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BS8414 Review

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Review

for:

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THE INDEPENDENT FIRE SAFETY ENGINEERING CONSULTANTS

Issue and amendment record

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1	22 March 2018	M Bullock	A Hay	Issue 1

Important information

Contents:

1 Introduction

1.1 Functional requirement B4(1) of the Building Regulations deals with the combustibility of external wall materials. One means of compliance with that requirement (Clause 12.5 of Approved Document B) is to subject a “full assembly” wall construction to a fire test in accordance with BS8414-1[6.3] or BS8414-2[6.4] and demonstrate that the performance meets the criteria detailed in BR135[6.2].

1.2 As part of its Building Safety Programme, DCLG has recently commissioned and completed a programme of seven fire tests using BS8414.

1.3 The purpose of this short report is to provide readers with some background and context to the BS8414 test standard and associated BR135 performance criteria. This report is not an exhaustive study but an initial review that:

a) Considers an example building type aligned with the focus of DCLG’s Building Safety Programme (i.e. a high rise residential building – see Figure 1 below).

b) Summarises how the statutory guidance in support of Building Regulations in Approved Document B has evolved to rely on BS8414 testing and classification to BR135.

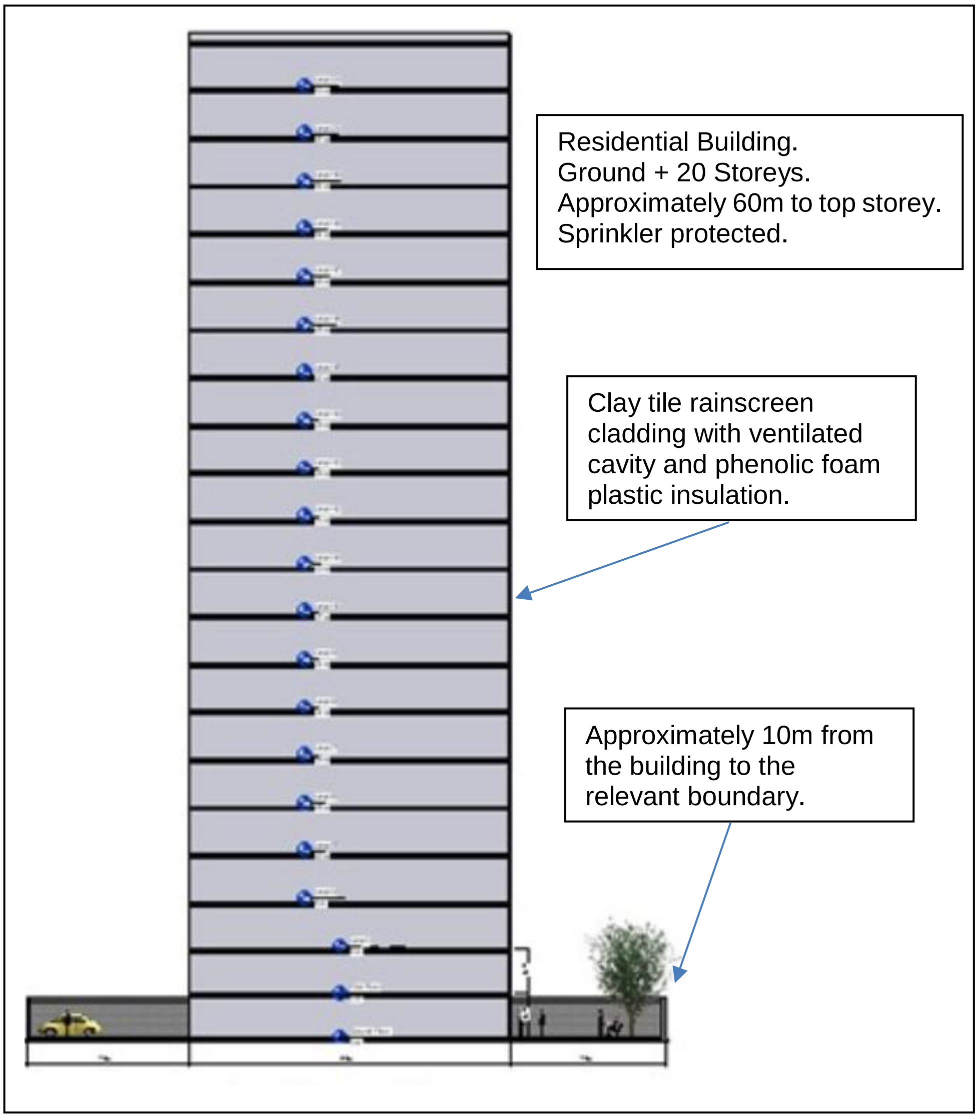
c) Compares (in the context of the example building) the basis of reliance on BS8414/BR135 in Approved Document B with similar approaches under other regulatory regimes (i.e. NFPA 285).

d) Compares the severity of the BS8414/BR135 test and classification criteria with the NFPA 285 external cladding test that has widespread adoption internationally.

e) Considers whether data from real fires (that is readily accessible in the public domain) suggests there is a need to review current reliance on BS8414/BR135.

