

Research Test Report WARRES No. 108956

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**RADAR 2 Project – Correlation of UK Reaction to Fire
Classes for Building Products with Euroclasses and
Guidance on Revision of Approved Document B.**

Part 3: Validity of Assessments within a Product Range

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FIRE
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1 Introduction

In Parts 1 and 2 of the RADAR 2 Project, the comparative reaction-to-fire testing and classification procedures for the UK and new European systems have been studied (ref.1, 2, 3, 7 and 8). A database on 64 individual construction products has been assembled as a means to examine whether the two systems may be correlated and proposals have been made about the classification transpositions which may be possible. It is the intention of DETR to utilise this information as a basis to prepare a new European Supplement for use with Approved Document B.

In comparison with existing UK tests, the Euroclass tests are relatively expensive to conduct, especially the SBI test prEN 13823. If manufacturers had to test their entire product range (such as all thicknesses of a sheet product) to the new EN tests, the cost is likely to be prohibitive. For this reason, European regulators and industry recognise that there will be an increased role for assessments of fire performance within a product range based on the testing of only a few products within that range. In Task 6 of the RADAR 2 Project, five product ranges have been identified so that the validity of assessments on the Euroclassification of the reaction-to-fire performance of products could be examined.

2 Direct and Extended Application of Reaction to Fire Test Results

During the course of the RADAR 2 Project, the European Fire Regulators Group (FRG) and the European Group of Official Fire Laboratories (EGOLF) identified a need to discuss how the various national procedures for extending the validity of test results and classifications could be transferred to the European market. At present, direct and extended application of fire test results are based on national traditions without harmonised rules being established.

Since this area of fire testing and classification is still developing within the EU, it may be useful to consider various definitions applying to possible future European rules and how these may be related to the results of the RADAR 2 Project. Key concepts may be defined as follows:

- (a) **Parameter affecting fire performance** : Such parameter of the product that may affect the fire behaviour of the product in the test of concern in respect to one or more of those parameter results used for fire classification.

Examples of such parameters are:

- Thickness
- Density
- Colour
- Coating
- Substrate
- Attachment technique (e.g. mechanical fixing, adhesive, joints etc.)
- Structural form of the product (e.g. surface profile, air-gap)
- Mounting of linear products (e.g. area/volume of the product tested, how spaced, how fixed, etc).

- (b) **Validity of Test Results** : Results are valid within defined tolerances for the tested product including used substrates and attachment technique.

- (c) **Direct application of test results** : Use of only one classifying result.

- (d) **Extended application of test results** : Use of more than one classifying result (on a range of one or more parameters which affect the fire performance of the product of concern).

The classification standard proposal, prEN 13501-1 (ref.3), in section 13 defines the following:

- Applicability of test results using standard substrates given in prEN 13238 are included in that Standard. (Direct application)
- Field of application of non-standard substrates is limited to those tested. (Direct application)
- Field of application of attachment method to substrates is limited to those tested. (Direct application)
- If generic adhesives are used the results apply for all adhesives of the same type. (Direct application)
- A test result is applicable for the tolerance range of thickness and density which is permitted within the relevant product standard, for a given product. (Direct application).
- If a given product is available over a range of thicknesses and results are obtained for two different thicknesses, then the worst result obtained is applicable for all products within the intermediate range of thicknesses. This applies also to density ranges. (Extended application).

In the context of the work planned for RADAR 2 Task 6, the research had the objective to examine a small number of parameters (i.e. thickness, density and colour) which will be relevant to the extended application of the test results.

3 Product Selection

Based on discussions within the Industry Advisory Group, the five product ranges shown in Table 1 were selected for evaluation in Task 6.

Table 1 : Composition of Product Ranges Tested

Product Range	Product Description	Variable Parameter	Values of Parameter Tested
1	Oriented Strand Board; screwed to steel spacer frame	Thickness	9, 11, 18.5, 22mm
2	Fire Retarded Plywood	Thickness	9, 12, 18, 25mm
3	Unfaced Polyisocyanurate (PIR) Slabstock Foam; bonded to calcium silicate substrate with filled silicate adhesive	Thickness	12.5, 25, 40, 60mm
4	Unfaced Glasswool Slabstock; bonded to calcium silicate substrate with filled silicate adhesive.	Density	10, 16, 48, 64kg/m ³
5	Fabric-backed Vinyl Wallcovering; bonded to calcium silicate sheet substrate with PVA heavyweight grade adhesive.	Colour of wall-covering	5 different colours

4 Test Methods and Conditions

The five product ranges were examined in the European tests which were considered to be necessary for their Euroclassification. For product ranges 1, 2, 3 and 5, these tests were SBI (prEN13823) and small burner (prEN ISO 11925-2). For product range 4, the tests were SBI (prEN 13823) and furnace (prEN ISO 1182). Product ranges 1, 3, 4 and 5 were tested at Warrington Fire Research Centre. Product range 2 was tested at Chiltern International Fire.

