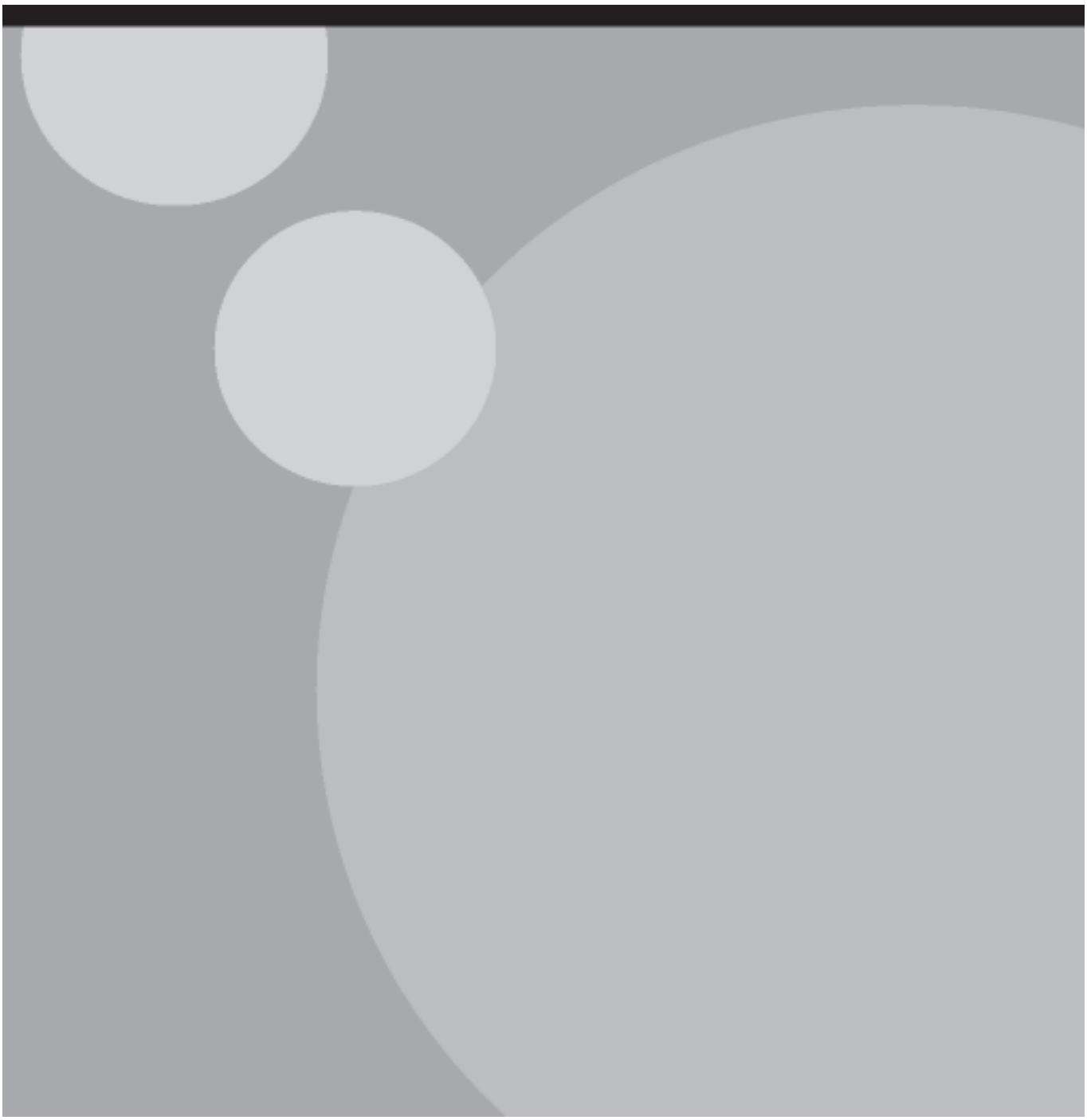
Communities and Local Government

The impact of European fire test and classification standards on wallpaper and similar decorative linings



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The impact of European fire test and classification standards on wallpaper and similar decorative linings

BRE

March 2012
Department for Communities and Local Government

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Executive Summary

This is the final report from a Department for Communities and Local Government sponsored research project carried out by BRE. The specific objective of the work was to understand the impact of European fire test and classification standards on building regulations and UK industry in relation to wallpapers and similar decorative linings.

With the introduction of the CPR (Construction Products Regulation) in July 2013, CE marking of construction products covered by European Technical Standards will become mandatory. As part of this process an EN standard for decorative wall linings will require reaction to fire performance to be declared in accordance with the harmonised European classification system instead of the national classes obtained previously by testing to British Standards.

For use in circulation spaces (including the common areas of blocks of flats) and in non dwelling houses (which include corridors in hotels, hospitals, care homes etc), the building regulations currently require national “Class O”, or European Class B. However, many heavy duty wallcoverings commonly used in these applications and which have previously achieved national “Class O”, do not achieve European Class B.

Fire incident data was analysed to assess the importance of fires in location where such heavy duty wallcoverings are commonly used. The data does not suggest a particular problem with these types of fire, although it should be noted that the fire statistics do not contain sufficient detail to evaluate whether or not any wallcoverings specifically contributed to the fires.

An experimental programme was carried out on six products chosen by the project Steering Group, which included a number of wallcovering manufacturers. These achieved either national Class 2 or Class 3 when tested on the standard plasterboard substrate. In the European tests they correspondingly achieved Class C or D. These products would therefore not meet the requirements of the building regulations, for use on end use plasterboard substrates, in circulation spaces using either the national or European classification system.

Tests on a calcium silicate board substrate using the current national tests (BS 476 Parts 6 & 7) on three of the products did produce better results than on the standard plasterboard substrate, demonstrating that the substrate does influence the test outcome. This clearly highlights the importance of manufacturers defining the field of application of test results and regulators such as building control professionals understanding the field of application.

Standardised large scale room corner tests were used to assess the hazard that these products actually represent in terms of flashover. Three of the products were tested and this showed that they were capable of reaching flashover under the conditions of the room corner reference scenario for the European classification system.

Contents

1 Introduction and Objectives

This is the Final Research Report for the project “The impact of European fire test and classification standards on wallpapers and similar decorative coverings” commissioned by Department for Communities and Local Government (DCLG).

The overall aim of this project was to understand the impact of European fire test and classification standards on building regulations and UK industry, in particular, on wallpapers and similar decorative linings. The outcome from the project would seek to establish the realistic performance of these types of products and determine whether the classifications that they achieved were appropriate to the actual hazard to life that they posed.

This report details the test methodology, results and observations from the fire tests undertaken.

1.1 Background

The Construction Products Directive (CPD) has been in force within the Member States of the European Union (EU) since December 1991. The primary purpose of the CPD was to remove technical barriers to trade for product manufacturers within Europe through the development and adoption of European Technical Specifications (harmonised product standards and European Technical Approvals). When the European Technical Specifications were/are published, conflicting national standards should be withdrawn. The intent of the CPD was to enable product manufacturers to sell their products throughout Europe by complying with a single common European Technical Specification recognised and accepted by all Member States, rather than having to test and comply with different national standards in each Member State. There was no intention that the adoption of the CPD would remove construction products from the market that have been used satisfactorily for a number of years. However, the realisation of this intent within the context of fire performance was not possible in all cases.

Within the UK, CE marking for construction products covered by European Technical Specifications currently remains voluntary under the CPD, and therefore the full consequences of the move over to European standards have not yet been realised. In July 2013, the Construction Products Regulation (CPR) will come into force. This will mean that for construction products covered by a harmonised product standard, CE marking will become mandatory and in such cases, fire performance will have to be declared in accordance with the European fire classifications. Current national classifications, based on BS 476 tests, are not accepted for CE marking.

1.2 Classification of wall linings

The national reaction to fire classes are based on the performance in the fire tests BS 476 Parts 4, 6, 7, and 11 [1-4]. The European classification system for reaction-to-fire testing consists of six standards; a suite of four test standards, a classification standard and a standard covering specimen conditioning and substrate selection. The documents are as follows:

BS EN 13501-1: Fire Classification of construction products and building elements. Part 1: Classification using test data from reaction to fire tests. [5]

BS EN ISO 1182: Reaction to fire tests for building products. Non-combustibility test.[6]

BS EN ISO 1716: Reaction to fire tests for products - Determination of the heat of the gross heat of combustion (calorific value). [7]

BS EN 13823: Reaction to fire tests for building products - Building products excluding floorings exposed to the thermal attack by a single burning Item.[8]

BS EN ISO 11925-2: Reaction to fire tests Ignitability of building products subjected to direct impingement of flame Part 2: Single-flame source test. [9]

BS EN 13238: Reaction to fire tests for building products Conditioning procedures and general rules for selection of substrates. [10]

The European classifications were first introduced, alongside the national classes, in Approved Document B, as amendments in 2002. A series of back to back tests was carried out to compare the European and national classes achieved by a range of different construction products. The data were used to develop correlations to align the European classifications with the existing national classes to ensure that current safety levels were maintained in accordance with the primary policy objective of life safety of people in and around buildings in the event of a fire.