1.4 The report has been prepared at the request of Kingspan Insulation Ltd.

Figure 1 – Example building



Terms used in this document:

1.5 For the purposes of this document, the following abbreviations have been used:

- **ADB** = Approved Document B
- **IBC =** International Building Code
- **EPS** = Expanded Polystyrene foam insulation (combustible thermoplastic polymer).
- **PUR =** Polyurethane foam insulation (combustible thermoset polymer).
- **PIR =** Polyisocyanurate foam insulation (combustible thermoset polymer).
- **MF** = Mineral fibre insulation (non-combustible fibre bonded with combustible resin).
- **ACM** = Aluminium Composite Material.
- **PE =** Polyethylene (combustible thermoplastic polymer).

2 Regulatory context

Evolution of ADB guidance

1985 edition of ADB

2.1 This was the first edition of the Approved Document B.

2.2 It permitted the use of combustible external cladding materials in tall buildings provided:

- the external surface was controlled (Class 0 surface spread of flame rating) to limit the potential for flame propagation;
- the insulation component of the system was at least Limited Combustibility for buildings **higher than 15m**, unless used in a masonry cavity wall.

1992 edition of ADB

2.3 It permitted the use of combustible external cladding materials in tall buildings provided:

- the external surface was controlled (Class 0 surface spread of flame rating) to limit the potential for flame propagation;
- the insulation component of the system was at least Limited Combustibility for buildings **higher than 20m**, unless used in a masonry cavity wall.

2.4 The guidance introduced reference to BR135 1988[6.7] for advice on using thermal insulation but did not state it as an alternative option for compliance with the above.

BR135 1988

- This initial version of BR135 was a research study carried out by BRE that reported on the results of large scale testing to identify a series of design recommendations to reduce the hazard to life.
- The fire tests used the test rig and timber crib fire source which became the basis of Fire Research Station Fire Note 9[6.22] and then the current BS8414 test.
- Recommendations made by the BR135 1988 report were not limited to buildings over any particular height.

2000 edition of ADB

2.5 It permitted the use of combustible external cladding materials in tall buildings provided:

- the external surface was controlled (Class 0 surface spread of flame rating) to limit the potential for flame propagation;
- the insulation component of the system was at least Limited Combustibility for buildings higher than 18m, unless used in a masonry cavity wall but introduced words to the effect that this applied to ventilated cavities.

2.6 The introduction of the reference specifically to a 'ventilated cavity' effectively permitted use of insulation not achieving at least Limited Combustibility in cladding systems without a 'ventilated cavity'. However, it should be noted that the ADB guidance did not define what was meant by a 'ventilated cavity' and, consequently, the industry applied various interpretations of this.

2.7 Reference was retained to BR135 1988[6.7] for advice on using thermal insulation.

2006 edition of ADB (current edition)

2.8 It permits the use of combustible external cladding materials in tall buildings provided that

- the external surface is controlled (Class 0 or Euroclass B surface spread of flame rating) to limit the potential for flame propagation;
- insulation and any filler material (not including gaskets, sealants and similar) in the system are at least Limited Combustibility for buildings higher than 18m, unless used in a masonry cavity wall. Compliance with BS8414/BR135 as follows is stated as an alternative approach.

BR135 2nd edition and BS8414

2.9 The 2006 edition of ADB introduced reference to compliance with the performance criteria of BR135 2nd edition[6.2] using full scale test data from BS8414-1 or BS8414-2 tests as an alternative means of demonstrating compliance with Part B4(1) of the Building Regulations.

Separation of windows.

2.10 It is reported by BRE[6.8] that experimental work carried out in 1960 concluded that measures to provide fire resisting separation between windows in adjacent storeys would not be effective without making the windows themselves fire resisting.