5 Test Results

The test results obtained during the RADAR 2 Task 6 are detailed in Tables 2 to 6. These results are key to the determination of the Euroclass derived for each product.

6 Analysis of Test Data on Product Ranges

(a) Oriented Strand Board

All four products gave Euroclass D, S2, D1. These results are consistent with those for the chipboard reference material used to compare the SBI test-data obtained by WFRC and Chiltern Fire laboratories; in addition, they are in line with the WPIF comments in RADAR 2 Project Part 2 Report (ref.8).

Whilst all products were comfortably categorised as Euroclass D, sample 2 at 11mm thick had higher heat release and smoke contributions than samples 1, 3 and 4. The variation of average FIGRA values obtained for this range was 421 ± 53 ; i.e. $\pm 12.6\%$.

(b) Fire-retarded Plywood

All four products gave Euroclass B, D0. The smoke data was on the border of S1/S2 so that two samples were S1 and two samples were S2. This difference in smoke classification is due to variability of the TSP₆₀₀ test-data rather than an expected thickness effect.

The variation of average FIGRA values obtained for this range was 23 (+5, -9); i.e. +21.7% and -39.1%. Whilst this variability appears relatively high, all samples were comfortably categorised as Euroclass B.

(c) PIR Foam Slabstock

All four products gave Euroclass C, S2, D0. The FIGRA, THR₆₀₀ and TSP₆₀₀ values increase consistently up the thickness range but the average values for the test parameters are comfortably within the Euroclass C specification. The variation of average FIGRA values obtained for this range was 197±27; i.e. ±13.7%.

Whilst the present data shows that the classification remains at Euroclass C up to 60mm thick, the increasing values of FIGRA indicate that foam thicknesses greater than 60mm are likely to give FIGRA values nearer to the Euroclass C/D border.

The results obtained for the PIR foam slabstock range substantiate comments in the RADAR 2 Part 2 report, section 4.5(h) (ref.8); i.e. a product which forms a char layer in contact with the ignition source will show less dependence on thickness for a heat release classification system than other kinds of cellular plastics which will burn completely or melt under the same ignition conditions.

(d) Glass Wool Slabstock

All four products show negligible contribution in the SBI test and are at least Euroclass B, S1, D0. When the products were tested in the prEN 1182 furnace test, all 4 products satisfied the requirement for Euroclass A1. There was more heat released and a longer flaming time for the higher density products; however, the test results are comfortably within the Euroclass A1 specification for the full range up to 64 kg/m³.

No further tests were conducted to prEN 1716 since the only difference was density and the calorific value could be calculated arithmetically from the two tests conducted for products in this range in the back-to-back testing reported in Part 1 of the Project (ref.7). The calorific values for this product range all fall within the allowed criteria for the products to achieve Euroclass A1.

(e) Vinyl Wallcovering

All four products gave Euroclass B, S2, D0. However, there was a large spread in the FIGRA data, both between the colours and also within the three tests conducted for each colour. The variability in the repeatability of the three tests within each colour band makes it difficult to draw any conclusions as to the effect of colour on the fire performance. As a very tentative conclusion, the data does indicate that colours which include a red pigment gave slightly higher FIGRA values when compared to the other two colours, yellow and beige. Further study would be necessary to confirm this on products, which in themselves are not variable in their fire behaviour in the SBI test.

The variation of average FIGRA values obtained for the range was 80.6 ± 37.6 , i.e. 46.6%. This is a very significant variation and would lead to the conclusion that any assessment made based on colour variation within a product range, which itself gave variable FIGRA values, would need to include a significant number of data points and not just the data from the extremes of the range.

7 Variability of SBI Test Data (Direct Application)

Two laboratories, Warrington Fire Research Centre and Chiltern Fire International, participated in the RADAR 2 Project and produced test-data on the prEN 13823 (SBI) test. Since this test has only recently been developed and is still in the EN standardisation process, it was considered to be desirable to duplicate the testing on a range of 8 wood products as well as performing some additional checks with a non-FR chipboard reference material. The results for this comparative exercise between the two laboratories are shown in Table 7.

