DESIGN FIRE
CONSULTANTS

CladFire Project

Possible ways to use the Data

Revision 00

11 February 2026

Summary

Background

Following the tragic fire at Grenfell Tower, it has been identified that UK buildings were not always designed or indeed built in accordance with the guidance provided within Approved Document B ("ADB"), and possibly not accordance with Part B to Schedule 1 of the Building Regulations.

The initial government response to this realisation, was to require that buildings be remediated such that insulation should be of limited combustibility and 'adequate' cavity barriers or that the system should in accordance with a BR 135 classification. However, it was subsequently confirmed by government that such remediation was not always necessary, nor proportionate, and that a risk-based appraisal should be conducted.

Such a risk-based approach necessitates some consideration of the potential hazard of fire and/or smoke spread (herein "Spread Hazard") via external wall constructions, but there is very little knowledge or data that allows such consideration.

The CladFire Project

Therefore, in order to provide some data, in 2024, we embarked on experimental project ("CladFire") that would provide heat release rate (and other) data for the response to fire of combinations of cladding products, tested in close proximity to one another in a ventilated cavity configuration, that could be used by suitably competent fire safety professionals in consideration of Spread Hazard.

The Preliminary Findings

The CladFire data and test observations lead us to consider that Peak HHR is one of the key metrics of Spread Hazard.

The CladFire data and test observations lead us to consider that:

- ACM PE cladding systems have a 'high' Spread Hazard regardless of the type of insulation.
- The systems comprising non-combustible cladding have a 'low' Spread Hazard regardless of the whether the insulation is mineral wool, PIR or phenolic foam.
- The systems with wood derivative cladding have a 'low' to 'medium' Spread Hazard (relative to non-combustible cladding and ACM PE cladding) regardless of whether the insulation is mineral wool, PIR or phenolic foam but that the Fire Spread Hazard is slightly greater where the insulation is combustible.

The CladFire data and observations provide evidence that, as opposed to PIR insulation, phenolic foam insulation can exhibit smouldering combustion and continue burning.

Limitations

Whilst the CladFire test configuration is readily repeatable and has resulted in data that we think could be useful in contextualising Spread Hazard, we recognise that there are limitations:

- The test arrangement was not directly representative of the fire source, the size or the full complexities of an external wall system on a real building.
- The CladFire Project was not intended and does not provide any acceptance criteria against which Spread Hazard can be measured.

As such, the data should only be used by competent professionals who must account for the many variations and complexities that can exist on a real building and assess the Spread Hazard against their own metrics of acceptability.

Contents

1 Introduction

1.1 Background

The Building Regulations[1,2,3,4] require that buildings be constructed such that they secure a reasonable standard of health and safety for person in or around buildings. For fire safety, the expectations of a reasonable standard of health and safety are set out in Part B of Schedule 1 to the Building Regulations ("Part B").

In recent decades, the typical approach taken with respect to Part B was to develop a design using relevant design guidance (for example the relevant edition of Approved Document B[5,6,7,8] ("ADB")).

However, following the fire at Grenfell, it has been established that many buildings were not built in accordance with relevant design guidance (either because they were not designed in accordance with the guidance and/or because they were not built in accordance with the design and/or there are workmanship defects).

The initial response from government[9,10,11,12] was to encourage building owners to ensure that existing walls on their existing buildings were either constructed or remediated to comprise insulation and cladding of limited combustibility[13] or better, or installed in accordance with a BR 135[14] classification[15].

This expectation of was echoed by key stakeholders within the sector such as building insurers, the fire services, freeholders and leaseholders.

However, it was subsequently confirmed by government that this was not always necessary nor proportionate and that a risk-based appraisal should be conducted[16].

[1] Statutory Instruments, '1985 No. 1065 Building and Buildings, The Building Regulations 1985', 1965, HMSO.
[2] Statutory Instruments, '1991 No. 2768 Building and Buildings, England and Wales, The Building Regulations 1991', (as amended).
[3] Statutory Instruments, '2000 No. 2531 Building and Buildings, England and Wales, The Building Regulations 2000', (as amended).
[4] Statutory Instruments, '2010 No. 2214 Building and Buildings, England and Wales, The Building Regulations 2010' (as amended).
[5] Department of the Environment and The Welsh Office, 'The Building Regulations 1985, Approved Document B2/3/4 – Fire spread', 1985, HMSO.
[6] Department of the Environment and The Welsh Office, 'The Building Regulations 1991, Approved Document B – Fire safety, 1992 edition Second impression (with amendments)', 1992, HMSO.
[7] Department of Transport Local Government Regions, 'The Building Regulations 2000, Approved Document B – Fire safety, 2000 edition, HMSO.
[8] HM Government, The Building Regulations 2000, Approved Document B (Fire Safety), Volume 2 – Building other than dwellinghouses, 2006', HMSO.
[9] Ministry of Housing, Communities and Local Government, 'Advice on external wall systems that do not incorporate Aluminium Composite Material', 18 December 2018.
[10] Ministry of Housing, Communities and Local Government, 'Advice for owners of buildings which are partially clad in Aluminium Composite Material (ACM) cladding system', September 2018.
[11] Ministry of Housing, Communities and Local Government, 'Advice for owners of buildings which in include spandrel panels/ window panels/ infill panels', 17 October 2018.
[12] Ministry of Housing, Communities and Local Government, 'Advice for owners of Multi-storey, Multi-occupied Residential Buildings', 20 January 2020.
[13] As defined by ADB: 2006
[14] S Colwell and T Baker, 'Fire performance of external thermal insulation for walls of multistorey buildings: (BR 135) Third edition', 2013, BREPress.
[15] This was meant to mean a system that had been classified as meeting the BR 135 performance critieria using data from tests in accordance with BS 8414.
[16] https://www.gov.uk/guidance/remediation-enforcement-guidance-for-regulators/2-principles-for-remediation-enforcement#para2-3

This change of approach has not been universally accepted and there is much debate[17] about whether the most appropriate approach for existing buildings is to:

- Assess the requirements for any remediation works by a risk-based assessment that considers proportionality (as currently advocated by Government).
- Remediate the external walls such that they would have met the requirements of the Building Regulations at the time when they were originally constructed.
- Remediate the external walls such that they would comply with the current Building Regulations.

This report and the associated research and data do not seek to respond to the above debate, nor do they seek to comment on the standard that would have been required for compliance with the Building Regulations at the time of construction. Instead, they are simply intended to provide data that might (or might not) assist those choosing to conduct a risk-based assessment, as is currently suggested by Government.