2.11 This has been evidenced in real fires and has recently been verified by BRE in experimental testing[6.9]. This testing submitted a number of external wall assemblies to exposure from the timber crib fire source used in the BS8414 test simulating a fire breaching the window of an external façade. A glazed window was provided in the façade at one storey height above the fire opening and with the external wall in-between (i.e. spandrel panel) provided in different constructions with varying degrees of combustibility and fire performance. Even in the case of a non-combustible fire resisting spandrel panel being used, the heat flux received at the centre of the window opening above the spandrel panel was sufficient to cause failure of the glazing in the window and potential for ignition of any combustible materials, in the room above, that would be close to the window opening.

2.12 Current ADB guidance does not seek to control fire separation between windows in habitable accommodation on adjacent storeys and, thereby, the inherent risk of fire spread between vertically adjacent windows is effectively accepted by current regulation.

2.13 Therefore, even with a completely non-combustible external façade construction, fire spread via vertically adjacent windows can occur during a significant fire event. The ADB guidance described in 2.8 - 2.9 above relating to the control of reaction to fire performance of cladding materials will act to prevent the external wall construction accelerating the fire spread across the façade and contributing significantly to the intensity of the external fire plume in a manner which would greatly increase this risk.

3 Comparison with other international regulation

3.1 Table 1 shows a comparison of a number of jurisdictions which use a regulatory regime that would permit the acceptance of a cladding system for the building in Figure 1 incorporating combustible material by means of the BS8414 or NFPA 285[6.13] 'full assembly' test i.e. a test of the cladding system including bracketry, insulation and rainscreen material which uses a heating regime that simulates exposure of the system to a fire breaking out of the interior of the building.

3.2 There are a number of other international jurisdictions that apply regulatory control of external cladding systems by means of testing a full cladding assembly to a simulated fire source. Some of these tests employ a timber crib fire source in a similar manner to BS8414 whilst others utilise gas burners or trays of liquid fuel.

3.3 For the purposes of this concise initial report the NFPA 285 test has been selected for comparison as it is referred to by the IBC and is thereby widely used around the world to approve the use of external cladding systems for construction.

3.4 The comparison in Table 1 also compares the degree to which various regulatory regimes which refer to these tests make additional provisions for fire precautions over and above passing the test.

Table 1 – Comparison of regulatory regimes using BS8414 or NFPA 285 ‘full assembly’ fire test applied to the example building as shown in Figure 1.

<table>
<tr><th rowspan="3">Country</th><th colspan="8">Approval by ‘full assembly’ fire test</th><th rowspan="3">Additional material performance requirement for materials?</th><th colspan="5">Associated passive fire protection measures required for compliance with the building code in addition to those incorporated in the tested system</th></tr>
<tr><th rowspan="2">Standard</th><th rowspan="2">Fire exposure intensity</th><th rowspan="2">Window or vent openings included?</th><th rowspan="2">Defects included in test specimen?</th><th colspan="4">Failure criteria</th><th rowspan="2">Separation of windows</th><th colspan="4">Cavity fire barriers in the rainscreen void</th></tr>
<tr><th>External fire spread</th><th>Internal fire spread</th><th>Flaming droplets</th><th>Mechanical</th><th>Thermal barrier (min 0.5 inch plasterboard on room side of external wall)</th><th>On compartment wall and floor lines</th><th>Around openings (e.g. vents & windows)</th><th>Limitation the undivided extent of cavity</th></tr>
<tr><td>England & Wales[6.1]</td><td rowspan="2">BS8414 method with BR135 classification criteria</td><td rowspan="2">At least 20 minutes at > 600ºC (~50kW/m²) in total test duration of 60 minutes.

Fire source extinguished at 30 minutes.</td><td rowspan="2">✗</td><td rowspan="2">✗</td><td rowspan="2">>600ºC at 2 storeys above fire source for >30 seconds in first 15 minutes of test (measured at 50mm from face of wall)

Or

Sustained flaming above top of test assembly</td><td rowspan="2">>600ºC at 2 storeys above fire source for >30 seconds in first 15 minutes of test (measured in either cavity or insulation material)

Or

Burn-through of the wall at 0.5m (or higher) above fire opening resulting in flaming for >60 seconds in first 15 minutes of test</td><td rowspan="2">Observations recorded</td><td rowspan="2">Observations recorded</td><td>✗</td><td>✗</td><td>✗</td><td>✓</td><td>✓</td><td>✓ Note 1</td></tr>
<tr><td>UAE[6.10] Note 2</td><td>ASTM E84 Class A</td><td>✗ Note 3</td><td>✓</td><td>✗</td><td>✗</td><td>✗</td></tr>
<tr><td>USA[6.11]</td><td rowspan="2">NFPA 285</td><td rowspan="2">Increasing to ~40kW/m² at 25-30 minutes.