Excellent reproducibility was obtained for the SBI tests on the chipboard reference material. For the range of 8 wood products, both laboratories obtained the same Euroclass for each product. In only one product (R2/1/11) was there a difference in the smoke classification of S1 (Lab 1) and S2 (Lab 2); this product gives smoke measurements which are on the S1/S2 border (i.e. $TSP\ 600s \leq 50m^2$) and there was no pattern indicating that one laboratory was recording consistently higher smoke results than the other. There was some variability in the heat release data for the two laboratories; however, the variation is within the 50% recognised as acceptable for the majority of fire test methods. These results indicate that a new round-robin is required now that the details of the test equipment, procedure and calculation methods have been essentially confirmed in CEN/TC127. The reassuring point about this RADAR 2 comparative exercise is that both laboratories clearly obtained the same Euroclassification for each product.

8 Generic Performance

In Appendix A of the Approved Document B (ref.2), Table A8 gives examples of typical performance ratings of some generic materials and products. Based on the back to back testing carried out in the RADAR 2 Project, there are clear examples where the expected product performance is not what the industry or the testing laboratories expected and hence, it is not reliable to assign typical Euroclass generic performance to products as has been done in a simple way for UK performance in Approved Document B. Reasons for this recommendation are the sensitivity and variability of the Euroclassification due to FIGRA derivations, variability of product composition (e.g. fire retardant levels, adhesive type and level, coating weights) and the importance of using specific mounting arrangements with some products. The RADAR 2 Project data indicates that Table A8 should be deleted from a future European supplement to Approved Document B.

9 Conclusions

- a) That extended application of test results may be used to reduce the extent of testing to harmonised European Standards. Parameters such as thickness, density and colour may be varied within a product range without significant change in the product performance.
- b) That some products (e.g. vinyl wallcoverings) show inherent variability to Euroclass testing. These products could possibly be classified by extended application procedures; however, these procedures would need to be based on a more expanded testing programme. Where products give borderline classification and also have inherent variability, it may be advisable not to attempt to classify a range.
- c) That assignment of typical Euroclass performance to generic materials and products is unreliable. There should not be any transposition of classification performance typified by Table A8 in the European supplement to Approved Document B.
- d) That a round-robin on the SBI test should be carried out as soon as possible with the agreed EN 13823 procedure.

10 Acknowledgements


Warrington Fire Research Centre acknowledge the valuable contribution made by Chiltern Fire International, and especially James Lavender, to the SBI testing of wood products in the RADAR 2 Project.

References

- 1 Official Journal of the European Communities L50, 23.2.2000, p.14 – 18, "Commission Decision of 8 February 2000 implementing Council Directive 89/106/EEC as regards the classification of the reaction to fire performance of construction products".
- 2 DETR. The Building Regulations 1991 Fire Safety. Approved Document B (2000 Edition).
- 3 prEN 13501 Fire Classification of Construction Products and Building Elements. Part 1 Classification using Test Data from Reaction to Fire Tests.
- 4 prEN ISO 11925-2 Reaction to fire tests for building products – Part 2: Ignitability when subjected to direct impingement of flame.
- 5 prEN 13823 Reaction to fire tests for building products – Building products excluding floorings exposed to the thermal attack by a single burning item (SBI test).

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Table 2: Effect of Thickness Variation on Euroclassification of Wood (Oriented Strand Board)

Product Reference	Product Description	Thickness (mm)	prEN 13823 (SBI)								prEN11925-2		Euroclass
			THR(t) 0.2MJ FIGRA (W/s)	THR(t) 0.4MJ FIGRA (W/s)	THR 800 (MJ)	FS to End Long Wall (Y/N)	SMOGRA (m ² /s ³)	TSPS00 (m ³)	Flaming Debris	Debris Flames ≥10s	time FS to 160mm (s)	flaming debris? (Y/N)	
T6/1/1	Oriented Strand Board	9		Sp1=358.7 Sp2= 412.6 Sp3= 334.2 Av= 368.5	38.4	N	6.72	65.54	Y	Y	not reached	none	D,S2,D1
T6/1/2	Oriented Strand Board	11		Sp1= 481.8 Sp2= 497.1 Sp3= 442.9 Av= 473.9	38.22	N	7.63	84.43	Y	Y	not reached	none	D,S2,D1
T6/1/3	Oriented Strand Board	18.5		Sp1= 489.2 Sp2= 378.8 Sp3= 443.3 Av= 427.1	35.52	N	3.69	51.45	Y	Y	not reached	none	D,S2,D1
T6/1/4	Oriented Strand Board	22		Sp1= 400.2 Sp2= 359.2 Sp3= 395.4 Av= 384.9	33.28	N	3.49	50.59	Y	Y	not reached	none	D,S2,D1

