8:08min	After 7:44min	After 7:35min	No	After 10:39min
Pool fire	After 6:57min	After 10:35min	After 8:49min	After 9:35min	After 14:20min	None recorded	After 10:56min
Max. recorded height of flame	3m (intermittent 4m)	3m	5m	4m (intermittent 4.2m)	5m	3m	3.5m (6m behind render coat)

NOTE 1: There are variations within each system type but they have been grouped into four different types to make comparison easier.

Note 2: BS 8414-1 'pass/fail' after classification to BR135

Table 6 Comparison of BS 8414-1 & draft DIN 4102-20 test results

		
BRE test 262211 BS 8414-1 test arrangement Photo before test starts	BRE test 262211 BS 8414-1 test arrangement Photo during test	BRE test 262211 BS 8414-1 test arrangement Photo after test
300mm EPS with inorganic render	300mm EPS with inorganic render	300mm EPS with inorganic render

Figure 7 Photos taken for test on EPS system with inorganic render to BS 8414-1

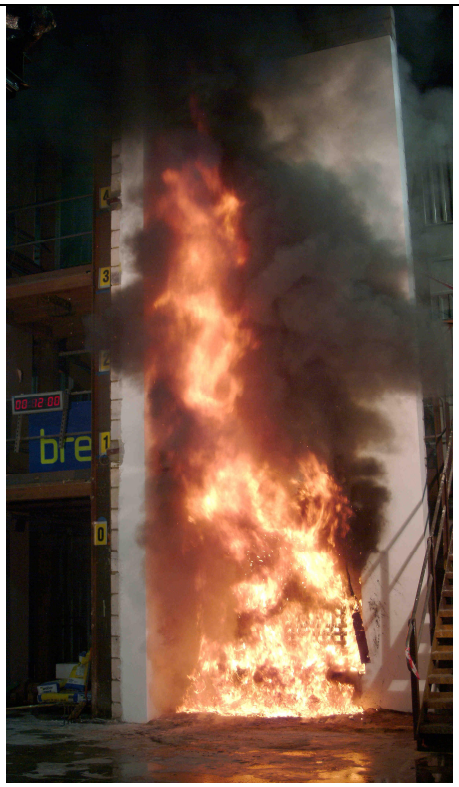
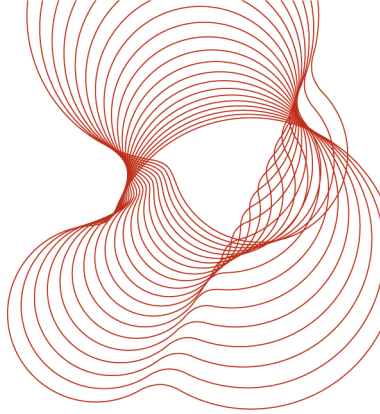
	
BRE test 264425 BS 8414-1 test prior to the termination of the test. Note pool fire visible on the floor in front of the main wall.	BRE test 264425 BS 8414-1 after test.
200mm EPS with organic render	200mm EPS with organic render

Figure 8 Photos taken for test on EPS system with organic render to BS 8414-1

	
MPA NRW 230007586 Draft DIN 4102-20 Before test	MPA NRW 230007586 Draft DIN 4102-20 After test
200mm EPS with organic render	200mm EPS with organic render

Table 9 Photos taken before and after test on EPS with organic render to draft DIN 4102-20



5.5.1 Temperatures within the cladding system and the effect of insulation thickness

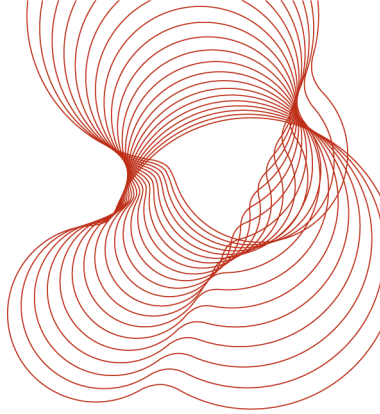
The draft DIN 4102-20[2] standard measures the temperatures within the cladding system at six heights up to 4.2m, at quarter and mid-depth. BS 8414-1[1] normally only measures the temperatures at a height of 5m within the cladding system at mid-depth of each combustible layer and in any cavity. (Both standards also measure air temperatures in front of the cladding system). However, in two of the EURIMA BS 8414-1 tests the temperatures were also measured inside the insulation at quarter depth. Maximum temperatures measured at mid-depth and quarter-depth of the insulation are given in Tables 10 and 11 respectively.

As temperature measuring positions were at different locations it is difficult to make a good comparison between the temperature data collected from the two standards. However they do indicate that higher temperatures were experienced in the BS 8414-1[1] tests as illustrated by the air temperatures referred to in 5.1.4 and within the insulation in Tables 10 & 11. This also correlates with the larger heat source used with the BS 8414-1[1] test.