Fire source extinguished at 30 minutes.</td><td rowspan="2">✗</td><td rowspan="2">✗</td><td rowspan="2">>538ºC at 1 storey above fire source at any time in test

Or

Vertical flame projection at greater than 1 storey above fire source

Or

Horizontal flame projection greater than 0.53m from vertical edge of fire source</td><td rowspan="2">>538/417ºC at 1 storey above fire source or at any time in test (for cavity temp/insulation temp rise respectively)

Or

>278ºC or flaming visible in the room 1 storey above the fire source

Or

Flaming from cavity beyond the horizontal extent of the side walls of the test rig</td><td rowspan="2">✗</td><td rowspan="2">✗</td><td>ASTM E84 Class A</td><td>✗</td><td>✓</td><td>✗</td><td>✗</td><td>✗</td></tr>
<tr><td>New Zealand[6.12]</td><td>✗</td><td>✗</td><td>✗</td><td>✗</td><td>✗</td><td>✗</td></tr>
</table>

Note 1

The extent of undivided cavity is limited by the cavity barriers provided at every floor level, at every party wall location and at the compartment walls enclosing protected escape routes.

Note 2

This table refers to the 2011 edition of the UAE Fire and Life Safety Code of Practice including Annexure A.1.2.1 Rev 2 which are currently referred to officially by the Civil Defence authority (https://www.dcd.gov.ae/portal/en/). It is understood that a 2017 edition of the code has been prepared but that is, currently, only unofficially available on internet file sharing sites. This 2017 edition includes provisions that appear intended to more greatly restrict the use of metal skinned composite cladding panels with combustible cores of the type believed to have been involved in significant fires in the region (see Table 2 later in this report). However, the 2017 edition document also contains various errors including incorrect references to fire test standards. For these reasons it is assumed as having no official status for the purposes of this report.

Note 3

The UAE code states that separation of windows by means of fire resisting spandrel panels should be provided and no relaxation on the basis of sprinkler protection is stated. However, it is reported in a report by CSIRO and FireSERT[6.18] that it is understood that such a dispensation is being permitted based on the designs being implemented.

3.5 Key points shown by the comparison in Table 1 are summarised and discussed as follows:

a) Cavity fire barrier provision

i. Irrespective of whether the results of the 'full assembly' fire test achieves a pass without fire breaks, compliance with ADB in the UK requires the provision of cavity fire barriers at the interface of compartment floors and compartment walls and around all vent and window openings.

ii. In contrast, the other jurisdictions using BS8414 and NFPA 285 tests do not prescribe the additional cavity barrier provision in addition to what was provided to pass the test.

b) Additional penetrations

i. Neither NFPA 285 or BS8414 require service, vent or window openings to be incorporated in the test assembly.

ii. As referred to above in a)i, compliance with ADB guidance requires any such openings to be provided with cavity barrier protection when the building is being either constructed or modified.

c) Simulation of defects in the cladding system under test

i. It is understood from Kingspan Insulation Ltd that some criticism has been levelled at BS8414 because cladding systems may not be installed on site in a manner which replicates the quality of installation used at the test laboratory.

ii. Neither NFPA 285 or BS8414 require simulation of defective construction in the test specimen assembly.

iii. Other fire test standards referenced by the recommendations in ADB for demonstrating compliance with functional building regulations requirements B1 to B5 do not require faults with materials, products or installation to be reproduced or simulated in specimens under test.

iv. For instance, compliance with ADB guidance relating to fire doors requires that the performance of fire doors is determined in respect of compliance to either BS 476: Part 22 (national standard)[6.14] or BS EN 1634-1 (European standard)[6.15]. Despite the incidence of defects or damage to installed fire doors that are identified for action by Fire Risk Assessments (carried out for compliance with Article 9 of the Fire Safety Order)[6.16], these test standards do not require 'defects' to be built into the test specimens submitted for test.

v. Compliance with Regulation 7 of the Building Regulations[6.17] places a duty on the person doing the work to comply with the regulation (shown below) and for the appointed Building Control Body to decide whether this regulation has been complied with, using the guidance in Approved Document 7. Significant defects in installations should thereby be avoided by dutyholders and enforcement bodies appropriately discharging their respective responsibilities.

Regulation

Materials and workmanship

7. Building work shall be carried out—

(a) with adequate and proper materials which—

(i) are appropriate for the circumstances in which they are used,

(ii) are adequately mixed or prepared, and

(iii) are applied, used or fixed so as adequately to perform the functions for which they are designed; and

(b) in a workmanlike manner.