Risk is typically defined as a function of the probability of a hazard causing harm. Therefore, as a minimum, risk-based assessments of external wall constructions require some consideration of the potential hazard of fire and/or smoke spread (herein “Spread Hazard”) via external wall constructions.

However, partly because of the historical reliance on guidance such as ADB and BR 135, there are implicit challenges with contextualising the Spread Hazard:

- Methodology: There is no recognised methodology for determining the Spread Hazard (e.g. there is no means of calculating the potential rate or extent of fire or smoke spread for external wall constructions as systems).
- Data: Testing has focused on ‘pass/fail’ acceptance criteria, and as such, there is little data available to allow quantification of the Spread Hazard. Indeed, there is little data to allow any form of contextualising the Spread Hazard.
- Defects: Test such as BS 8414 tests have typically been conduct for systems that have been installed correctly (i.e. without any defects), and as such, there is little knowledge or data on the impact that defects might have on the Spread Hazard.
- Acceptance Criteria: Even if the Spread Hazard of systems could be ranked relative to each other, there is no recognised acceptance criteria of what constitutes a sufficiently low hazard or risk. This is not solved by ADB because it does not include any metric or basis against which its guidance is considered to achieve a reasonable standard of health and safety.

This has been borne out in DFC’s experience of conducting our own risk assessments and reviewing those of others:

- There is rarely BS 8414 test data for tested systems that directly match the as-built construction, and
- There are almost always some workmanship defects, particularly associated with cavity barrier installation.
- It is very difficult to robustly evidence the expected Spread Hazard. This is not only in absolute terms but even in relative, qualitative terms between the as-built system and a known system.

In respect of the final bullet point above, Design Fire Consultants Ltd (“DFC”) has been working with the University of Edinburgh (“UoE”) on a library of heat release data for different cladding systems.

[17] DFC does not have a specific reference to support this statement, but based on our experience working in the industry and with posts on social media platforms such as LinkedIn, we are confidence that it is a reasonable statement to make.

Initially, this was on a project specific, ad-hoc basis, but in 2024, DFC cosponsored (with support from the University of Edinburgh's Engineering and Physical Sciences Research Council Impact Accelerator Account) a more generic data acquisition testing project[18] (herein "CladFire" Project).

The intent for the CladFire Project is to provide some context to the relative Spread Hazard of different wall systems. To that end, the CladFire data provides context on relative performance, but they do not explicitly address acceptance criteria.

We also recognise that the CladFire tests are conducted at a 'small' scale (this was to allow for testing of multiple systems and repeatability) and that they have not been explicitly validated against large scale tests. Therefore, whilst the CladFire data might provide some useful context, it remains necessary and important that they only be used by competent professionals who must account for the many variations and complexities that can exist on a real building and assess the Spread Hazard against their own metrics of acceptability.

1.2 The CladFire Reports and Data

There are three CladFire Reports: the Methodology Report[19], the Results Report[20] and the Usage Report (this report).

The Usage Report provides:

- A summary of the CladFire data and our interpretations of what we think it suggests in respect of the Spread Hazard associated each of the tested combinations of cladding and insulation.
- Examples of how the data might be used by competent professionals as a means of contextualising Spread Hazards of different external wall systems.
- Our preliminary thoughts on the key findings of the above.

The reports and data are available for review and download on the following website:

https://claddingdata.dfc.co.uk

1.3 Disclaimer

This report is provided for information purposes only. We make no warranties, representations, or assurances regarding its accuracy, completeness, quality or suitability for any particular purpose.

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We accept no liability for any loss, damage, expense or any other consequence arising from the use of, or reliance on, this report, expect where such liability cannot be lawfully excluded.

[18] EPSRC IAA PV184 External Wall System Fire Performance: Closing the Gap between Test and Application
[21] S Colwell and B Martin, 'Fire performance of external thermal insulation for walls of multistorey buildings: (BR 135) Second edition', 2003, BREPress.
[21] S Colwell and B Martin, 'Fire performance of external thermal insulation for walls of multistorey buildings: (BR 135) Second edition', 2003, BREPress.

2 Summary the CladFire Data

2.1 Key Metrics

From the outset, it was established that there are three primary factors with respect to the fire performance of an external wall system:

- How fast might fire spread. The rate of spread via external walls needs to be sufficiently slow that:
  - Occupants are not put at undue risk before they can evacuate.
  - Where there is an assumption of fire service intervention from outside, there is sufficient time for such intervention.
  - Where there is an internal fire service access strategy, the fire service can sufficiently affect their operations from within the building.
- How far might fire spread. The more floors that are affected, the greater the risk.
- How much heat is produced by the fire. The more heat that is produced by a spreading fire the greater the hazard.

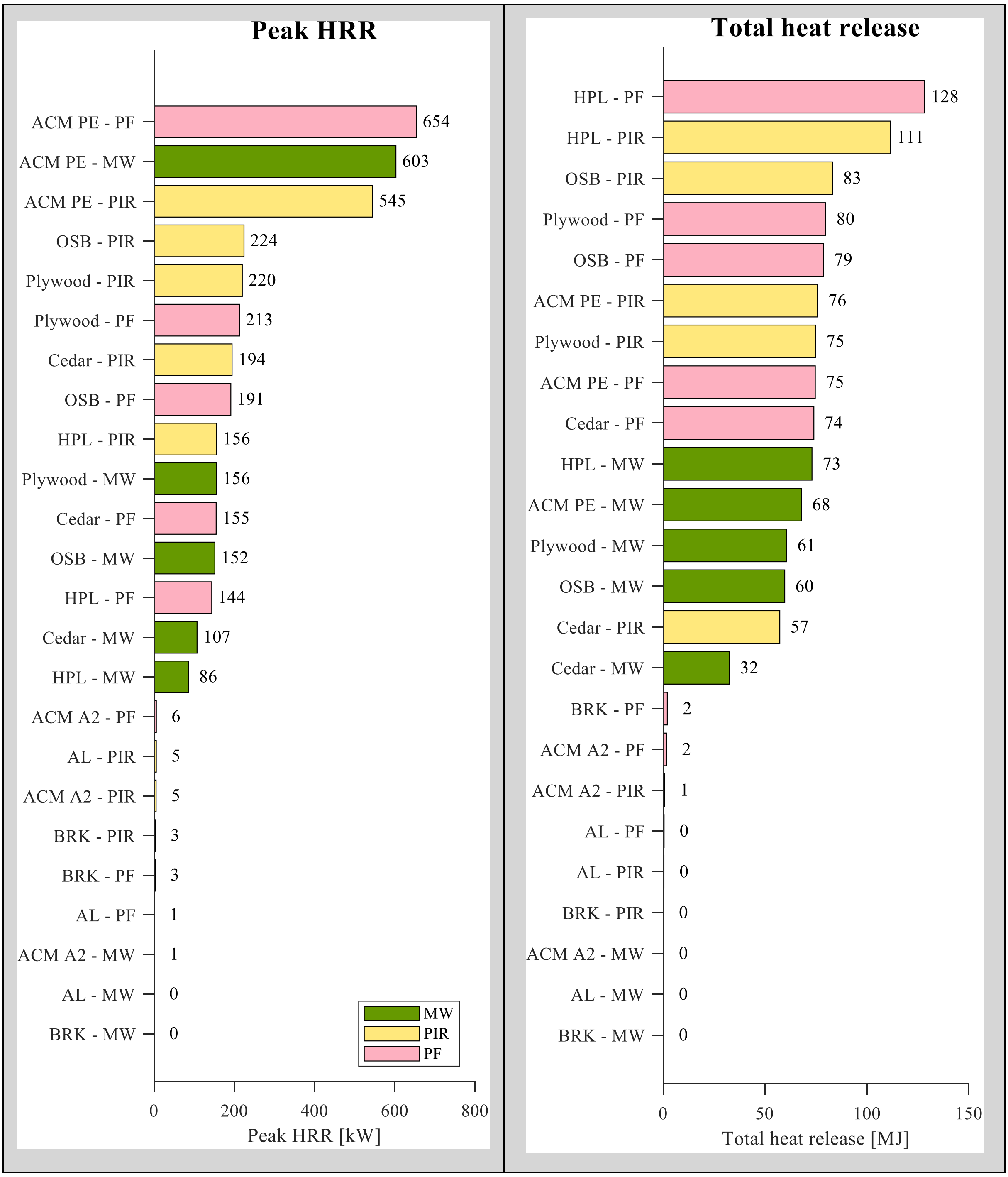
Therefore, the following metrics are included within the CladFire data:

- Heat release rate with respect to time.
- Peak heat release rate.
- Time to peak heat release rate.
- Total heat release.
- Peak rate of rise of heat release rate.
- Time to peak rate of rise of heat release rate.

2.2 Sample Data

Figure 1 shows the peak heat release rate ("Peak HRR") data and the total heat release ("THR") data for all the tested systems.

Figure 1: Peak HHR and THR values for each of the tested systems



2.3 Our Interpretation of the Data

The CladFire data cannot be used to quantify the Spread Hazard, but it can be used to compare and contextualise and rank the relative performance of different systems against multiple metrics.

As users will find, the ranking differs by metric. For example, the Peak HRR of HPL cladding is lower than that of plywood, but the THR is higher. Therefore, users might use each metric separately depending on the hazard under consideration (for example Peak HRR and/or time to Peak HRR might be good indicators of how fast fire might spread via an external wall construction) or in combination (for example the Peak HRR combined with THR might be good indictors of the severity of the hazard potential that would result from fire spread from one storey to another storey).

Having reviewed the CladFire data (and observations made during the tests), we think that Peak HRR is a key metric of Spread Hazard because it is an indicator of how fast fire can spread via the system and how much heat is produced as is spreads. Examination of the CladFire data suggests (to us) that the systems can be grouped into three distinct groupings:

- ACM PE: The Peak HHR for all three systems is approximately three times that of any of the other system and ACM PE is in a group of its own. The Peak HRR is dominated by the ACM PE with the type of insulation having some (but not much) impact the difference in Peak HRR.
- Wood Derivatives: For the tests conducted that have combustible cladding, the claddings are all wood or wood derivatives (i.e. cedar, HPL, ply or OSB). These systems have Peak HHRs of between approximately 15% and 40% of those of ACM PE.
- Non-combustible Cladding: The Peak HHRs of the brick, aluminium and ACM A2 systems are less than approximately 1% of the ACM PE systems. This is for all three insulation types.

Please note that the above groupings are based on the materials and products tested in the CladFire Project and might not be representative of other similar products (e.g. there might be other wood derivative cladding systems that fall outside of the range of those tests).

Of interest to us is that CladFire data seems to suggest that:

- ACM PE has a ‘high’ Spread Hazard regardless of the type of insulation.
- The systems comprising non-combustible cladding have a ‘low’ Spread Hazard regardless of the type of insulation.
- The systems with wood derivative cladding had a ‘low’ to ‘medium’ Spread Hazard (relative to non-combustible cladding and ACM PE cladding) regardless of the type of insulation but that the Fire Spread Hazard is slightly greater where the insulation is combustible.

3 Using the CladFire Data

3.1 Context vs Compliance

As discussed in Section 1.1, the most common approach to the design and construction external walls of blocks of flats in England is to follow guidance such as ADB. The guidance tends to include four options for external walls:

- The Low-Rise Route: Recommendations are limited to the reaction to fire characteristics of the building envelop and adequate cavity barriers must be installed.
- The Brick Cavity Wall Route: Cavity walls where the inner and outer leaves are brick or concrete at least 75mm thick and cavity adequate are adequately sealed. For such constructions the guidance makes no recommendations regarding the combustibility of insulation within the cavity wall.
- The Leaner Route: It is recommended that insulation must be of limited combustibility, there are recommendations in respect of the reaction to fire characteristics of the building envelop and adequate cavity barriers must be installed.
- The BR 135 Route: Systems that have been shown to meet the BR 135[21,22] performance criteria using data from tests in accordance with BS 8414[23,24] and that have adequate cavity barriers installed.

As can be seen, these options simply prescribe forms of construction and none of them include any information regarding the associated Spread Hazard (aside from by reference to the BR 135 performance criteria, which are also the subject of debate) or information regarding what constitutes and acceptable or otherwise Spread Hazard.

Consequently, a risk-based assessment fundamentally shifts the requirements of engineering judgement from one of judging whether the as-installed construction is sufficiently close to one of the guidance options to one of contextualising the Spread Hazard and the associated risk.

However, most testing methods and associated data are not useful for contextualising fire performance of external wall systems because:

- They are material or product tests (i.e. they are not relevant for external wall systems), and/or
- They are based around pass-fail criteria that might be useful for compliance but are not intended for providing context on the actual fire performance of an external wall system (particularly if the as-built system is not sufficiently similar in all relevant details to the tested system).