The reaction to fire classifications are incorporated within Approved Document B [11] in relation to requirement B2, Internal fire spread (linings). They are presented in table 10 of Approved Document B (see below). It should be noted that the national classifications do not automatically equate with the equivalent classifications in the European column of table 10 and therefore construction products cannot typically assume a European Class unless they have been tested accordingly. The classification s3, d2 means that there is no limit set for smoke production and/or flaming droplets/particles.

Table 10 **Classification of linings**

Location	National class (1)	European class (1)(3)(4)
Small rooms (2) of area not more than: a. 4m² in residential accommodation b. 30m² in non-residential accommodation	3	D-s3, d2
Other rooms (2) (including garages)	1	C-s3, d2
Circulation spaces within dwellings		
Other circulation spaces, including the common areas of blocks of flats	0	B-s3, d2

BS EN 13823 (the Single Burning Item (SBI) test) simulates the conditions experienced by a construction product in the corner of a room, when exposed to the thermal attack of a single burning item positioned in that corner (see figure 1 below). BS EN ISO 11925-2 (Small flame test) simulates exposure to a small flame ignition source (see figure 2 below).

The fire test methods BS 476 Parts 6 and 7 measure different characteristics of fire performance from the European fire test methods BS EN 13823 and BS EN ISO 11925-2. In particular, the BS 476 tests are material tests where the fire performance is determined

by the characteristics of the surface of the material where as the SBI test is a test of the performance of the construction product in an arrangement representative of end use. That is, it is tested with joints, air gaps and/or fixings that are typical of its end use application and the level of thermal exposure in the test method resulting from direct flame contact means that the construction product is tested through its thickness. Measurements are made of heat release rate and smoke production rate as functions of time. From these, values of FIGRA (FIre Growth RAte index) and SMOGRA (a SMoke Growth RAte index) are calculated. FIGRA is basically a parameter that measures the rate at which a construction product will contribute heat to a fire.

Figure 1. EN 13823 SBI test specimen

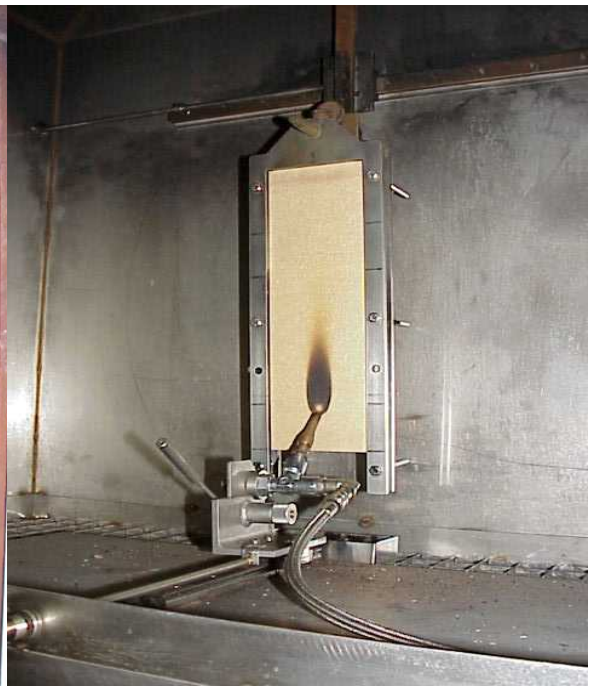

Figure 2. ISO 11925-2 Small flame test.

The room corner test (ISO 9705 [12]) was the “reference scenario” used in the development of the European classification system. This is a large-scale test (2.4 m wide by 3.6 m long by 2.4 m high) in which the ceiling and walls are covered by the construction product which is mounted in the same way as in end use application (see Figure 3). The test (BS EN 14390 [13]) is representative of a fire that starts in the corner of a small room with a single doorway. The ignition source delivers 100 kW for 10 minutes and then 300 kW for a further 10 minutes. It evaluates the contribution of the construction product to the fire growth in the room by measuring the heat release rate as a function of time. The class limits were defined in terms of the contribution of the construction product to flashover (the point on the fire growth versus time graph at which all combustible surfaces ignite) within the small room;

Class B No flashover

Class C No flashover for 100kW ignition source but flashover occurred with 300kW ignition source

Class D Flashover after 2 minutes with 100kW ignition source

Class E Flashover before 2 minutes with 100kW ignition source

Based upon this work, it therefore follows that a construction product that achieves class B-s3, d2 should not cause flashover in a small room or enclosure where there is little additional fire load.

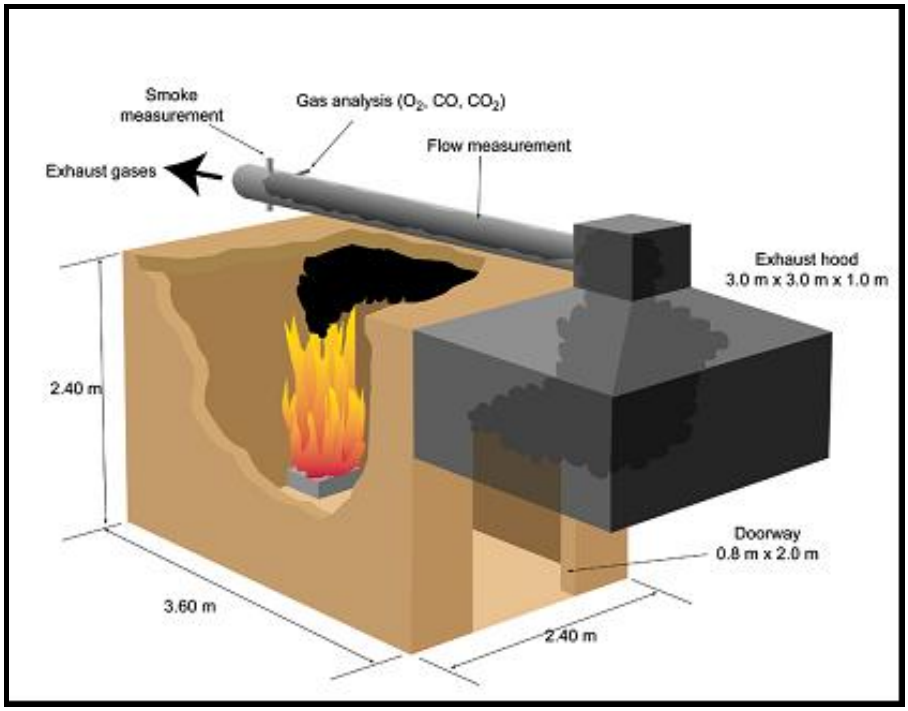

Figure 3. EN 14390 Room corner test.

2 Programme of work

The work programme consisted of the following tasks:

2.1 Task 1 - Steering Group

A Steering Group of key stakeholders was established. In addition to BRE and the Department for Communities and Local Government, the Steering Group members included representatives of regulatory bodies, fire and rescue service and manufacturers of products and were as follows:

- Department for Communities and Local Government (DCLG) (Project sponsor)
- Building research Establishment (BRE) (Project delivery team)
- Association of Interior Specialists (AIS)
- British Coatings Federation (BCF)
- British Contract Furnishing Association (BCFA)
- Fire Brigades Union (FBU)
- Association of Building Engineers (ABE)
- Scottish Building Standards (SBS)

The Steering Group provided valuable input to the project by providing guidance, data and materials to define an appropriate and representative experimental programme and providing expert review of the results from the work.

Three Steering Group meetings were held during the project. The Steering Group meetings and subsequent discussions and correspondence have been key to the success of the project and these contributions are gratefully acknowledged.

2.2 Task 2 - Literature review and development of experimental programme

This task included a literature reveiw and collated available data on reaction to fire classifications of a range of wall coverings.

In addition, information has been gathered on fire incidents, primarily in England and Wales, where fire growth in circulation spaces has occurred or where this has been identified as a significant factor. The outcomes of the fire incident data analysis are detailed in Section 4.

The findings from the literature review are reported in Section 3 below and were analysed and used to define the experimental programme of work in detail with the agreement with DCLG and the Steering Group.