System	Test no.	Thickness of EPS (mm)	Maximum temperature at mid-depth of insulation (^{0}C)					
			0.5m	1m	2m	3m	4.2m	5m
1	MPA NRW 230007546	300	664	660	451	355 (2.8m)	157 (4.4m)	
1	BRE 262211	200						190
2	MPA NRW 230007586	200	371	349	349	312 (2.8m)	161 (3.4m)	
2	BRE 264425	200						250
3	MPA NRW 230008038	300	274	267	34*	245 (2.8m)	52 (3.4m)	
3	BRE 266619	300						425
4	BRE 269340	300						850

*This reading appears to be too low.

Table 10 Maximum temperatures measured at mid-depth of insulation



System	Test no.	Thickness of EPS (mm)	Maximum temperature at quarter-depth of insulation (^{0}C)					
			0.5m	1m	2m	3m	4.2m	5m
1	MPA NRW 230007546	300	425	389	334	356 (2.8m)	161 (4.4m)	
2	MPA NRW 230007586	200	383	373	333	322 (2.8m)	162 (3.4m)	
3	MPA NRW 230008038	300	288	278	241	255 (2.8m)	110 (3.4m)	
3	BRE 266619	300						500
4	BRE 269340	300						990

Table 11 Maximum temperatures measured at quarter depth of insulation

5.5.2 Render

The tests on system types 1 & 2 demonstrate that the two test methods are able to differentiate between the inorganic and organic render systems, when mounted as tested on the particular EPS insulation used in the test. The inorganic rendered system 'passed' both tests whereas the organic rendered system 'failed'.

5.5.3 Influence of insulation fixing method

It can be seen from Tables 1 & 6 that the EPS was bonded and mechanically fixed in system type 2 but only adhesive fixed in system type 3. Both systems used the organic render system but system type 2 used 200mm EPS whereas system type 3 used 300mm EPS. Also, system type 2 did not have a fire break fitted immediately above the opening whereas system type 3 did. All the systems 'failed' except system type 3 when tested to the draft of DIN 4102-20[2]. It is uncertain whether any variations in performance are due to the mechanical fixing, the EPS thickness or the location of the fire barriers. In this case, as the mechanical fixings and the EPS have a relatively low melting point it is probable that the mechanical fixings had a negligible effect. The tests on system type 3 indicate that testing to BS 8414-1[1] is more onerous than testing to the draft of DIN 4102-20[2].

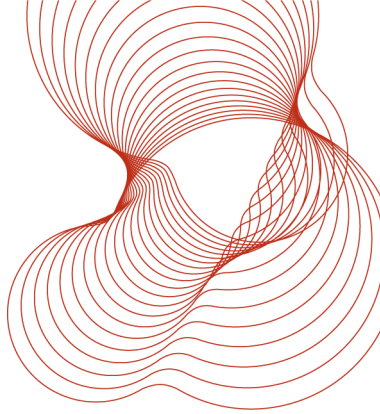
5.5.4 Influence of thickness of EPS

Because of the other variations in the test specimens it is not clear if a change in the EPS thickness has affected the results.

5.5.5 Influence of size & location of fire barriers

The size and location of the fire barriers are given in Tables 1 & 6.

The BS 8414-1[1] tests indicate that there was no advantage in increasing the height (size) of such barriers from 200mm (system type 2) to 500mm (system type 4) although it should be noted that the performance of system type 4 used a thicker EPS and no mechanical fixings.



The draft DIN 4102-20[2] tests on systems types 2 and 3 indicate that adding a fire barrier immediately above the opening to the fire chamber will improve the fire performance. The extent of flaming and droplets and the temperatures within the EPS were reduced as shown in Tables 6, 10 and 11. It should be noted that system type 2 secured the EPS with adhesive and mechanical fixings whereas system type 3 only used adhesive. Also, the EPS thickness was 200mm in system type 2 and 300mm in system type 3. It is uncertain how these differences have influenced the result. This improvement in performance was not obtained when testing to BS 8414-1[1].

6 Conclusions

A comparison has been made between test standards BS 8414-1: 2002[1], DIN 4102-20[2] (draft), EN 13823[3], ISO 13785-1 & 2[4] and EN ISO 11925-2[5]. These tests are intended to represent the action of a fire impinging on the external surfaces of the cladding system of an external wall. In addition, the results from tests submitted by EURIMA have been considered to try and identify the effects, if any, on variations in the cladding system.