To be able to provide context, the following is required:

- An understanding of the different fire behaviours associated with the hazards so that they can be considered fully within the risk-based framework.
- Either:
  - A means of quantifying the Spread Hazard, or

[21] S Colwell and B Martin, 'Fire performance of external thermal insulation for walls of multistorey buildings: (BR 135) Second edition', 2003, BREPress.
[22] S Colwell and T Baker, 'Fire performance of external thermal insulation for walls of multistorey buildings: (BR 135) Third edition', 2013, BREPress.
[23] BS 8414-1, 'Fire performance of external cladding systems. Test methods for non-loadbearing external cladding systems applied to the face of building', 2020.
[24] BS 8414-2, 'Fire performance of external cladding systems. Test methods for non-loadbearing external cladding systems fixed to and supported by a structural steel frame', 2020.

– A means of classifying different fire behaviours that would be exhibited by external walls systems.

Therefore, to close gaps between product tests, single parameter metrics and binary pass-fail data gathering, the CladFire Project sought to develop a test arrangement that:

- System: Is a test that could test external wall systems as system, but without having to test every component of the system. For rainscreens, it was identified that the primary interactions of system performance are the insulation and the cladding (hence the set-up was reduced to the insulation, the cavity and the cladding).
- Multiple Parameters: Measures heat release with respect to time and mass loss. This allows determination of multiple parameters.
- Full Data: Relevant data would be gathered for the full duration of the test (as opposed to a single pass-fail criterion).
- Size and Expense: The test would be at a size and expense that would allow multiple systems to be tested including multiple tests per system to ensure adequate repeatability.

The overall intent was that the CladFire data could be used to provide context regarding the fire performance of different systems relative to each other and ultimately support an informed judgement regarding Ranking.

It is not intended that the CladFire data would be definitive nor that it would be used in isolation. Instead, it intended to provide context and insights to enable a more robust and evidenced contextualisation of the hazard for use in a risk-based appraisal.

We also recognise that the CladFire test arrangement was not directly representative of the fire source, the size or the full complexities of an external wall system on a real building. As such, whilst the data might be useful in contextualising the relative Spread Hazard of the respective combinations of insulation and cladding, users must still account for the many variations and complexities that can exist on a real building.

The purpose of the CladFire project was to provide data that might be useful for those wanting to contextualise Spread Hazard. We do not intend to prescribe or constrain how the data is used, but the following sections describe two ways in which the data might be useful.

3.2 Fire Performance Ranking

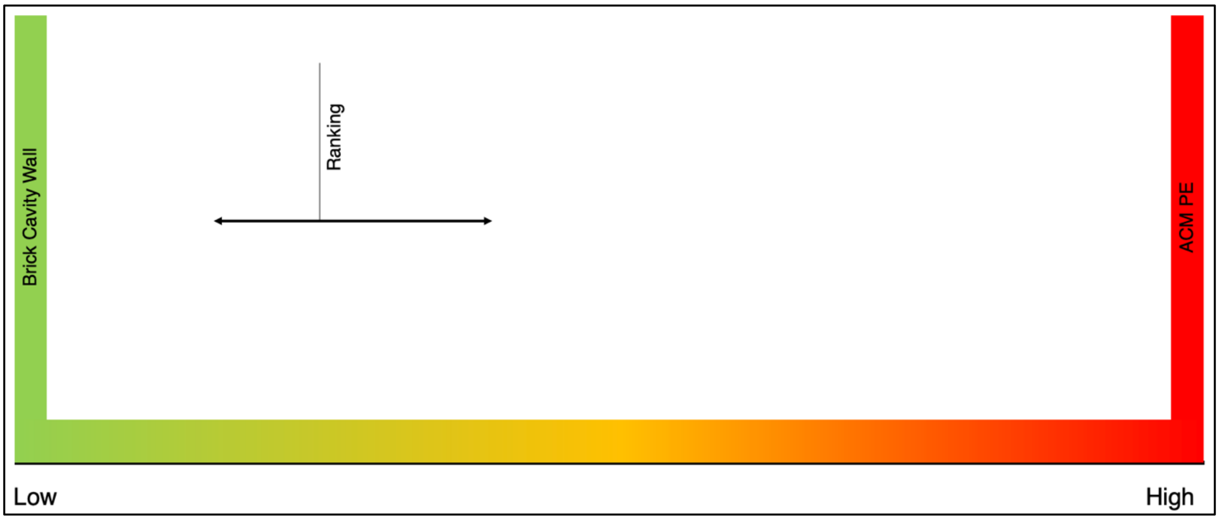
3.2.1 Concept

PAS 9980[25] (sponsored by government) was published to provide a pragmatic and risk-proportionate approach determine the need for any risk proportionate actions in relation to external walls of blocks of flats. It provides a framework for performing a risk-based assessment, part of which requires the fire performance of the external wall system to be ranked on a spectrum between low hazard and high hazard (herein a Fire Performance Ranking, or "Ranking").

PAS 9980 requires that Ranking be done between low hazard (PAS 9980 gives brick cavity wall as an example) and high hazard (PAS 9980 gives aluminium composite panels with a polyethene core ("ACM PE") as an example). This is illustrated in Figure 2.

[25] PAS 9980, 'Fire risk appraisal of external wall construction and cladding of existing blocks of flats – Code of practice', 2022.

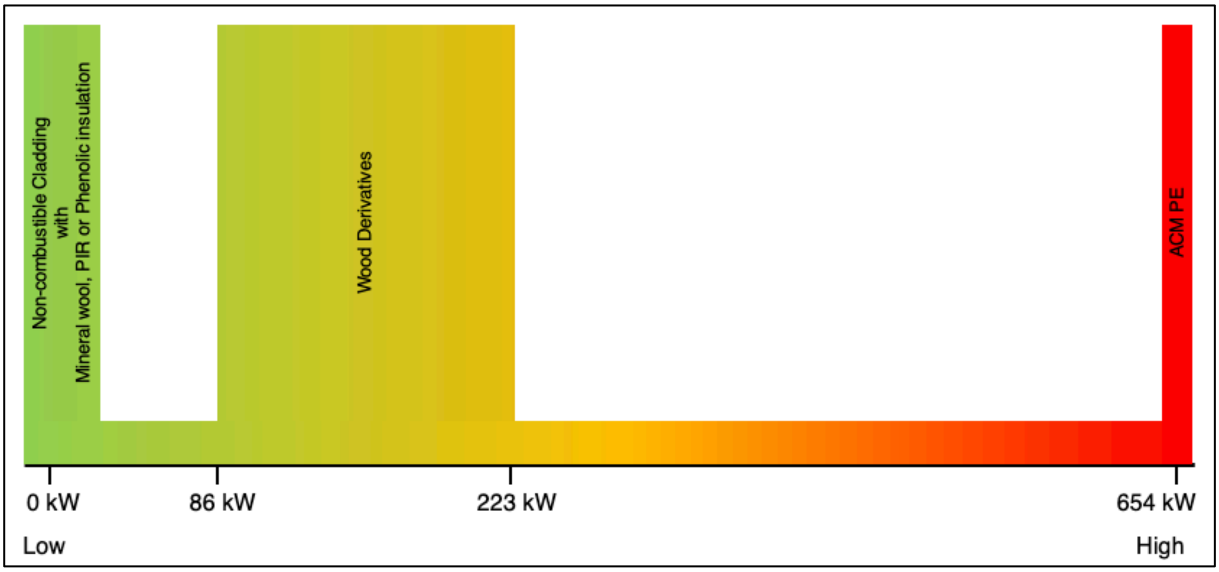
Figure 2: Ranking



3.2.2 The CladFire Systems

The CladFire data could be used to Rank the associated systems between the PAS 9980 low and high examples. Figure 3 gives an example of what this would look like for the Peak HHR metric.