2.3 Task 3 - Experimental programme

The aims of the experimental programme were first to obtain reliable and consistent bench mark data on each of the products according to the key tests used for both the UK national and the European classification systems on the appropriate end use substrate. Based on the outcomes of these tests, three of the poorest performers were then tested in the room corner reference scenario to determine the level of hazard that they represent in terms of contribution to flashover in end use. Full details of the experimental programme and the results are summarised in Section 5 below.

3 Findings of the literature review

3.1 Development of the European system for the classification of reaction to fire of construction products

As part of the development programme for the European classification system (see Appendix A), two round robins for the Single Burning Item (SBI) test (BS EN 13823) were carried out. Initially, a set of 30 products were tested in 1997. In 2004, a further series of tests on 70 products (there was some overlap of products) was conducted to verify enhancements to the methodology, of which 30 were also tested[14] in the reference scenario, room corner test (ISO 9705), to examine the correlation between the SBI test and the larger scale test. These products were not tested in parallel to the national standards.

Only one of the samples was a paper wall covering (200 g/m^2) on a non-combustible substrate. The product weighed 200 g/m^2 and was tested on a paper faced gypsum plasterboard (700 kg/m^3). This achieved an average $FIGRA_{0.2MJ}$ in the SBI test of 200 W/s, which would meet the requirement for Class C i.e. $FIGRA_{0.2MJ}$ <250 W/s.

In a round robin on 9 materials performed by the EGOLF laboratories, a 0.25 mm thick vinyl wall covering was tested on plasterboard. This gave a $FIGRA_{0.2MJ}$ of 102 W/s meeting the requirement for Class B. No data for the room corner test is available for this product.

Paper faced gypsum plasterboard tested alone, in these round robins, gave a $FIGRA_{0.2MJ}$ value of 22 W/s equivalent to Class A2/B and did not reach flashover in the room corner test. A material described as PVC wall carpet (1500 g/m^2) on a plasterboard substrate, gave an average $FIGRA_{0.2MJ}$ of 365 W/s equivalent to Class D and reached flashover in 11 mins:11 secs in the room corner test.

3.2 RADAR2 project - Correlation of UK Reaction to Fire Classes for Building Products with Classes

The RADAR2 project[15], sponsored by DETR, carried out comparative back to back testing of 75 products from eight different product sectors. Six wall coverings were tested, all using calcium silicate board as the substrate. All of the products achieved national, "Class O", as defined in Approved Document B, when tested for surface spread of flame and fire propagation index to BS 476 Part 6 and BS 476 Part 7 respectively. All but one of the products achieved Class B according to BS EN 13501-1, using the tests to EN 13823 (Single Burning Item (SBI) test) and BS EN ISO 11925-2 (Small flame test).

The exception was a 330 g/m^2, 0.44 mm thick gravure printed, paper backed, vinyl wall covering which was rated Class D, with a FIGRA of 477 W/s (Class C requires FIGRA ≤ 250).

In fact in the national tests, all six products were well within the limits for Class O ($I < 12$, $i_1 < 6$ and Class 1 flame spread < 165 mm). It is interesting to note that the "exception" (see above) achieved one of the lowest fire propagation index values in the group, I = 0.66 (group range 0.5 - 2.5), but for one specimen, it also exhibited flame spread to 110 mm (group range 50 - 60 mm) in BS 476 Part 7.

3.3 Data from DCLG Steering group members

Data has been provided on approximately 90 products in total by five companies. The products included paper, vinyl and hybrid types, with paper, woven and non-woven textile backing and a variety of facings. The weights of the products generally fell within the range from 110 to 580 g/m^2 though there was one exceptional product with a weight of 1400g/m^2. Thicknesses ranged from 0.18 to 3.0 mm.

Four companies reported that all of their past testing to BS 476 Parts 6 and 7 had been carried out using skimmed plasterboard substrates, because this was the most commonly used end use surface on which the coverings are applied. All but two of the 55 products for which a national class was reported had achieved Class O using this substrate. The two exceptions were heavy weight textile faced products which had achieved Class 2 and Class 3 and which both subsequently achieved Class D tested on plasterboard.

Results from the European Classes tests ranged from B to D, but it was reported that the results are dependent on the substrate used.

On calcium silicate substrates the majority of the 22 tests resulted in a Class B rating. There was one example of a heavy weight 320 g/m^2 vinyl sandwich product that was rated either B or C when tested on calcium silicate boards from different suppliers. One other textile faced non-woven backed 320 g/m^2 wall covering achieved Class C on this substrate, but no national class was reported.

On fibre cement board, used as a substrate in 24 of the reported tests, all but one achieved a Class B rating.

In total, 17 SBI tests were reported in which a plasterboard substrate had been used. Five of the products were rated Class D and eleven were rated Class C. One product, a 120 g/m^2 vinyl, which achieved Class B had been tested on a plasterboard known to have a higher density than the standard substrates that should be used in these tests. The same wall covering achieved Class C when tested on the standard plasterboard substrate.

3.3.1 FIGRA data

For a limited number of the products FIGRA data from the SBI test have been provided and these are plotted against mass per unit area in Figure 4 below.

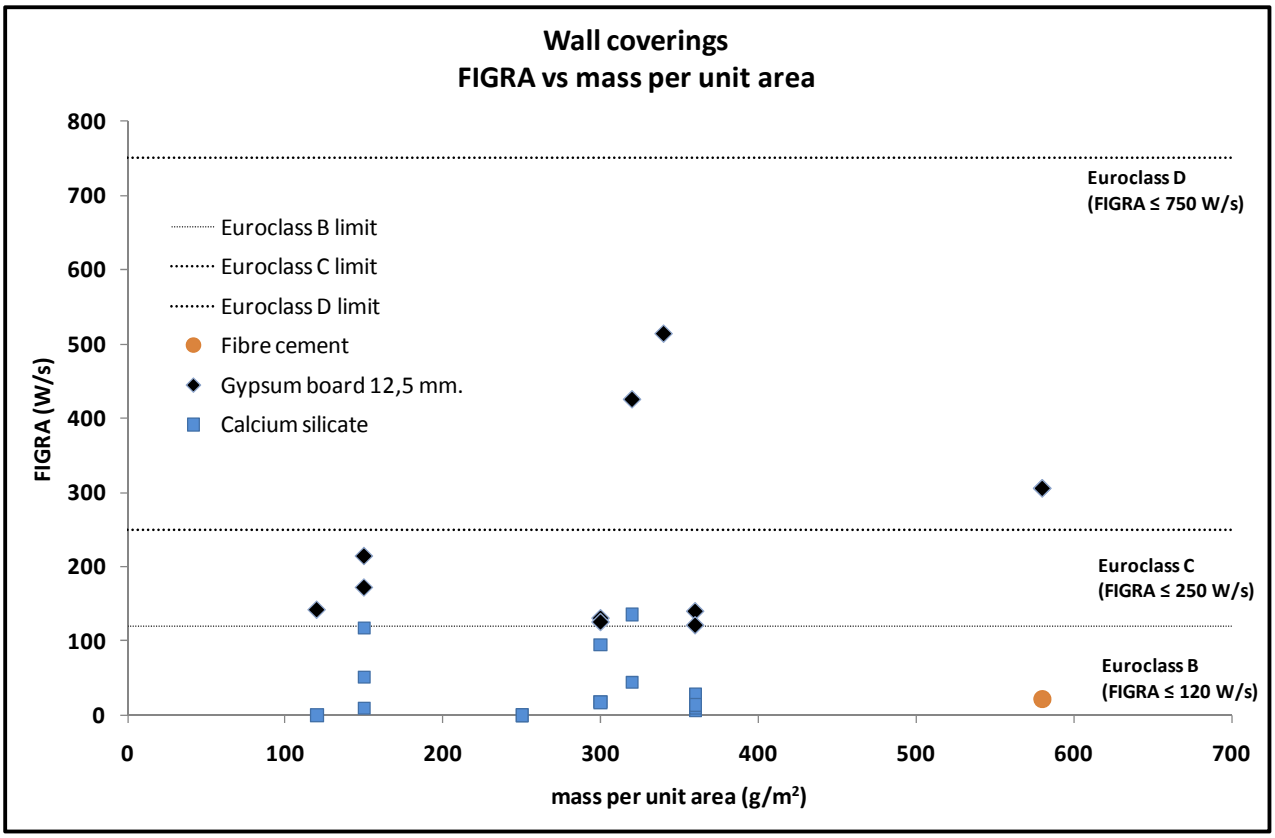

Figure 4 – FIGRA versus mass per unit area for wall coverings

In this data set there was no clear correlation between mass and FIGRA value in the SBI test, although it is significant that the three products with FIGRA above 300W/s have masses above 300 g/m^2.