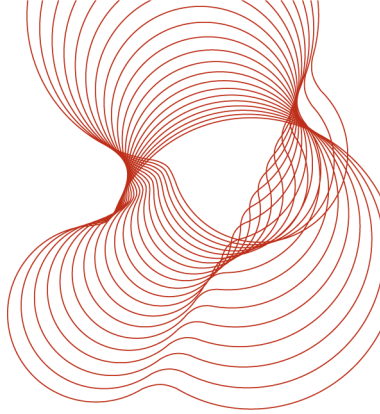
It has been concluded that BS 8414-1: 2002[1], DIN 4102-20[2] (draft) and ISO 13785-2[4] are useful tests that reproduce the heating conditions and performance of external wall systems when exposed to a fire being emitted from an opening. ISO 13785-1[4] can only be used as a screening test for the manufacturer's information before proceeding to ISO 13785-2[4]. EN 13823[3] and EN ISO 11925-2[5] are much smaller scale reaction-to-fire tests that do not give any indication of how the complete wall systems will perform when exposed to a fully developed fire.

No reports were available on systems tested to ISO 13785-2[4] but the results from tests to BS 8414-1[1] and the draft of DIN 4102-20[2] have been considered in detail. The main conclusions of this report are listed below.

1. To properly assess the fire performance of external cladding systems when subjected to a fire being emitted from an opening, tests in the scale of BS 8414-1[1], draft DIN 4102-20[2] or ISO 13785-2[4] are required. Smaller scale tests are not able to incorporate design features such as fire barriers and joints which can have a noticeable effect on the fire performance of the system.
2. The heating conditions in BS 8414-1[1] are more onerous (severe) that those of draft DIN 4102-20[2].

Based on the tests conducted on the particular EPS insulation system described in this report the following conclusions can be made.

3. The type of render can have a noticeable effect on the fire performance in all standards.
4. It is not possible to confirm whether or not the removal of the mechanical fixing had an effect on the fire performance although in this case we consider that any effect was probably negligible.
5. It is not possible to confirm whether or not the thickness of the EPS had an effect on the fire performance.
6. The tests did indicate that placing a fire barrier immediately above the opening to the fire chamber may have improved the fire performance.



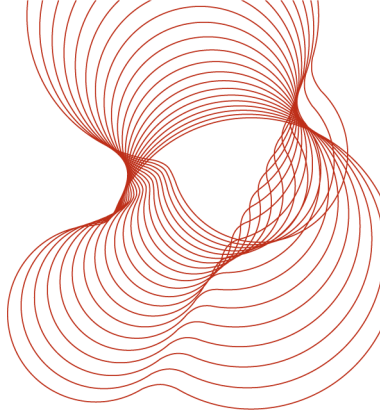
7. It is not possible to confirm whether or not the height (size) of the fire barrier had an effect on the fire performance.

It should be noted that the conclusions on the influence of any of the particular components of the tested systems are solely based on the performance of the test specimens described in this report. This may vary with different systems. However, it is clear from these tests that the overall fire performance of an ETICS system is a complex interaction between the substrate wall, thermal insulation, fire barriers, render, mesh and fixing method.

7 Reason for re-issue

Comments were submitted for our consideration after the original report was issued. The following changes have been made.

1. The heat output in EN 13823 has been added to Table 2 and the size of the timber cribs in BS 8414-1 and draft DIN 4102-20 have been added to Table 3.
2. Photographs of the test specimens in tests to BS 8414-1 and draft DIN 4102-20 have been added (Tables 7, 8 and 9) as typical examples.
3. Section 5.5.3 and Conclusion 4 in Section 6 have been modified to reflect that the influence on the test result of the mechanical fixings used for the EPS in some test specimens was probably negligible.
4. Conclusion 6 has been modified by changing ‘will improve’ to ‘may have improved’.



8 References

1	BS 8414-1: 2002, Fire performance of external cladding systems – Part 1: Test method for non-loadbearing external cladding systems applied to the face of the building.
2	DIN 4102-20 (draft September 2009)*, Brandverhalten von Baustoffen und Bauteilen, Teil 20: Besonderer Nachweis für das Brandverhalten von Außenwandbekleidungen
3	EN 13823: 2010, Reaction to fire tests for building products – Building products excluding floorings exposed to the thermal attack by a single burning item
4	ISO 13785-1 & 2: 2002, Reaction-to-fire tests for façades – Part 1: Intermediate-scale test and Part 2: Large-scale test. Also Czech Republic National Annex.
5	EN ISO 11925-2: 2010, Reaction to fire tests – Ignitability of products subjected to direct impingement of flame, Part 2: Single-flame source test
6	BR 135, Fire performance of external thermal insulation for walls of multi-storey buildings, second edition, 2003, BRE report.
7	EN 13501-1:2007 + A1 2009, Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests
8	BS 8414-2: 2005, Fire performance of external cladding systems – Part 2: Test method for non-loadbearing external cladding systems fixed to and supported by a structural steel frame.
9	LPS 158: Issue 2.0: 2010, Requirements and tests for LPCB approval of non-loadbearing external cladding systems applied to the masonry face of a building.
10	LPS 1582: Issue 1.0: 2010, Requirements and tests for LPCB approval of non-loadbearing external cladding systems fixed to and supported by a structural steel frame.

*Comments were also received from MPA on the performance criteria in the January 2012 draft.

==========REPORT ENDS==========