Severity of test fire exposure

3.6 The photograph shown in Figure 2 is an image taken from a BS8414 test with a terracotta tile (i.e. non-combustible) rainscreen.

Figure 2

3.7 The 'calibration' of the NFPA 285 test is based on the gas burners achieving a step-wise increase in heat flux (stipulated in units of kW/m^2) measured close to the top of the fire room opening.

3.8 In contrast, the calibration of the timber crib fire source of the BS8414 test[6.5] is stated as, simply, achieving a minimum exposure temperature of 600ºC just above the timber crib opening and 500ºC at Level 1 (a notional storey level above the opening) for a period of at least 20 minutes.

3.9 To provide a basis of comparison, it is necessary to convert the minimum temperature of exposure in the BS8414 test standard to a heat flux. This can be achieved by calculating the estimated radiative and convective generated by a fire plume temperature of 600ºC required by the test calibration immediately above the timber crib opening.

3.10 The DCLG Test 6 used a combination of mineral fibre insulation and limited combustibility cladding. Hence the contribution of the cladding assembly to overall heat release in heat release in the test would have been minimal.

3.11 The image in Figure 2 demonstrates that the cladding under test is directly impacted by a highly luminous and sustained fire plume directly above the timber crib fire source. The total heat flux delivered by the fire to the surface of the cladding at this point based on the minimum exposure temperature required to be achieved by the timber crib directly above the opening can be estimated by the following calculation:

$Q_T = Q_R + Q_C$ where,

Q_T = Total heat flux (kW/m^2) at the point of contact with the fire plume with the cladding
Q_R = Radiative heat flux (kW/m^2)
Q_C = Convective heat flux (kW/m^2)

$Q_R = \varepsilon \sigma T^4$ where
ε = flame emissivity (1.0)
σ = Stefan Boltzmann constant (5.67×10^{-8} $W/m^2.K^4$)
T = Minimum plume temperature required (600 + 273 = 873K)

Hence,

Q_R = 1.0 x 5.67x10^{-8} x 873^4

= 32,900 W/m^2

= 32.9 kW/m^2

Q_C = c x dT where
c = convection coefficient (30 W/m^2.K)
dT = temperature of fire plume above ambient (580ºC)

Hence,

Q_C = 30 x 580

= 17,400 W/m^2

= 17.4 kW/m^2

Therefore,

Q_T = 32.9 + 17.4

= 50.3 kW/m^2

This value of 50.3 kW/m^2 is the minimum heat flux to which the cladding in a BS8414 test would be exposed close to the top of the timber fire crib opening based on the requirement to achieve a minimum temperature of 600ºC at this location. This compares to a maximum exposure of 40kW/m^2 required from the NFPA 285 test.

Test apparatus geometry and failure point locations

3.12 Figure 3 shows a diagrammatical comparison of the NFPA and BS8414/BR135 tests.

3.13 The schematic drawing to the top left of Figure 3 shows a comparison of the geometry of the BS8414 test apparatus (in black) with the NFPA test apparatus (in blue). It also shows the approximate locations for determination of the various calibration and failure criteria. Notable points are as follows:

a) If the 538ºC external temperature failure temperature position in the NFPA 285 test was applied to the BS8414 test at the same relative height above the fire source opening then the minimum required exposure severity required by the ‘calibration’ of the timber crib fire source in the BS8414 test would result in, effectively, immediate failure of the test even with a completely non-combustible façade construction.

b) The NFPA 285 test effectively sets the locations of its failure points at notionally 1 storey above the test fire source. The BS8414 tests sets the failure points at a notional 2 storeys position above the fire source to account for the higher base level of exposure required in the BS8414 test at a height of one storey above the fire source.

Comparison of minimum exposure intensity required by calibration

3.14 The graph to the bottom left of Figure 3 shows a comparison of the exposure intensity required by each of the tests on the cladding close to the fire source.

a) The blue line shows the exposure intensity for the BS8414 test based on the calculation of heat flux intensity in section 3.11 which is required to be maintained for a minimum period of 20 minutes when the crib is burning at effectively peak intensity. The graph assumes a notional 10 minute growth period to this point.

b) The red line shows the step-wise increase in the gas-fired fire source in the NFPA 285 test.

c) It can clearly be seen that there is a significant difference in the area under these curves and this difference indicates that the BS8414 test will impart into the cladding under test about twice the heat energy than in the NFPA 285 test.