Figure 3: Peak HHR Ranking by group



Users of the CladFire data might choose to Rank by other metrics if they consider them more appropriate.

Similarly, because the CladFire test specimen and configuration are relatively small and simple, the test is highly repeatable. As such, it would be possible to conduct additional tests for different products and Rank them against the full body of CladFire data.

3.3 Fire Behaviour Classification

3.3.1 Concept

Ranking is useful insofar as it allows appraisers to contextualise the hazard, but it does not really help with determining what might be acceptable and what might be unacceptable.

A concept that might be more useful in this regard might be to think in terms of the potential behaviour of the external fire (herein “Classification”). In this regard, Figure 2 of BR 135 already identifies two different behavioural regimes:

- Restricted Fire Spread: Cladding system does not contribute to flame spread. Risk of secondary fires is limited. The dominant mechanism for fire spread is via windows. Continued vertical fire spread is via a repeating process of a secondary fire being allowed to develop and then spread again via windows.

- Rapid Fire Spread: Cladding system contributes to flame spread resulting in risk of multiple simultaneous secondary fires (potentially across all floors). The dominant mechanism for fire spread is the external wall system.

In reality, there are at least two additional characteristic behaviours within these two extremes:

- A variant of Restricted Fire Spread where the external wall construction has some contribution to external fire spread (i.e. the extent external flaming might be slightly greater due to combustible materials but not significantly greater) but does not fundamentally change the overall behaviour (i.e. the dominant mechanism is a repeating process of secondary fire development on the floor above the initial fire, and subsequent fire spread via windows).

- A less rapid that Rapid Fire Spread where fire could spread via the external wall construction, but the rate is not rapid and would not lead secondary fires burning simultaneously on all floors.

To this end, there are potentially four fire behaviour classifications of external fire behaviour. These are summarised below and shown indicatively in Figure 4.

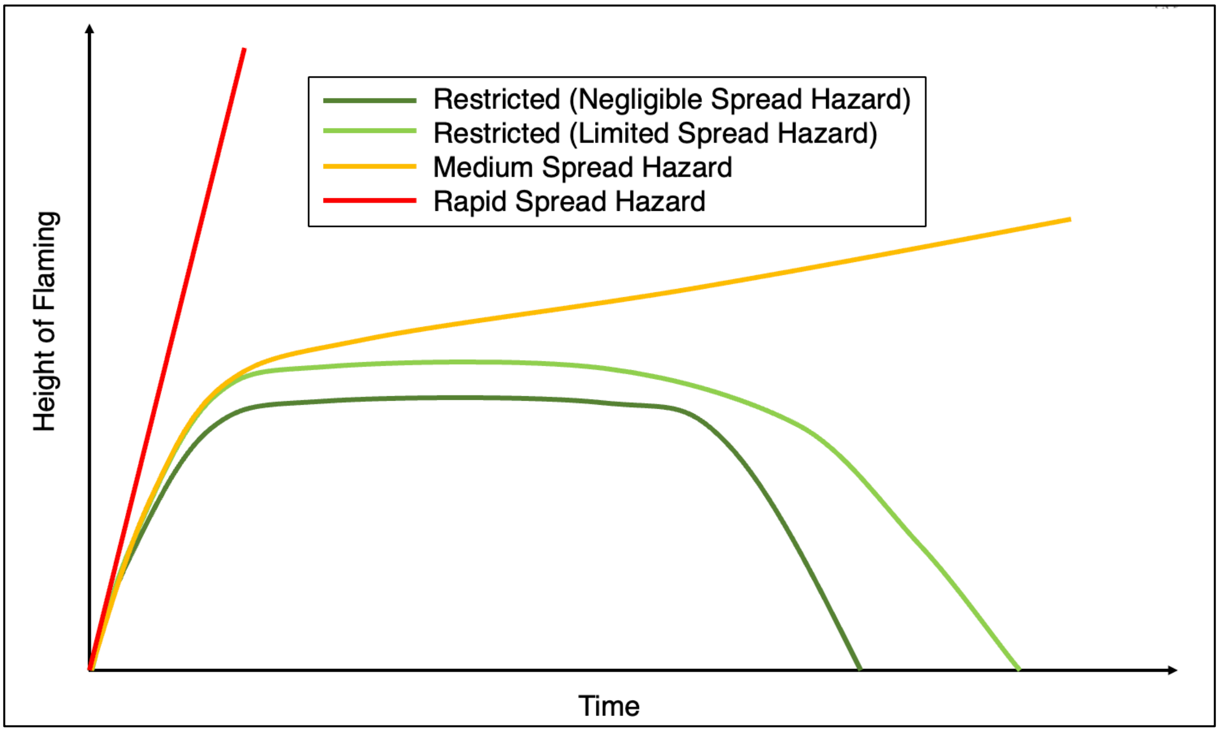
- Restricted (Negligible Spread Hazard): Fire spread via the outside of the building where the dominant mechanism for fire spread is via windows and the external wall construction has negligible contribution to external flaming or the rate of fire spread. (e.g. because the components are not combustible or because combustible components are protected in a way that prevents them from contributing to external flaming). Such fires might extend vertically up the elevation, but once the originating fire(s) (e.g. a fire within a flat) decays or is extinguished, the external flaming ceases and there is no additional spread via the wall construction.

- Restricted (Limited Spread Hazard): A fire with similar characteristics to Restricted (Negligible Spread Hazard), but where there are combustible components that make the extent of flaming slightly greater. Importantly, the contribution would be limited to the extent of external flaming and not the rate of fire spread, and once the originating fire(s) decays or is extinguished, the external flaming ceases and there is no additional spread via the wall construction (there might be some local smouldering or similar).

- Medium Spread Rate: A fire where there is additional fire spread via combustible components in the external wall and the rate of such fire spread is not rapid. Once the originating fire decays or is extinguished, there could be continued fire spread via the wall construction.