Table 3: Effect of Thickness Variation on Euroclassification of Wood (FR Plywood)

Product Reference	Product Description	Thickness (mm)	prEN 13823 (SBI)								prEN 11925-2		Euroclass
			THR(t) 0.2MJ FIGRA (W/s)	THR(t) 0.4MJ FIGRA (W/s)	THR 600 (MJ)	FS to End Long Wall (Y/N)	SMQGRA (m²/s²)	TSPSS0 (m²)	Flaming Dabris	Debris Flames ≥10s	time FS to 160mm (s)	flaming debris? (Y/N)	
T6/2/1	Vacuum Impregnated FR Plywood	9	Sp1=27.0 Sp2= 6.0 Sp3= 9.0 Av= 14.0		1.67	N	8.33	59.33	Y	Y	not reached	none	B,S2,00
T6/2/2	Vacuum Impregnated FR Plywood	12	Sp1= 27.0 Sp2= 29.0 Sp3= 27.0 Av= 27.67		2	N	4.67	41.67	Y	Y	not reached	none	B,S1,D0
T6/2/3	Vacuum Impregnated FR Plywood	18	Sp1= 23.0 Sp2= 23.0 Sp3= 37.0 Av= 27.67		2	N	4	45	Y	Y	not reached	none	B,S1,D0
T6/2/4	Vacuum Impregnated FR Plywood	25	Sp1= 42.0 Sp2= 8.0 Sp3= 18.0 Av= 22.67		2	N	5.33	50.67	Y	Y	not reached	none	B,32,00

Table 4: Effect of Thickness Variation on Euroclassification of PIR Slab Foam

Product Reference	Product Description	Thickness (mm)	prEN 13823 (SBI)							prEN 11925-2			Euroclass
			THR(t) 0.2MJ FIGRA (W/s)	THR(t) 0.4MJ FIGRA (W/s)	THR 600 (MJ)	FS to End Long Wall (Y/N)	SMOGRRA (m ² /s ⁴)	TSP600 (m ²)	Flaming Debris	Debris Flames ≥10s	time FS to 150mm (s)	flaming debris? (Y/N)	
T6/3/1	PIR Slab Foam	12.S		Sp1= 176.3 Sp2= 199.5 Sp3= 135.3 Av= 170.3	1.58	N	260.18	71.52	N	N	not reached	none	C,S2,D0
T6/3/2	PIR Slab Foam	25		Sp1= 175.0 Sp2= 218.0 Sp3= 177.8 Av= 189.8	2.74	N	167.12	89.96	N	N	not reached	none	C,S2,D0
T6/3/3	PIR Slab Foam	40		Sp1= 118.9 Sp2= 230.1 Sp3= 254.0 Av= 224.32	4.39	N	290.4	140.39	N	N	not reached	none	0,S2,D0
T6/3/4	PIR Slab Foam	60		Sp1= 201.7 Sp2= 222.3 Sp3= 238.0 Av= 220.7	5.67	N	266.64	182.6	N	N	not reached	none	0,S2,D0

Table 6: Effect of Density Variation on Euroclassification of Glass Wool Slab.

Product Reference	Product Description	Density (kg/m³)	prEN 1716	prEN1162			prEN 13501 (SBI)										prEN1325-2		Euroclass
			PES (mJ/kg)	Δt (°C)	Δm [%]	t (s)	THR(t) 0.2MJ FIGRA (W/s)	FNRI(t) 0.4MJ FIGRA (W/s)	THR 640 (MJ)	FS to Emi Long Wall (Y/N)	SMOGRA (m²/s²)	TSP646 (m²)	Flaming Debris	Debris Flames ≥ 10s	Time FS to 150mm (s)	Sampling debris? (Y/N)			
T6/4/1	Glass Wool Slab	64	0.65	10	6.2	3.6	0		0.56	N	1.4	44.23	N	N	not reached	none	A1		
T6/4/2	Glass Wool Slab	48	0.64	5	6.6	1	0		0.49	N	0	34.46	N	N	not reached	none	A1		
T6/4/3	Glass Wool Slab	16	0.21	6	7	oil	0		0.17	N	0	31.7	N	N	not reached	none	A1		
T6/4/4	Glass Wool Slab	10	0.13	5	12.5	nil	0		0	N	1.47	43.6	N	N	not reached	none	A1		