3.4 Substrate selection and field of application for the classification

The above data clearly indicate that the choice of substrate influences the results of the SBI test. The Construction Products Directive (CPD) requires that samples are tested in their end use condition, which for wall coverings could necessitate a large number of tests on the wide variety of possible end use substrate materials. However, EN 13238 defines a number of, “standard substrates”, which enable most common end use substrates to be represented. It also defines rules for the applicability of the classification derived from tests carried out on each particular type of “standard substrate”.

There are three substrates which may be relevant to end use applications for wall coverings which are listed below and which have been used in the testing discussed above.

Fibre cement board (ISO 390 [16])	8 mm thick	density 1800 kg/m^3.
Calcium silicate board (EN 14306 [17])	11 mm thick	density 870 kg/m^3.
Gypsum plaster board (EN 520 [18])	12.5 mm thick	density 700 kg/m^2.

Note that although these standard substrates are Class A2-s1, d0, the calcium silicate and fibre cement boards cannot be used to represent gypsum plasterboard end use substrates. The rule in EN 13238 clause 5.3.2.4 specifically excludes calcium silicate board as an equivalent to plasterboard in terms of end use application. In addition, the density rule in EN 13238 clause 5.3.2.1 states that standard substrates only represent end use substrates having a density at least 75% of their own, which in this case would be substrates of density ≥ 1350 kg/m^3. Therefore for wall coverings which in end use may be used on plasterboard it is necessary to test on plasterboard in the SBI test.

3.5 Published CE declaration of conformity information

An Internet search identified 21 manufacturers who have published copies of their CPD Declaration of Conformity. Of these, 9 classify products as Class D-s3, d2, using the Commission Decision 2010/82/EU (see Appendix B). This provides for classification without further testing (CWFT), of the reaction to fire performance of wall coverings, provided the products meet the specified criteria for maximum weight per unit area and thickness. The manufacturer is responsible for their declaration of conformity in accordance with the CWFT Decision. No classification better than Class D – s3, d2 can be claimed against the CWFT Decision. Higher Classes are only possible based upon testing.

Of those declaring a Class based on testing, only three of the certificates state that a plasterboard substrate was used and these products achieved Class B, C and D ratings. None of the remaining certificates state what type of substrate was used and only five state the weight of the product tested, so the information is of limited use. Nine products are classified Class B, three Class C, one D and one F.

4 Analysis of Fire Incident Data

This analysis has been limited to the UK fire statistics. Other sources, for example the London Fire Brigade incident database, have not been considered at this stage.

The UK fire statistics are collected by the DCLG (formerly Home Office and then ODPM) Research, Development and Statistics Directorate. Up to 2008, they were based on the FDR1(94) forms filled in by the fire brigades after a fire has been attended. Only a fraction (typically about 20%) of all reported fires were transferred from the paper forms to the electronic database. However, all fires where there was injury or death are included in the database. In order to estimate the actual number of fires, each recorded fire must be multiplied by a weighting figure (>1) which is the ratio of reported fires (on paper forms) to recorded fires (in the database). This weighting figure varies from brigade to brigade, but is a known value.

In 2008, the reporting system changed, abandoning the paper FDR1(94) forms in favour of electronic reporting via the internet. This new system has the advantage that all fires can be included, and consistency checks are made at the time of input to reduce the likelihood of errors in the data submitted to the database.

Because the statistics are only based on fire brigade reports, the sample is biased when it comes to considering the population of all fires. There will be a large number of small fires that are unreported. Estimates from the British Crime Survey put this fraction at between 85-90%. This bias in the sample obviously requires that care be taken when interpreting the statistics. Nevertheless, for many analyses (especially those focussing on life safety) these unreported small fires can be neglected as they have almost no impact.

The UK fire statistics contain considerable detail, much more than can be reported in the annual digests published by the CLG. For this analysis it was necessary to refer to the raw data, since the published digests only refer to the room of origin for domestic fires, not all fires.

In order to give an approximate indication of the importance of wall linings, the numbers of deaths and injuries in different building types, and different rooms of origin with within the building, have been collated. A further breakdown considered whether the fire spread from the room of origin or not (if it did, it is quite likely that wall linings in the circulation spaces might have been involved). The “Type of Property (TOP)” field in the fire statistics database was used to assign the building to the appropriate AD B purpose group. If the “use of the room of fire origin (USEROOM)” field had values of “corridor or hall” or “stairs” the fire occurred in a circulation space, or elsewhere if not. The “extent of fire spread (FSPREAD)” field was used to determine whether the fire had spread beyond the room of origin.

Analysis of the data covered the years 1996 (the first year that the FSPREAD field was included in the database) to 2002. If it is considered desirable to extend the analysis to more recent years, then CLG would have to be approached to provide the raw data.

In order to simplify the interpretation of the results, the numbers of deaths and injuries in the different circumstances and purpose groups were converted to a monetary figure, The “Willingness to Pay” value for the prevention of a death was taken as £1.37m, and the value for the prevention of an “average” fire injury was taken as £0.047m [19].

The results are presented in Table 1 below, and graphically in Figure 5.

	origin in circ. space		origin elsewhere		total
AD B purpose group (see Appendix C)	non-spread	spread	non-spread	spread	all fires
1a	£21.6	£7.2	£284.2	£75.6	£388.6
1b / 1c	£23.4	£11.3	£465.4	£225.5	£725.7
2a	£1.4	£0.3	£29.4	£2.7	£33.7
2b	£0.8	£0.1	£7.0	£3.5	£11.5
3	£0.1	£0.0	£2.5	£0.8	£3.5
4	£1.0	£1.1	£16.8	£6.6	£25.5
5	£0.8	£0.2	£5.9	£1.4	£8.3
6	£0.7	£0.8	£19.1	£8.2	£28.8
7a	£0.9	£1.5	£18.1	£7.9	£28.4
7b	£0.0	£0.0	£0.1	£0.1	£0.1

Table 1. Life safety impacts of fires in different locations and purpose groups, converted to annual monetary costs (£m)

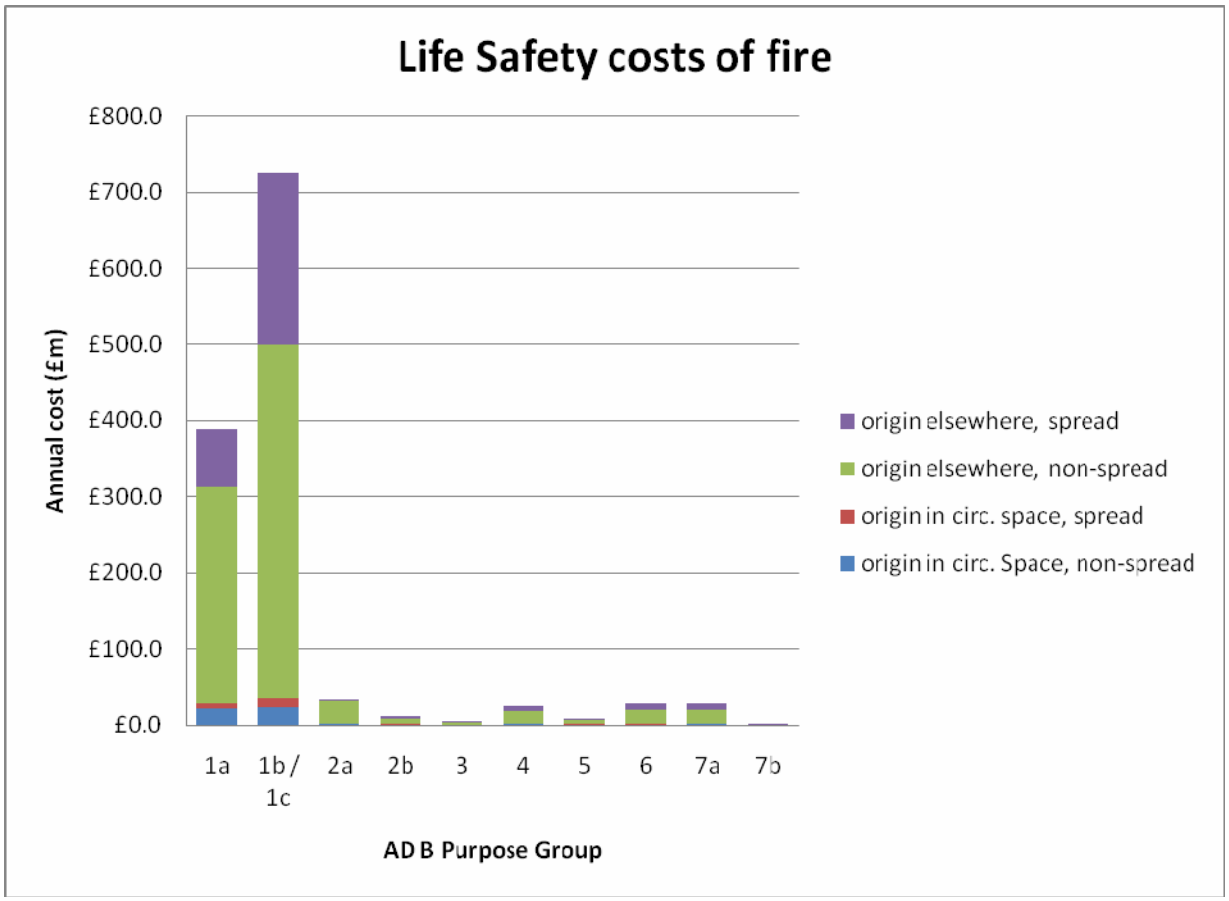

Figure 5. Life safety impacts of fires in different locations and purpose groups, converted to annual monetary costs (£m)