- Rapid Spread Rate: A fire where the external wall construction is a medium for rapid and extensive spread and could lead to multiple simultaneous secondary fires.

Figure 4: Indicative representation of fire behaviours (in the absence of any intervention)



3.3.2 The CladFire Systems

As discussed in Section 2.3, the CladFire data in conjunction with observations made during all the associated tests, leads us to consider that that the systems could be grouped into three categories:

- ACM PE: The systems comprising ACM PE cladding and the three different insulations.
- Wood Derivatives: The systems ceder, HPL, ply and OSB claddings with the three different insulations.
- Non-combustible Cladding: The brick, aluminium and ACM A2 claddings with the three different insulations.

The data and test observations lead us to consider that the same groupings are relevant in terms of Classification in that:

- The non-combustible cladding systems showed negligible fire spread. Therefore, in the absence of any exacerbating features or details, they would likely constitute Restricted (Negligible Spread Hazard) or Restricted (Limited Spread Hazard) fires on a real building.
- The ACM PE systems exhibited the most rapid fire spread (by a significant degree). Therefore, in the absence of any mitigating features or details, would likely constitute Rapid Spread Rate fires on a real building.
- The wood derivative systems did result in fire spread, but at a significantly reduced compared to the ACM PE systems. Therefore, in the absence of any exacerbating or mitigating features or details, they would likely constitute Medium Spread Rate fires on a real building.

3.3.3 Comparison against BS 8414 Data

Data Set

In 2017 / 2018, the Department of Communities and Local Government ("DGLG") sponsored six BS 8414 tests of ACM rainscreen systems. Data from four of these tests (as summarised in Table 1) along with data[26] from a test conducted on an aluminium rainscreen system with phenolic foam insulation (the "Al Test") can be used to infer useful information about fire behaviours.

Table 1: Summary of DGLG Tests 3 to 6

Test	Insulation	Cladding
Test 3[27]	PIR	Category 2[28] ACM
Test 4[29]	Mineral Wool	Category 2 ACM
Test 5[30]	PIR	Category 1[31] ACM
Test 6[32]	Mineral Wool	Category 1 ACM

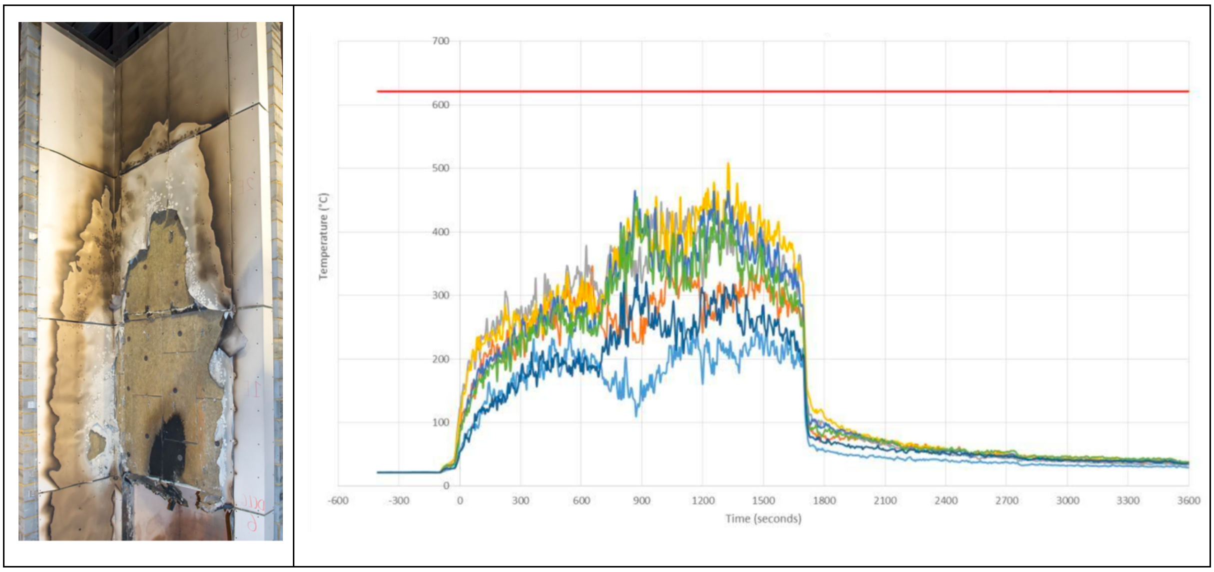
Restricted (Negligible Spread Hazard) Fires

Test 6 comprised ACM cladding that achieved Class A2-s1, d0 and mineral wool insulation. As such, this system did not include any combustible components that would result in any discernible increase in flame extent. Consequently, under the Classification concept, the associated fire behaviour would be Restricted (Negligible Spread Hazard).

The photograph in Figure 5 was taken after the test. BS 8414 Level 2 is 5m above the test chamber which is approximate at the interface between the top ACM panel and the one beneath. It can be seen from the photograph that the fire reached Level 2 (or close to Level 2).

[26] Al Futtaim Exova, 'Fire Performance Testing of an External Cladding System – Test Report – 100mm Kingspan Kooltherm K15 with Dri-Design Aluminium Cassette', DLR1547 Revision 0, September 2018
[27] Building Research Establishment, 'BS 8414-1:2015 + A1:2017 test referred to as DCLG test 3', 8 August 2017 (Issue 1.1), Department of Communities and Local Government.
[28] An aluminium composite cladding panel that achieves Class B-s3, d2
[29] Building Research Establishment, 'BS 8414-1:2015 + A1:2017 test referred to as DCLG test 4', 11 August 2017 (Issue 1.0), Department of Communities and Local Government.
[30] Building Research Establishment, 'BS 8414-1:2015 + A1:2017 test referred to as DCLG test 5', 10 August 2017 (Issue 1.1), Department of Communities and Local Government.
[31] An aluminium composite cladding panel that achieves Class A2-s1, d0
[32] Building Research Establishment, 'BS 8414-1:2015 + A1:2017 test referred to as DCLG test 6', 25 August 2017 (Issue 1.0), Department of Communities and Local Government.

Figure 5: Post test photograph and Level 2 external temperature data for Test 6



It can also be seen from the Level 2 temperature data and the fire damage in the photograph that:

- The fire grew rapidly in the first 300 seconds (5 minutes) and then steadily up to a peak at around 1350 seconds (22.5 minutes).
- The fire started to decay at approximately 1350 seconds (22.5 minutes) – i.e. before the crib was extinguished at approximately 1700 seconds (28 minutes and 20 seconds).
- The height of external flaming peaked at somewhere between about 20 and 25 minutes and started to decay at the same time.
- Based on the damage to the cladding, the height of external flaming peaked at about 5m above the opening.