Table 6: Effect of Colour Variation on Euroclassification of Vinyl Wallcovering

Product Reference	Product Description	Colour	prEN 13823 (SBI)								prEN11925-2		Euroclass
			THR(t) 0.2MJ FIGRA (W/s)	THR(t) 0.4MJ FIGRA (W/s)	THR 600 (MJ)	FS to End Long Wall (Y/N)	SMOGRA (m ² /s ⁴)	TSP ₉₀₀ (m ³)	Flaming Debris	Debris Flames ≥10s	time FS to 160mm (s)	flaming debris? (Y/N)	
T6/5/1	Fabric Backed Vinyl Wallcovering	Pink	Sp1= 145.2 Sp2= 106.1 Sp3= 84.6 Av= 112.3	Sp1= 152.8	1.31	N	37.54	89.22	N	N	not reached	none	B,S2,D0
T6/5/2	Fabric Backed Vinyl Wallcovering	Yellow	Sp1= 57.25 Sp2= 96.8 Sp3= 50.08 Av= 68.0		1.09	N	30.52	93.11	N	N	not reached	none	B,S2,D0
T6/5/3	Fabric Backed Vinyl Wallcovering	Red	Sp1= 81.61 Sp2= 120.1 Sp3= 69.3 Av= 90.34	Sp1= 149.6	1.33	N	48.06	100.72	N	N	not reached	none	B,S2,D0
T6/5/4	Fabric Backed Vinyl Wallcovering	Beige	Sp1= 70.41 Sp2= 37.05 Sp3= 21.92 Av= 43.13		0.81	N	26.19	92.17	N	N	not reached	none	B,S2,D0
T6/5/5	Fabric Backed Vinyl Wallcovering	Blue	Sp1=114.24 Sp2=46.38 Sp3=106.83 Av= 89.15		1.14	N	54.09	101.12	N	N	not reached	none	B,S2,D0

Table 7. Variability of SBI Data Between Two Laboratories

Product Identity		Laboratory	prEN 15823 (SBI) Result								Euroclass
Product reference	Generic Product Description		THR(t) 0.2MJ FIGRA (W/s)	THR(t) 0.4MJ FIGRA (W/s)	THR600 (MJ)	FS to End Long Wall (Y/N)	SMGGRA (m²/s²)	TSPS00 (m²)	Flaming Debris	Debris Flames ≥ 10s	
R2/REF	Non FR Chipboard	1		348.3	23.9	N	2.8	34.8	N	N	0,S1,00
R2/REF	Non FR Chipboard	2		356	26.8	N	3	28.8	N	N	0,S1,00
R2/1/1	FR MDF	1	49.17		2.75	N	6.79	71.89	N	N	B,S2,D0
R2/1/1	FR MDF	2	68.33		3.33	N	6	70.67	N	N	B,S2,00
R2/1/5	FR MDF	1		207.73	11.81	N	13.27	100.28	N	N	0,S2,00
R2/1/5	FR MDF	2		226.67	12	N	12.33	85.67	N	N	0,S2,00
R2/1/6	Birch Plywood B/BB, WBP Grade, FR0	1	37.97		2.12	N	0	30.4	N	N	B,S1,00
R2/1/6	Birch Plywood B/BB, WBP Grade, FR0	2	51.33		2.57	N	1.33	35	N	N	B,S1,D0
R2/1/7	Birch Plywood B/BB, WBP Grade, FR1	1	39.77		2.1	N	0	30.29	N	N	S,S1,00
R2/1/7	Birch Plywood B/BB, WBP Grade, FR1	2	60.67		4	N	0	25.67	N	N	B,S1,00
R2/1/8	Birch Plywood B/BB, WBP Grade, FR2	1		169	9.09	N	0.79	34.02	N	N	0,B1,00
R2/1/8	Birch Plywood B/BB, WBP Grade, FR2	2		207	11.33	N	0.67	28.67	N	N	C,S1,D0
R2/1/9	European Redwood TGV Boarding, FR0	1	24.03		2.23	N	1.69	45.1	N	N	B,S1,D0
R2/1/9	European Redwood TGV Boarding, FR0	2	27.67		2.33	N	1	49	N	N	B,B1,00
R2/1/10	European Redwood TGV Boarding, FR1	1	60.53		3.73	N	2.68	51.3	N	N	B,S2,00
R2/1/10	European Redwood TGV Boarding, FR1	2	96.33		5.67	N	4.33	53.67	N	N	B,S2,00
R2/1/11	European Redwood TGV Boarding, FR2	1		147.21	7.14	N	1.18	45.28	N	N	0,S1,00
R2/1/11	European Redwood TGV Boarding, FR2	2		182.33	9	N	2.33	54	N	N	C,S2,00

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