Intensity of BS8414 fire crib source in excess of minimum required

3.15 The graph to the right centre of Figure 3 shows the actual external temperatures recorded at Level 1 and Level 2 in DCLG Test 6 where all cladding and insulation materials were at least Limited Combustibility (Euroclass A2). The red line shows the minimum temperature required to be achieved by the fire source crib at level 1 (i.e. 500ºC for at least 20 minutes).

a) The blue line shows that the actual temperature achieved at Level 1 (with minimal contribution reasonably assumed from the A2 cladding and A2 insulation) actually achieves an exposure temperature at Level 1 that is significantly greater than the 500ºC required.

b) This means that the comparison described above in 3.14 is actually highly conservative and the real ‘in-test’ difference in severity of exposure between BS8414 and NFPA 285 is even greater.

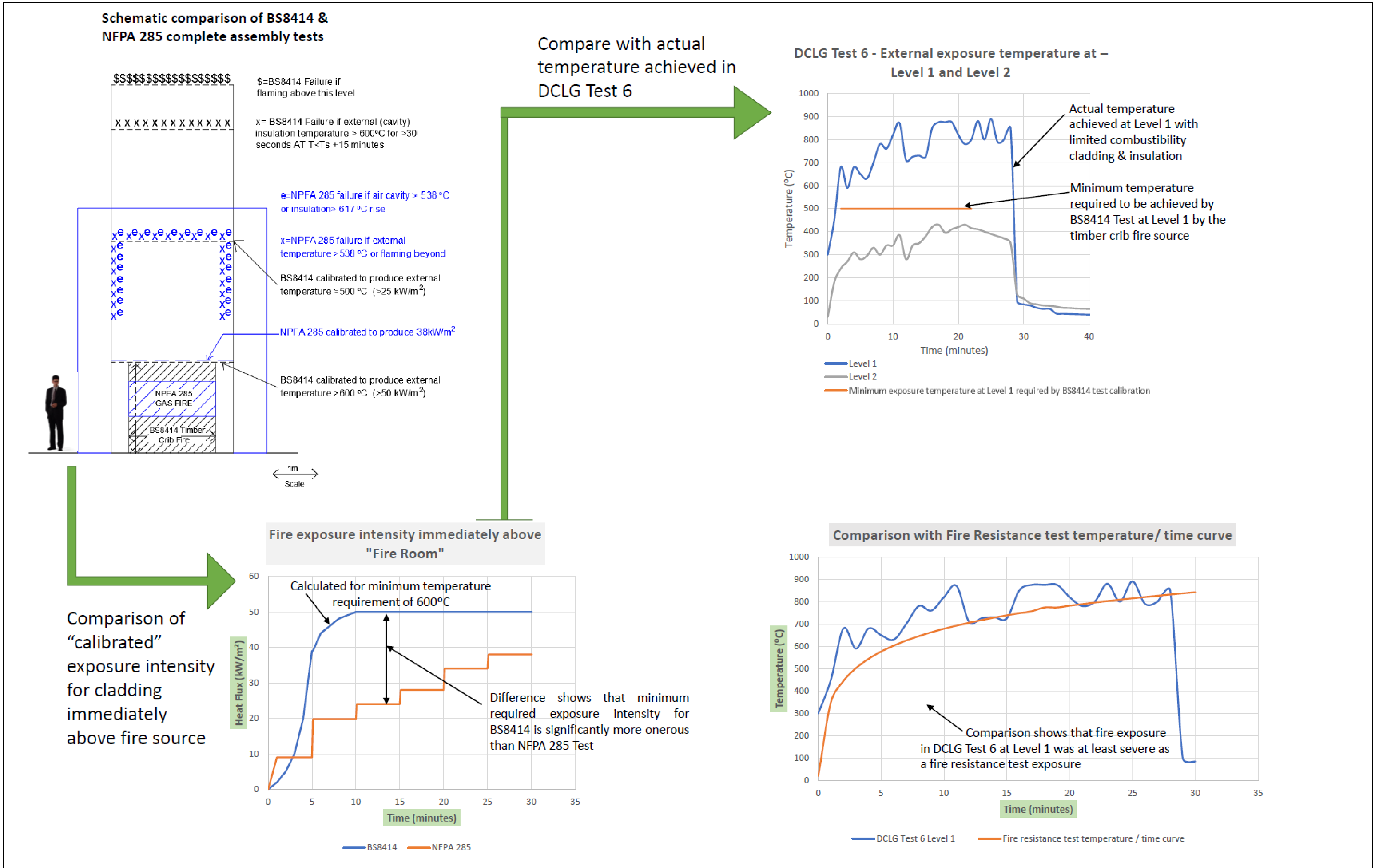
Comparison with exposure severity achieved in a fire resistance test