The above is compatible with the proposed characteristics of a Restricted (Negligible Spread Hazard) fire.

Restricted (Limited Spread Hazard) Fires

Figure 6 shows post-test photographs for Tests 3, 4, 5 and 6 and Figure 7 shows the external temperatures measured at Level 2 as defined by BS 8414 ("Level 2"). Figure 8 shows the corresponding photograph and temperature data for the AI Test.

As described above, under the Classification, concept Test 6 would be classified as a Restricted (Limited Spread Hazard). From examination of the photographs, Level 2 temperature data and test observations, it can be concluded that Tests 4 and 5 do exhibit the behavioural characteristics of a Restricted (Limited Spread Hazard) fire because:

- They both included combustible components (combustible ACM in the case of Test 4 and PIR in the case of Test 5) that result in an increase in the extent of flaming (from that of Test 6) (i.e. they are not Restricted (Negligible Spread Hazard) fires.
- There are no signs continued fire spread beyond the zone of flaming (i.e. they are not Medium Spread Rate fires).

Figure 6: Photographs from BS 8414 test reports

A: Test 6 (Cat 1 & MW) Restricted (Negligible Spread Hazard)	B: Test 5 (Cat 1 & PIR) Restricted (Limited Spread Hazard)	C: Test 4 (Cat 2 & MW) Restricted (Limited Spread Hazard)	D: Test 3 (Cat 2 & PIR) Medium Spread Rate?
			

Figure 7: External temperatures at Level 2

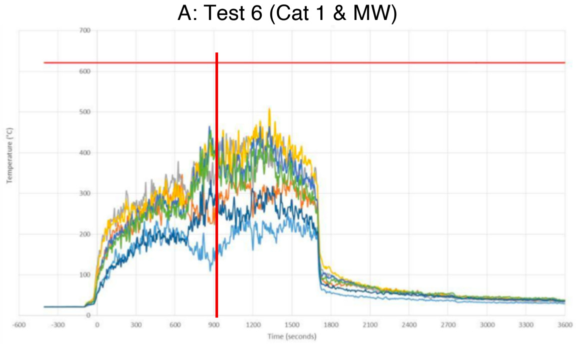
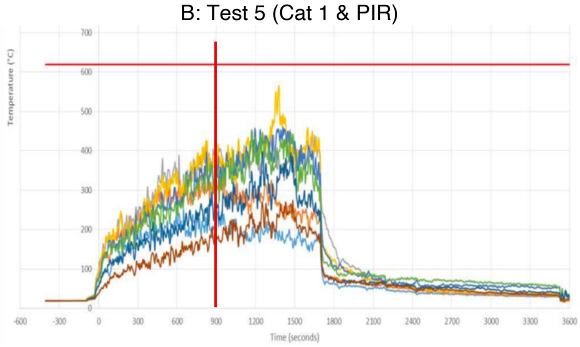
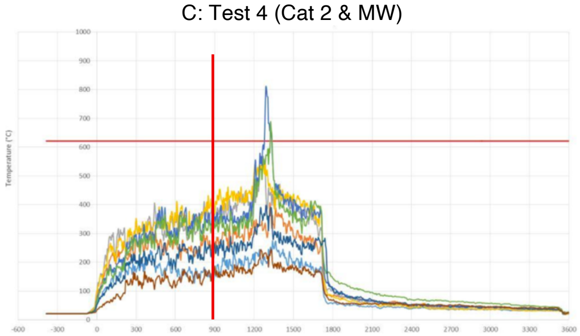
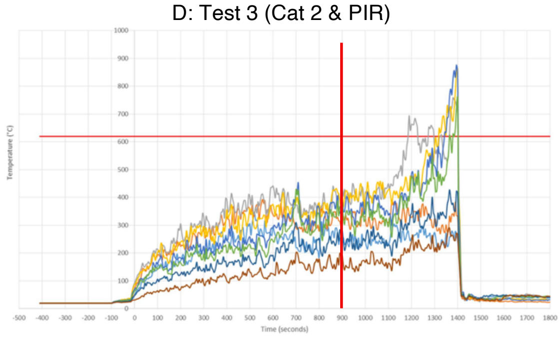
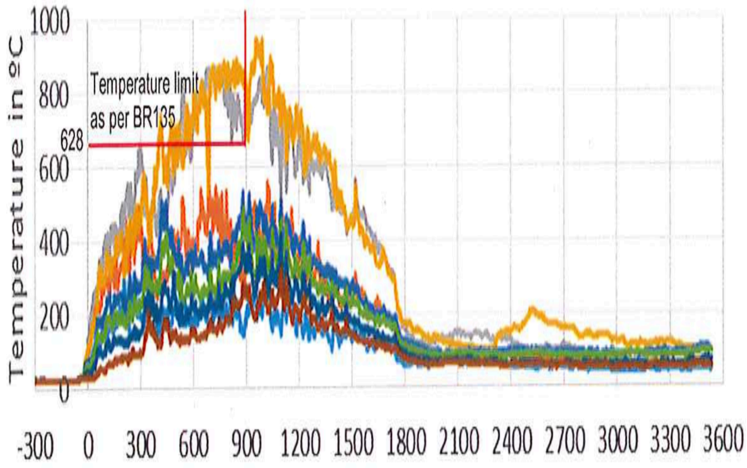
A: Test 6 (Cat 1 & MW)	B: Test 5 (Cat 1 & PIR)
	
C: Test 4 (Cat 2 & MW)	D: Test 3 (Cat 2 & PIR)
	

Figure 8: Photograph and external Level 2 temperatures for the Al Test

E: (Aluminium & Phenolic) Medium Spread Rate	E: (Aluminium & Phenolic)
	

It is also possible that Test 3 and the Al Test are Restricted (Limited Spread Hazard) fires, but it is not possible to confirm because:

- Test 3: Whilst the tests was terminated at 1400 seconds (23 minutes and 20 seconds) due to flaming above the top of the rig (i.e. this could be an indicator of Medium Spread Rate), it is possible that the flaming would have stopped shortly after termination even if the fire was not extinguished (i.e. an indicator that Spread Hazard might have been limited).
- The Al Test: Whilst the Al Test did not meet the BR 135 temperature criteria (i.e. this could be an indicator of Medium Spread Rate), the test observations do not document any flaming above the rig, and the post-test photograph show that the cladding topmost panels were largely undamaged (i.e. an indicator that Spread Hazard might have been limited).