The following conclusions can be drawn from this analysis:

- The life safety costs of fire in the UK are dominated (nearly 90%) by fires in residential premises, i.e. purpose groups 1a, 1b and 1c.
- Fires originating in circulation spaces are relatively uncommon (<20% of all fires, and <10% in most purpose groups), and the risks per fire do not differ significantly from fires originating elsewhere, hence the contribution of fires starting in circulation spaces to the overall life safety costs is not significant.
- Fires which spread beyond the room of origin are more dangerous (greater risk per fire) than fires which do not. However the proportion of fires which spread is relatively small, between 10% - 20% for most purpose groups, and thus the contribution of spreading fires to the life safety costs is less than the contribution of fires confined to the room of origin (NB. Although the fire is confined, this does not mean that the smoke is also confined).
- From the figures in Table 1, the annual life safety cost of spreading fires in purpose group 1a (Flats) was £82.8m, which is about 6% of the total life safety cost of all fires in the UK (just over £1,250m).
- From the figures in Table 1, the annual life safety cost of spreading fires in non-domestic purpose groups (2a – 7b) was £35.2m, which is about 3% of the total life safety cost of all fires in the UK.

In summary, the fire incident data was analysed to assess the importance of fires in location where heavy duty wallcoverings are commonly used. The data does not suggest a particular problem with these types of fire, although it should be noted that the fire statistics do not contain sufficient detail to evaluate whether or not any wallcoverings specifically contributed to the fires.

5 Experimental programme

5.1 Selection of products for testing and testing protocols

The experimental programme included testing of 6 products to both UK national and European fire tests:

BS EN 13823 (SBI test)

BS 476 Part 6 (Fire propagation test)

BS 476 Part 7 (Spread of flame test)

Based on the outcomes of these tests, three of the poorest performing products were selected for test in the room corner reference scenario (BS EN 14390) to determine the hazard that they represent in terms of contribution to flashover in end use.

Previous work has shown that the adhesive does not influence the classification of the wall coverings provided that the products are properly conditioned. The tests were carried out on a standard plasterboard substrate. Substrate has a major influence on the Class rating achieved. On both calcium silicate and fibre cement board most products achieved Class B, including some with relatively high mass per unit area up to 580 g/m^2. However, these substrates cannot represent one of the most common end use substrates, i.e. gypsum plasterboard, which in many instances represent a worst case. The tests were

conducted without any air gap behind the substrate to represent the now most common arrangement whereby the space behind the plasterboard is insulated. Again this was a worst case as it tends to retain heat in the test specimen.

The range of products selected for the experimental programme was required to be representative of the product types where poorer classifications have been achieved. From the data provided by the Steering Group and from previous comparison data described above, it is apparent that on any given substrate there is a tendency for poorer European Classes compared with the national classifications to be achieved by some of the heavier wall coverings, although this not the case for all heavy weight products. For example all of the products that achieved Class D on plasterboard had a mass of 320 g/m^2 or greater.

The list of products to be tested as part of the experimental programme was agreed with the Steering Group.

5.2 Products tested

The range of products selected for the experimental programme are described Table 2 in generic terms only for reasons of commercial confidentiality:

BRE Sample Ref.	**Generic description**
E4150	**Standard coated paper** (weight 162 g/m^2, width 52 cm)
E4151	**Paper backed vinyl (standard construction)** (weight 300 g/m^2, width 130 cm)
E4152	**Woven fabric backed vinyl** (weight 440 g/m^2, width 130 cm)
E4153	**Non-woven fabric backed vinyl** (weight 450 g/m^2, width 130 cm)
E4154	**Paper backed vinyl (sandwich construction)** (weight 320 g/m^2, width 68.6 cm)
E4155	**Un-backed foamed vinyl** (weight 550 g/m^2, width 100 cm)

Table 2. Generic description of wall coverings selected for experimental work.

5.3 Substrate used for testing

All products were tested using a standard substrate of 12.5 mm thick, paper faced gypsum plasterboard supplied to BS EN 520 [18] Type A. This is the substrate specified in BS EN 13238 to represent end use plasterboard substrates.

The plasterboard used was a widely available commercial product, whose EC Declaration of Conformity states that the product is classified as A2-s1,d0 according to BS EN 13501-1. This product has been classified as A2-s1, d0, by the manufacturer, without further testing in accordance with Annex B of BS EN 520. This requires that the gypsum core is tested to the requirements for European Class A1 and places restrictions on the grammage of the paper facing.

In addition, single indicative EN 13823 (Single Burning Item) and BS 476-7 (Surface Spread of Flame) tests were carried out on the plasterboard (without wallcovering) to confirm the classification and the following results (tables 3 and 4) were obtained;

EN13823 indicative test results (one specimen) - plasterboard	
$FIGRA_{0.2MJ}$ (W/s)	23.7
$FIGRA_{0.4MJ}$ (W/s)	0.0
THR_{600s} (MJ)	0.8
SMOGRA (m^2/s^2)	0.0
TSP600s (m^2)	31.9
Indicative class	**A2-s1, d0**

Table 3. Indicative test result and classification for standard plasterboard substrate in the SBI test.

BS 476-7 indicative test results (one specimen) – plasterboard	
Spread of flame at 1.5 minutes (mm)	50
Final spread of flame (mm)	50
Indicative class	**Class 1** (see note)

Table 4. Indicative test result and classification for standard plasterboard substrate in the BS 476 part 7 test.

Note: to obtain national Class O the product would need to be tested to BS 476-6, but this was not carried as part of this programme.

5.4 Adhesives and bonding procedures

The manufacturers supplied product specific adhesives for each wall covering, all of which were PVA based. The adhesives were applied at the recommended spreading rates and in accordance with instructions provided with each product. All were allowed to cure in the workshop overnight, before being transferred to the conditioning room at (23°C, 50% R.H.) All of the products were conditioned to constant mass before testing as required by the relevant standards.

5.5 Test programme

5.5.1 National and European classification tests:

Each of the six products was tested using a standard plasterboard substrate (see 2.2) according to the following programme:

BS EN 13823 (SBI test) - three replicates of each product

BS 476 Part 6 (Fire propagation test) - three replicates of each product

BS 476 Part 7 (Spread of flame test) - six replicates of each product

5.5.2 Room corner reference scenario tests:

Three of the products were tested to BS EN 14390 (room corner test) using the same plasterboard substrate from the same batch.

5.5.3 Indicative tests on calcium silicate:

A single specimen for each of three of the wallcovering products, was tested to BS 476 Part 7 using an calcium silicate board substrate (11 mm thick, 1000 kg/m^2) to determine the effect of the difference in substrate.

5.6 Class definitions

The wallcoverings were classified according to the appropriate parameters of the national and European schemes as specified in Approved Document B and BS EN 13501-1 respectively, except for the European class, where only the SBI test data and criteria have been used, i.e.it has been assumed that each of the products would perform satisfactorily in the BS EN ISO 11925-2 test method.

Classification of the performance in the BS EN 14390 room corner test was on the basis used originally to define the European classification system (BS EN 13501-1). The class is defined in terms of the time to flashover, which is deemed to occur when the heat release rate from the room reaches 1000 kW. This includes the burner output, so that the peak heat release rate for the product at flashover is either 900 kW or 700 kW depending on whether flashover occurs during the 100 kW burner exposure or after the burner output is increased to 300 kW. The classification in the room corner test is based on the following criteria;

Class B No flashover

Class C No flashover for 100 kW ignition source, but flashover occurred with 300 kW ignition source

Class D Flashover after 2 minutes with 100 kW ignition source

Class E Flashover before 2 minutes with 100 kW ignition source

(Note: the 100 kW ignition source operates for the first 10 minutes of the test period, at which time the output is increased to 300 kW for up to a further 10 minutes.)