3.16 The graph to the bottom right of Figure 3 shows a comparison of the external exposure temperature at Level 1 from DCLG Test 6 compared with the prescribed temperature/time curve that is used in BS476 (national) and European fire resistance tests for 30 minutes duration.

a) The blue line shows the external temperature at Level 1 measures in DCLG Test 6. The red line shows the temperature/time curve required to be achieved in a gas-fired furnace for a fire resistance test.

b) The comparison shows that the intensity of exposure to the cladding under test at nominally 1 storey above the timber crib fire source in DCLG Test 6 was slightly greater than the intensity of fire test exposure to which an FD30S fire door intended for use as a flat entrance door would be subjected for its approval.

Figure 3


Schematic comparison of BS8414 & NFPA 285 complete assembly tests
$=BS8414 Failure if flaming above this level
x= BS8414 Failure if external (cavity) insulation temperature > 600ºC for >30 seconds AT T<Ts +15 minutes
e=NFPA 285 failure if air cavity > 538 °C or insulation> 617 °C rise
x=NFPA 285 failure if external temperature >538 ºC or flaming beyond
BS8414 calibrated to produce external temperature >500 ºC (>25 kW/m²)
NFPA 285 calibrated to produce 38kW/m²
BS8414 calibrated to produce external temperature >600 ºC (>50 kW/m²)
NFPA 285 GAS FIRE
BS8414 Timber Crib Fire
1m
Scale
Compare with actual temperature achieved in DCLG Test 6
DCLG Test 6 - External exposure temperature at – Level 1 and Level 2
Temperature (ºC)
Time (minutes)
Actual temperature achieved at Level 1 with limited combustibility cladding & insulation
Minimum temperature required to be achieved by BS8414 Test at Level 1 by the timber crib fire source
Level 1
Level 2
Minimum exposure temperature at Level 1 required by BS8414 test calibration
Comparison of “calibrated” exposure intensity for cladding immediately above fire source
Fire exposure intensity immediately above "Fire Room"
Heat Flux (kW/m²)
Calculated for minimum temperature requirement of 600ºC
Difference shows that minimum required exposure intensity for BS8414 is significantly more onerous than NFPA 285 Test
Time (minutes)
BS8414
NFPA 285
Comparison with Fire Resistance test temperature/ time curve
Temperature (ºC)
Comparison shows that fire exposure in DCLG Test 6 at Level 1 was at least severe as a fire resistance test exposure
Time (minutes)
DCLG Test 6 Level 1
Fire resistance test temperature / time curve

4 Evidence from real fires

4.1 From a review of information readily available in the public domain, Table 2 lists significant fires in residential buildings over 5 storeys in chronological order.

Table 2 – Significant fires involving combustible cladding materials

Fire	Date	Building	Details of external wall (as reported)	Fire description (as reported)
393 Kennedy St, Winnipeg Canada.[6.18]	10/01/90 0500hrs	8 storey residential.	Rendered 'foamed plastic insulation' (type not stated). No horizontal fire breaks.	Fire started in ground level car park. Significant fire propagation both laterally and vertically.
Knowsley Heights UK.[6.18]	1991	11 storey residential.	Class 0 rainscreen. No further detail of composition. Rubberised coating to masonry wall behind. No fire barriers in the rainscreen void.	Fire in external rubbish compound spread to the top of the building. No fire barriers in the rainscreen void.
Munich.[6.18]	1996	5 storey residential.	Rendered EPS. No details on fire barriers.	Rubbish fire externally at ground level spread to top of façade on external cladding and re-entered building at multiple floor levels.
Berlin.[6.18]	21/04/05 0150hrs	7 storey residential.	Rendered EPS with mineral fibre fire breaks installed at 2nd and 4th floor slabs only.	Fire stated at 2nd floor and spread up external façade to full height of building. 2 fatalities.
Water Club Tower, Atlantic City USA.[6.18]	23/09/07	41 storey hotel (under construction).	ACM with PE core. Used as decorative feature over gable end concrete shear wall. No detail on insulation. No detail on fire barriers.	Fire started internally at 3rd floor where there was an opening to the void behind the ACM panelling. Fire spread to the full height of the building and consumed the ACM panelling within 10-15 minutes of fire brigade arrival.
MGM Montecarlo hotel LA.[6.18]	25/01/08 1100hrs	32 storey hotel.	Rendered EPS and polyurethane encapsulated EPS features.	Fire started at parapet and burned laterally and downwards with flaming droplets. Sprinklers prevented spread into building.
Miskolc, Hungary.[6.18]	15/08/09	11 storey residential. Refurbished in 2007.	Rendered EPS. No mineral fibre fire breaks through insulation and poorly applied render.	Fire started in 6th floor residential kitchen. Propagation to at least 3 floors above fire floor. 3 fatalities.
Mermoz Tower, Roubaix France.[6.18]	14/05/10 During day.	18 Storey residential.	ACM with 3mm PE core. No detail on insulation. No detail on fire barriers.	2nd storey external balcony fire spread to top of building within a few minutes. Fire and smoke spread into the building. One fatality and six injuries.
Wooshin Golden Suites, Busan, South Korea.[6.18]	01/10/10 AM	38 storeys residential.	ACM with PE core. Insulation shown to be glass fibre but reported that some newspaper articles referred to EPS. No detail on fire barriers.	Fire started on 4th floor in a room without sprinkler protection. Spread to façade and then externally to full height of building within 20 minutes. 4 injuries. People evacuated from roof by helicopter.