Medium Spread Rate and Rapid Spread Rate Fires

As discussed above, the BS 8414 test data and observations are not sufficient on their own to determine whether Test 3 or the Al Test are Restricted (Limited Spread Hazard) fires or whether they are Medium Spread Rate fires or even Rapid Spread Rate fires.

Ultimately, this is because the height of the BS 8414 test rig is not high enough to determine:

- Whether any flaming at the top of the rig was an indication that fire spread would continue to occur if the specimen was taller.
- The rate of any fire spread.

4 Preliminary Thoughts and Findings

4.1 The CladFire Data

The CladFire data includes multiple metrics that can be used to contextualise Spread Hazard for use in a risk-based assessment of risk of fire spread via external walls, but none of these metrics can or should be used to in isolation to define the acceptability of the Spread Hazard or quantify the associated risk.

The CladFire data and test observations lead us to consider that Peak HHR is one of the key metrics of Spread Hazard.

The CladFire data and test observations lead us to consider that:

- ACM PE has a 'high' Spread Hazard regardless of the type of insulation.
- The systems comprising non-combustible cladding have a 'low' Spread Hazard regardless of the type of insulation.
- The systems with wood derivative cladding have a 'low' to 'medium' Spread Hazard (relative to non-combustible cladding and ACM PE cladding) regardless of the type of insulation but that the Fire Spread Hazard is slightly greater where the insulation is combustible.

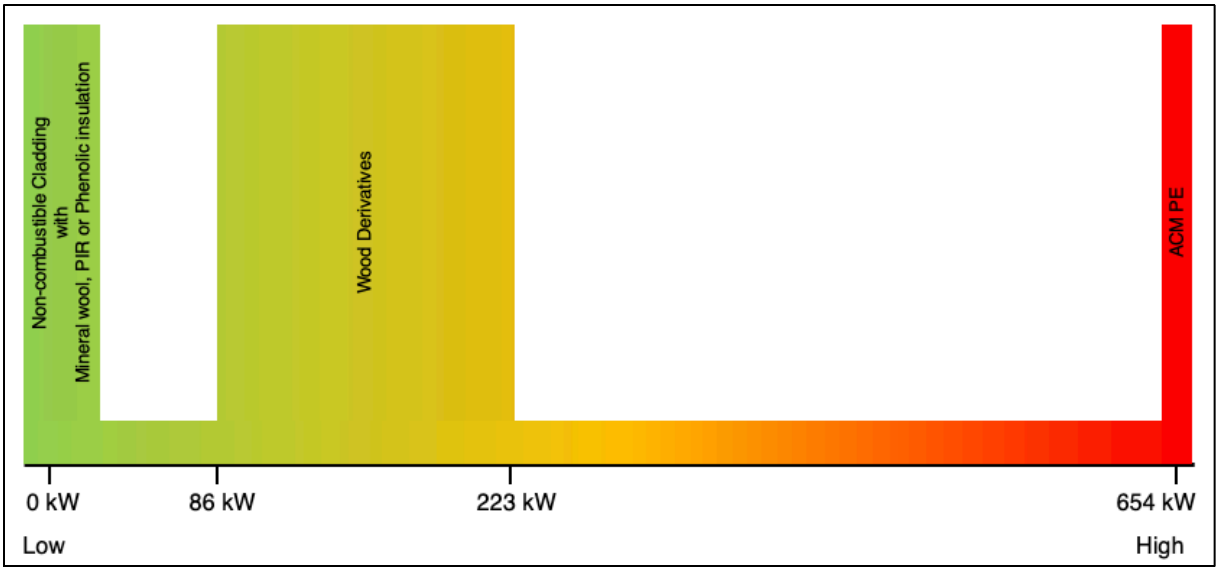
4.2 Using the CladFire Data

4.3 Ranking

PAS 9980 requires that Ranking be done between low hazard (PAS 9980 gives brick cavity wall as an example) and high hazard (PAS 9980 gives aluminium composite panels with a polyethene core ("ACM PE") as an example).

The CladFire data could be used to Rank systems between the PAS 9980 low and high examples as illustrated below (for Peak HRR – users may wish to Rank against other metrics).

Figure 9: Peak HHR Ranking by group



Similarly, because the CladFire test specimen and configuration are relatively small and simple, the test is highly repeatable. As such, it would be possible to conduct additional tests for different products and Rank them against the full body of CladFire data.

4.4 Classification

As an alternative to Ranking, users might wish to use the CladFire data to help classify the characteristic behaviour of fire spread via the external wall construction in question.

We have identified four potential behavioural classifications:

- Restricted (Negligible Spread Hazard): Fire spread via the outside of the building where the dominant mechanism for fire spread is via windows and the external wall construction has negligible contribution to external flaming or the rate of fire spread. (e.g. because the components are not combustible or because combustible components are protected in a way that prevents them from contributing to external flaming). Such fires might extend vertically up the elevation, but once the originating fire(s) (e.g. a fire within a flat) decays or is extinguished, the external flaming ceases and there is no additional spread via the wall construction.
- Restricted (Limited Spread Hazard): A fire with similar characteristics to Restricted (Negligible Spread Hazard), but where there are combustible components that make the extent of flaming slightly greater. Importantly, the contribution would be limited to the extent of external flaming and not the rate of fire spread, and once the originating fire(s) decays or is extinguished, the external flaming ceases and there is no additional spread via the wall construction (there might be some local smouldering or similar).
- Medium Spread Rate: A fire where there is additional fire spread via combustible components in the external wall and the rate of such fire spread is not rapid. Once the originating fire decays or is extinguished, there could be continued fire spread via the wall construction.
- Rapid Spread Rate: A fire where the external wall construction is a medium for rapid and extensive spread and could lead to multiple simultaneous secondary fires.

4.5 Smouldering

The CladFire data and observations provide evidence that, as opposed to PIR insulation, phenolic foam insulation can exhibit smouldering combustion and continue to burn.

However, we do not consider a risk assessment in in respect of health and safety of occupants would acknowledge the differences between a smouldering hazard and other hazards.

4.6 Further Work

Whilst the CladFire Project has resulted in data that we think could be useful in contextualising Spread Hazard, we recognise that there are limitations; both in terms of the limitations of the test configuration and in terms of the acceptability or otherwise of Spread Hazards.

We anticipate that the following further work could help.

Test Configuration

Conducting a series of larger scale tests (e.g. the FM Global parallel plate test) against which the CladFire data could be compared and cross validated.

Adapting the test configuration such that the impact of different system details (e.g. cladding rails, membranes, cavity barriers, etc.) can be assessed.

Acceptance Criteria

Development of quantified acceptance criteria against which Spread Hazard can be measured.