5.7 Test results

The test results are presented in tables 5 and 6 below.

5.7.1 National and European classifications

In the national and European classification tests the products achieved the following classes:

Sample No.	Agreed generic description	National Class (Plasterboard) BS 476-6 BS 476-7	National Class (CaSi) Indicative BS 476-6 BS 476-7	European Class EN 13823 (SBI only)
E4150	**Standard coated paper** (wt 162 g/m^2, width 52 cm)	**2Y**	**0**	**C-s1-d0**
E4151	**Paper backed vinyl (standard construction)** (wt 300 g/m^2, width 130 cm)	**2**	n/a	**C-s2-d0**
E4152	**Woven fabric backed vinyl** (wt 440 g/m^2, width 130 cm)	**2**	n/a	**C-s2-d0**
E4153	**Non-woven fabric backed vinyl** (wt 450 g/m^2, width 130 cm)	**3Y**	**2**	**D-s2-d0**
E4154	**Paper backed vinyl (sandwich construction)** (wt 320 g/m^2, width 68.6 cm)	**2Y**	n/a	**D-s2-d0**
E4155	**Un-backed foamed vinyl** (wt 550 g/m^2, width 100 cm)	**3**	**2**	**D-s3-d0**

Table 5. Summary of results from national and European classification systems.

Note: The Y suffix has been added to the national class results for products E4150, E4153 and E4154 because un-burnt parts of the surface peeled away without burning.

5.7.2 Room corner tests

The three products chosen for testing in the reference scenario test, in consultation with DCLG, were E4152 Woven fabric backed vinyl (440 g/m^2), E4154 Paper backed vinyl (320 g/m^2) and E4155 Un-backed foamed vinyl (550 g/m^2). The room corner test classification according, the $FIGRA_{RC}$ value and time to flashover information are summarised in the table below. Photographs and graphs of heat release rate vs. time are given in Appendix D.

Sample No.	Agreed generic description	Room corner classification EN 14390	$FIGRA_{RC}$ (kW/s)	Time to flashover (s)
E4152	**Woven fabric backed vinyl** (wt 440 g/m^2, width 130 cm)	**C**	**1.1**	**637**
E4154	**Paper backed vinyl (sandwich construction)** (wt 320 g/m^2, width 68.6 cm)	**C**	**1.1**	**630**
E4155	**Un-backed foamed vinyl** (wt 550 g/m^2, width 100 cm)	**E**	**16.6**	**54**

Table 6. Summary of room corner test (EN 14390) results

6 Conclusions

For use in circulation spaces / escape routes in non-domestic premises, the building regulations currently require national “Class O”, or European Class B. However, many heavy duty wallcoverings commonly used in these applications and which have previously achieved national “Class O”, do not achieve European Class B.

Fire incident data was analysed to assess the importance of fires in location where such heavy duty wallcoverings are commonly used. The data does not suggest a particular problem with these types of fire, although it should be noted that the fire statistics do not contain sufficient detail to evaluate whether or not any wallcoverings specifically contributed to the fires.

An experimental programme was carried out on six products chosen by the project Steering Group, which included a number of wallcovering manufacturers. These achieved either national Class 2 or Class 3 when tested on the standard plasterboard substrate. In the European tests they correspondingly achieved Class C or D. These products would therefore not meet the requirements of the building regulations, for use on end use plasterboard substrates, in circulation spaces / escape routes using either the national or European classification system.

Tests on a calcium silicate board substrate using the current national tests (BS 476 Parts 6 & 7) on three of the products did produce better results than on the standard plasterboard substrate, demonstrating that the substrate does influence the test outcome. This clearly highlights the importance of manufacturers defining the field of application of test results and regulators such as building control professionals understanding the field of application.

Standardised large scale room corner tests were used to assess the hazard that these products actually represent in terms of flashover. Three of the products were tested and this showed that they were capable of reaching flashover (two of the products reached flashover when exposed to the 300 kW burner and one with the 100 kW burner) under the conditions of the room corner reference scenario for the European classification system.

7 References

1. BS 476-4:1970 Fire tests on building materials and structures. Part 4: Non-combustibility test for materials.
2. BS 476-6:1989 Fire tests on building materials and structures. Method of test for fire propagation for products.
3. BS 476-7:1997 Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products.
4. BS 476-11:1982 Fire tests on building materials and structures. Method for assessing the heat emission from building materials.
5. BS EN 13501-1:2007+A1:2009 Fire classification of construction products and building elements. Classification using test data from reaction to fire tests.
6. BS EN ISO 1182: 2010 Reaction to fire tests for products. Non-combustibility test.

7. BS EN ISO 1716: Reaction to fire tests for products - Determination of the heat of the gross heat of combustion (calorific value).

8. BS EN 13823:2010 Reaction to fire tests for building products. Building products excluding floorings exposed to the thermal attack by a single burning item

9. BS EN ISO 11925-2:2010 Reaction to fire tests. Ignitability of products subjected to direct impingement of flame. Single-flame source test.

10. BS EN 13238:2010 Reaction to fire tests for building products. Conditioning procedures and general rules for selection of substrates.

11. The Building Regulations 2000. Fire Safety. Approved Document B. Volume 2 – Buildings Other Than Dwellinghouses. 2006 Edition. (Coming into effect April 2007).

12. ISO 9705 (BS 476 Part 33) Fire tests on building materials and structures. Full scale room test for surface products.

13. BS EN 14390: 2007. Fire test. Large-scale room reference test for surface products.

14. Results and Analysis from Fire Tests of Building Products in ISO 9705, the Room/Corner Test. SP report 1998:11. Sundström, B, Van Hees, P, and Thureson, P.

15. RADAR 2 Project – Correlation of UK Reaction to Fire Classes for Building Products with Classes and Guidance on Revision of Approved Document B. Part 1: UK and European Test Data and comparisons between classification systems. (DETR Ref: 39/3/571 cc1848)

16. ISO 390:1993 Products in fibre-reinforced cement -- Sampling and inspection.

17. BS EN 14306:2009 Thermal insulation products for building equipment and industrial installations. Factory made calcium silicate (CS) products. Specification.

18. BS EN 520:2004+A1:2009 Gypsum plasterboards. Definitions, requirements and test methods.

19. ODPM, Economic cost of fire, Estimates for 2004, Product Code: 05 RGG03676, pub. ODPM, April 2006.

Appendix A – Classes and classification criteria from EN 13501-1

Table 1 — Classes of reaction to fire performance for construction products excluding floorings and linear pipe thermal insulation products

Class	Test method(s)	Classification criteria	Additional classification
A1	EN ISO 1182 [a] and	$\Delta T \leq 30$ °C; and $\Delta m \leq 50$ %; and $t_f = 0$ (i.e. no sustained flaming)	-
	EN ISO 1716	$PCS \leq 2{,}0$ MJ/kg [a] and $PCS \leq 2{,}0$ MJ/kg [b c] and $PCS \leq 1{,}4$ MJ/m^2 [d] and $PCS \leq 2{,}0$ MJ/kg [e]	-
A2	EN ISO 1182 [a] or	$\Delta T \leq 50$ °C; and $\Delta m \leq 50$ %; and $t_f \leq 20$ s	-
	EN ISO 1716 and	$PCS \leq 3{,}0$ MJ/kg [a] and $PCS \leq 4{,}0$ MJ/m^2 [b] and $PCS \leq 4{,}0$ MJ/m^2 [d] and $PCS \leq 3{,}0$ MJ/kg [e]	-
	EN 13823	$FIGRA \leq 120$ W/s and $LFS <$ edge of specimen and $THR_{600s} \leq 7{,}5$ MJ	Smoke production [f] and Flaming droplets/particles [g]
B	EN 13823 and	$FIGRA \leq 120$ W/s and $LFS <$ edge of specimen and $THR_{600s} \leq 7{,}5$ MJ	Smoke production [f] and Flaming droplets/particles [g]
	EN ISO 11925-2 [i]: Exposure = 30 s	$F_s \leq 150$ mm within 60 s	
C	EN 13823 and	$FIGRA \leq 250$ W/s and $LFS <$ edge of specimen and $THR_{600s} \leq 15$ MJ	Smoke production [f] and Flaming droplets/particles [g]
	EN ISO 11925-2 [i]: Exposure = 30 s	$F_s \leq 150$mm within 60 s	
D	EN 13823 and	$FIGRA \leq 750$ W/s	Smoke production [f] and Flaming droplets/particles [g]
	EN ISO 11925-2 [i]: Exposure = 30 s	$F_s \leq 150$ mm within 60 s	
E	EN ISO 11925-2 [i]: Exposure = 15 s	$F_s \leq 150$ mm within 20 s	Flaming droplets/particles [h]
F	No performance determined		