Fire	Date	Building	Details of external wall (as reported)	Fire description (as reported)
Dijon, France. 6.18	14/11/10	10 storey residential.	Reported as "believed to be" rendered EPS with mineral fibre fire breaks installed. No official report available.	7 fatalities.
Al Tayer Tower, Sharjah. 6.18	08/04/12	40 storey residential	ACM with PE core. No detail on insulation. No detail on fire barriers.	1st floor balcony fire spread to the top of the building with 45 cars damage below due to falling burning debris.
Saif Belhasa, Tecom, Dubai. 6.18	06/10/12	13 storey residential	PE cored ACM. No detail on insulation. No detail on fire barriers.	4th floor fire spread to the top of the building and entered 9 flats. 2 injuries. 5 cars damaged due to burning falling debris.
Tamweel Tower Dubai. 6.18	18/11/12 0130hrs	34 storey residential.	PE cored ACM. No detail on insulation. No detail on fire barriers.	Fire started at roof level and spread downwards to effectively ground level due to falling flaming debris.
The Lacrosse Building Melbourne. 6.19	25/10/14	23 storey residential.	ACM with PE core. Fibreglass insulation.	Fire started on 6th floor balcony and spread upwards to 21st floor. Fire caused operation of sprinklers at multiple floor levels.
The Torch, Dubai.	21/02/15	79 storey residential.	No formal reports but understood to be ACM with PE core plus. Insulation no known.	No formal report but press reports indicate fire on balcony spreading to cladding.
Grenfell Tower. 6.20	14/06/17	24 storey residential.	ACM with PE core. PIR insulation.	(Facts relating to causality and fire spread still to be established by the Inquiry).
The Torch, Dubai.	04/08/17	79 storey residential.	No formal reports but understood to be ACM with PE core plus. Insulation no known.	No formal report but press reports indicate fire on balcony spreading to cladding.

4.2 The cladding constructions described in Table 2 were all reported as containing significant quantities of thermoplastic materials as cladding or insulation. In some, the absence of, or inability to confirm the presence of, fire breaks was also reported. For these reasons it is Tenos' opinion that the cladding systems would be unlikely to meet the criteria set by BR135 if tested to BS8414.

4.3 It is known that the system installed on Grenfell Tower failed the test, by virtue of the result of DCLG Test 1[6.20] published by the government.

4.4 On the basis of the above, there is no significant information in the public domain to suggest that external cladding systems meeting the BRE classification criteria based on a BS8414 test result have contributed to large fires in tall residential buildings.

4.5 The apparent absence of evidence in the public domain of real fires experiencing significant fire spread in external cladding systems compliant with BS8414/BR135 could be indicative that such systems are achieving the level of risk reduction required by regulation

5 Conclusions

5.1 The heating regime of the BS8414 test is more onerous than that of NFPA 285, because:

- the minimum heat flux to which the test specimen is exposed is greater in a BS8414 test than in an NFPA 285 test.
- the overall heat energy (i.e. intensity and duration of simulated fire exposure) to which the test specimen is subjected in the BS8414 significantly exceeds that achieved in NFPA 285.

5.2 The ADB recommendations for the example 'High Rise' building considered in this review (i.e. meeting BR135 criteria and providing cavity barriers) exceed those of the other international regulatory regimes that use either BS8414 or NFPA 285 as a basis for determining regulatory compliance.

5.3 There appears to be no evidence from the major fires reported in the public domain that cladding systems tested to BS8414, that satisfy the BR135 classification criteria, have been a major contributor to fire propagation in taller residential buildings.

6 References

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