[a] For homogeneous products and substantial components of non-homogeneous products.
[b] For any external non-substantial component of non-homogeneous products.
[c] Alternatively, any external non-substantial component having a $PCS \leq 2{,}0$ MJ/m^2, provided that the product satisfies the following criteria of EN 13823: $FIGRA \leq 20$ W/s, and $LFS <$ edge of specimen, and $THR_{600s} \leq 4{,}0$ MJ, and s1, and d0.
[d] For any internal non-substantial component of non-homogeneous products.
[e] For the product as a whole.
[f] In the last phase of the development of the test procedure, modifications of the smoke measurement system have been introduced, the effect of which needs further investigation. This may result in a modification of the limit values and/or parameters for the evaluation of the smoke production.
s1 = $SMOGRA \leq 30$m^2/s^2 and $TSP_{600s} \leq 50$m^2 ; **s2** = $SMOGRA \leq 180$m^2/s^2 and $TSP_{600s} \leq 200$m^2; **s3** = not s1 or s2
[g] **d0** = No flaming droplets/ particles in EN 13823 within 600 s;
d1 = no flaming droplets/ particles persisting longer than 10 s in EN 13823 within 600 s;
d2 = not d0 or d1.
Ignition of the paper in EN ISO 11925-2 results in a d2 classification.
[h] Pass = no ignition of the paper (no classification);
Fail = ignition of the paper (**d2** classification).
[i] Under conditions of surface flame attack and, if appropriate to the end–use application of the product, edge flame attack.

Appendix B – CWFT Classification without further testing for wall coverings

COMMISSION DECISION

of 9 February 2010

establishing the classes of reaction-to-fire performance for certain construction products as regards decorative wallcoverings in roll and panel form

(notified under document C(2010) 397)

(Text with EEA relevance)

(2010/82/EU)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products [1], and in particular Article 20(2) a thereof,

Whereas:

(1) Directive 89/106/EEC envisages that in order to take account of different levels of protection for the construction works at national, regional or local levels, it may be necessary to establish in the interpretative documents classes corresponding to the performance of products in respect of each essential requirement. Those documents have been published as the 'Communication of the Commission with regard to the interpretative documents of Directive 89/106/EEC' [2].

(2) With respect to the essential requirement of safety in the event of fire, interpretative document No 2 lists a number of interrelated measures which together define the fire safety strategy to be variously developed in the Member States.

(3) Interpretative document No 2 identifies one of those measures as the limitation of the generation and spread of fire and smoke within a given area by limiting the potential of construction products to contribute to the full development of a fire.

(4) The level of that limitation may be expressed only in terms of the different levels of reaction-to-fire performance of the products in their end-use application.

(5) By way of a harmonised solution, a system of classes was adopted in Commission Decision 2000/147/EC of 8 February 2000 implementing Council Directive 89/106/EEC as regards the classification of the reaction-to-fire performance of construction products [3].

(6) In the case of decorative wallcoverings in roll and panel form it is necessary to use the classification established in Decision 2000/147/EC.

(7) The reaction-to-fire performance of many construction products and/or materials, within the classification provided for in Decision 2000/147/EC, is well established and sufficiently well known to fire regulators in Member States that they do not require testing for this particular performance characteristic.

(8) The measures provided for in this Decision are in accordance with the opinion of the Standing Committee on Construction,

HAS ADOPTED THIS DECISION:

Article 1

The construction products and/or materials which satisfy all the requirements of the performance characteristic 'reaction-to-fire' without need for further testing are set out in the Annex.

Article 2

The specific classes to be applied to different construction products and/or materials, within the reaction-to-fire classification adopted in Decision 2000/147/EC, are set out in the Annex to this Decision.

Article 3

Products shall be considered in relation to their end-use application, where relevant.

[1] OJ L 40, 11.2.1989, p. 12.
[2] OJ C 62, 28.2.1994, p. 1.
[3] OJ L 50, 23.2.2000, p. 14.

Article 4

This Decision is addressed to the Member States.

Done at Brussels, 9 February 2010.

For the Commission
Günter VERHEUGEN
Vice-President

ANNEX

The table set out in this Annex lists construction products and/or materials which satisfy all of the requirements for the performance characteristic 'reaction-to-fire' without need for testing.

Table

Classes of reaction to fire performance for decorative wallcoverings in roll and panel form

Product (1)	Maximum mass per unit area (g/m^2)	Maximum thickness (mm)	Class (2)
Wallcoverings on cellulose fibre base	190	0,9	D-c3,d2
Wallcoverings on cellulose fibre base and polymer coated or printed	470	0,7	
Wallcoverings on a mixture of cellulose and polyester fibre base	160	0,3	
Wallcoverings on a mixture of cellulose and polyester fibre base and polymer coated or printed	410	0,5	
Wallcoverings on a polymer coated fabric base	510	0,7	
Wallcoverings of woven textile with a backing consisting of cellulose fibre or cellulose and polyester fibre	450	0,8	
Wallcoverings of foamed PVC with a backing consisting of cellulose fibre or cellulose and polyester fibre	310	1,8	

(1) Products in accordance with EN 15102 mounted on a substrate of at least class A2-s1,d0 with a minimum thickness 12 mm and with minimum density 800 kg/m^3 using starch, or starch/PVA, or cellulose/PVA adhesive applied at a maximum 200 g/m^2.
(2) Class as provided for in Table 1 of the Annex to Commission Decision 2000/147/EC.

Appendix C – Approved Document B – Purpose groups

Title	AD B Purpose Group
Residential (dwellings)	1(a) Flat
	1(b) Dwellinghouse which contains a habitable story >4.5m above ground level
	1(c) Dwellinghouse which does not contain a habitable story >4.5m above ground level
Residential (Institutional)	2(a) Hospital, home, school or similar
(Other)	2(b) Hotel, boarding house, college, hall of residence, hostel or any other residential purpose not described above
Office	3
Shop and commercial	4
Assembly and recreation	5
Industrial	6
Storage and other non-residential	7(a) 7(b)

Appendix D – EN 14390 Room corner tests – Graphical data and photographs

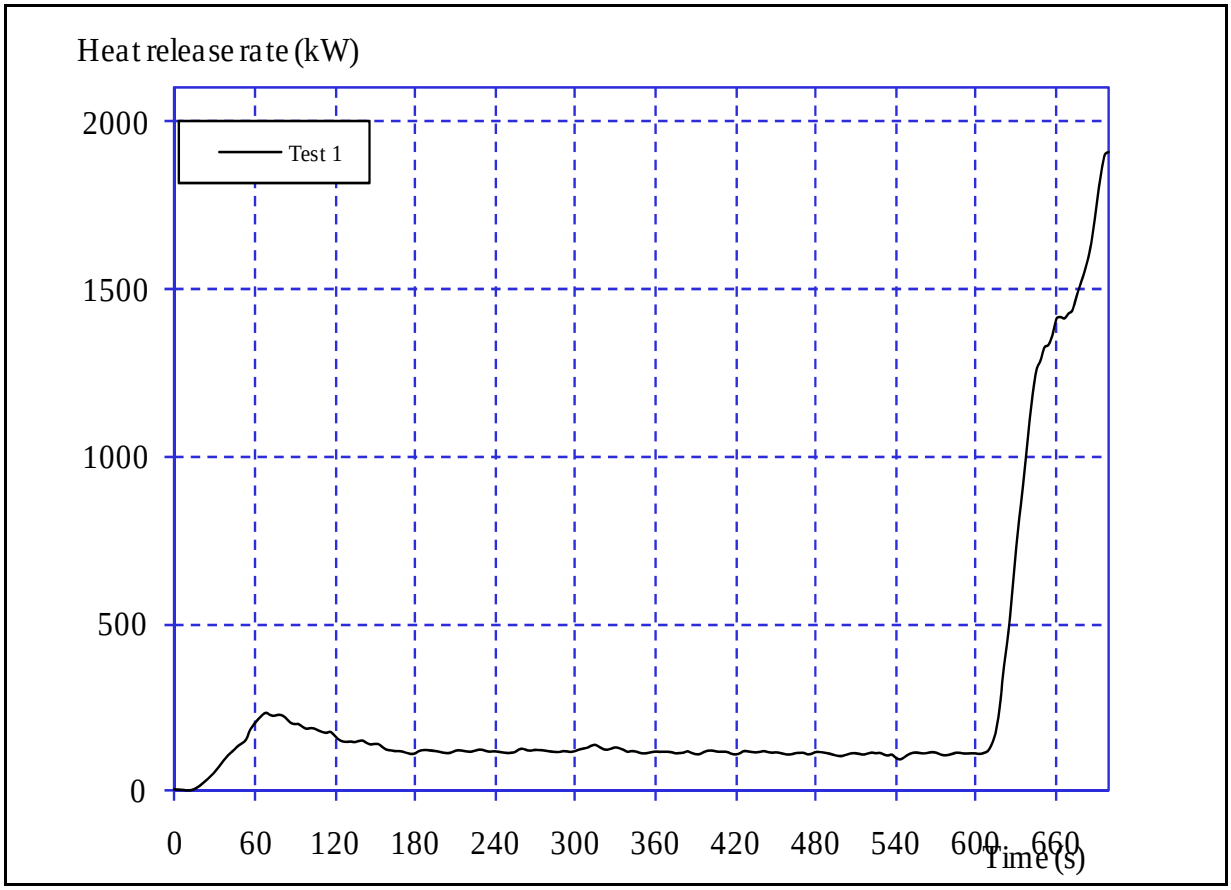

Figure D1 - Heat release rate (including burner output) - EN 14390 Room corner test - E4152 Un-backed foamed vinyl 440 g/m^2.

Figures D2 & D3 - Approaching flashover and post test interior photos E4152.

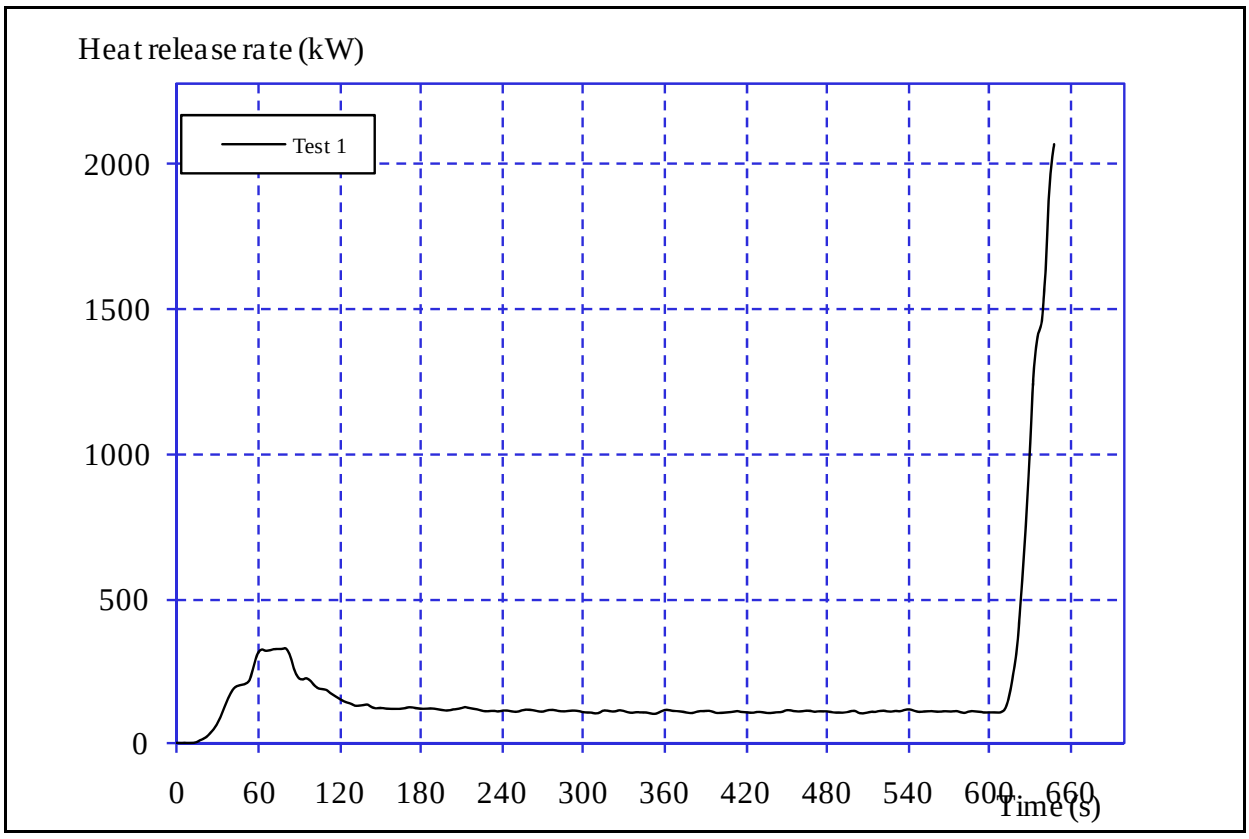

Figure D4 - Heat release rate (including burner output) - EN 14390 Room corner test - E4154 Paper backed vinyl (sandwich construction) 320 g/m^2.

Figures D5 & D6 - Approaching flashover and post test interior photos E4154.

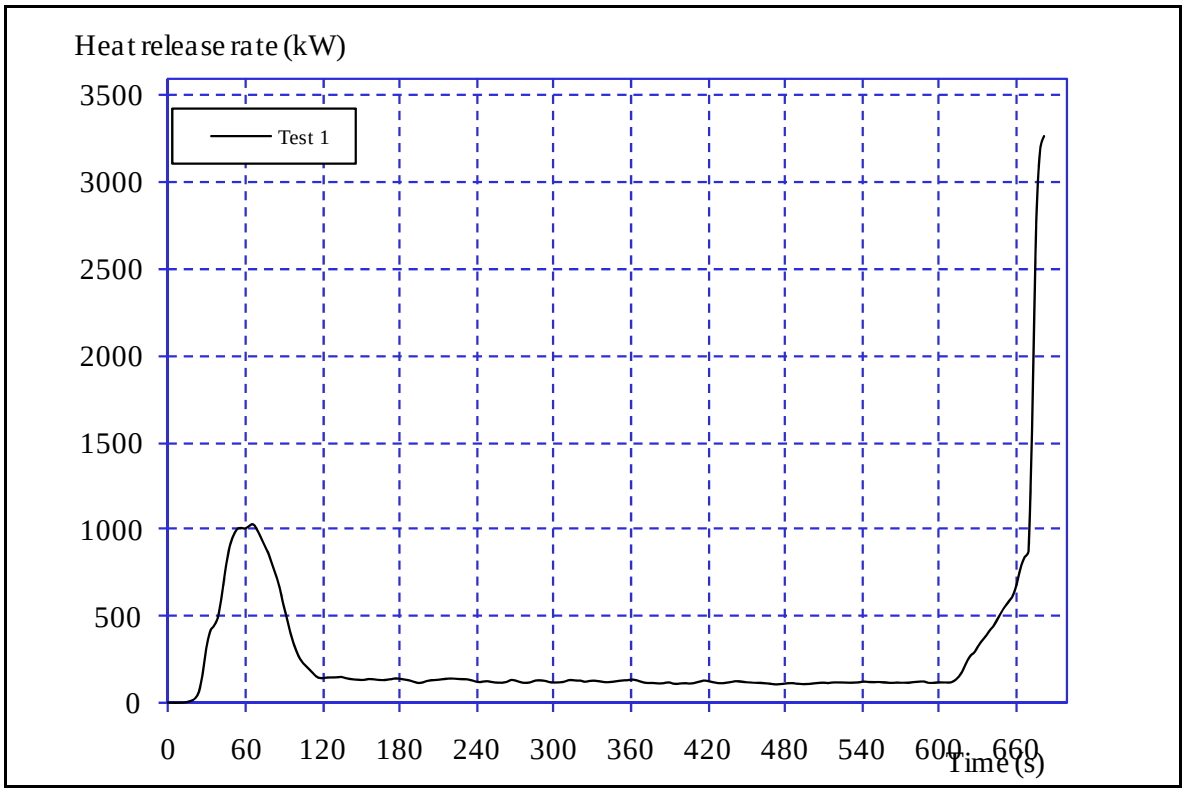

Figure D7 - Heat release rate (including burner output) - EN 14390 Room corner test - E4155 Un-backed foamed vinyl 550 g/m^2.

Figures D8 & D9 - Approaching 1st flashover and post test interior photos E4155.

(Note for this sample the test was run beyond the initial flashover that occurred at 54 seconds and a second flashover occurred after the burner output was increased to 300 kW.)

Department for Communities and Local Government

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