

PAS 9980:2022, *Fire risk appraisal of external wall construction and cladding of existing blocks of flats – Code of practice*

THIS PAGE DOES NOT FORM PART OF PAS 9980

What is PAS 9980?

PAS 9980 provides guidance on the risk of fire spread via external wall construction. It sets out a methodology to conduct and record fire risk appraisals of external walls, which can be scaled up or down depending upon the complexity of individual buildings; not all buildings will require an appraisal, and of those that do, not all will require intrusive inspection. It also gives recommendations for the competence of professionals completing such appraisals, with the aim of assisting with the ongoing effort to increase the number of competent professionals by providing the current state of the art knowledge on fire risk arising from various aspects of external wall construction.

PAS 9980 does not alter the obligations placed upon those carrying out building work on external wall construction, nor does it affect the compliance of past building work, whether measured against Building Regulations or contractual obligations. Given the complexity and range of different external wall systems that exist, it does not contain “off the peg” solutions for specific wall types and materials, but may enable a consistent approach to evaluating the risk when considering the external walls of actual buildings. Where homeowners and building owners are faced with external wall construction which does not meet the expected standards, PAS 9980 provides a voluntary methodology for assessing the level of safety. It also identifies the proportionate steps that could be taken to better safeguard residents while seeking not to expose them to undue financial burdens.

What do I need to know about PAS 9980?

- Having an external wall system that undergoes an assessment using this methodology does not mean that the building is unsafe.
- PAS 9980 is intended for use by competent professionals. It is not intended to be used by lay people.
- It is for use in situations where external wall constructions of existing blocks of flats have not been shown to resist fire spread adequately or where required to inform the fire risk assessment. Where it is obvious to the fire risk assessor that the walls don't pose a risk of fire spread (such as buildings of traditional brick and masonry construction), there may be no need for a PAS 9980 assessment.
- The PAS uses a five-step risk assessment process. It provides a methodology to assist in the identification of risk factors influencing the overall risk rating of a building, as well as mitigation steps that might improve the risk rating.
- The fire risk posed by external wall construction and cladding is considered to be influenced most by factors falling under the following three broad headings:
 - fire performance;
 - façade configuration; and
 - fire strategy/fire hazards.
- The height of the building is included as a risk factor. The extent to which a building's external walls pose a risk is inherently lower if the number of storeys is limited.
- PAS 9980 emphasizes the importance of proportionality in relation to risk and associated mitigation measures, including considerations of benefit gained, practicality and cost.

Do I need to read PAS 9980?

PAS 9980 has been specifically developed for competent fire engineers and other competent building professionals undertaking a fire risk appraisal of external walls (FRAEW).

PAS 9980:2022

Fire risk appraisal of external wall construction and cladding of existing blocks of flats – Code of practice



Department for Levelling Up,
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Foreword

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- Design Fire Consultants
- Probyn Miers (HKA Global Ltd)
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- Building Research Establishment
- Construction Products Association
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- Institution of Fire Engineers
- Local Authority Building Control
- London Fire Brigade
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- National Fire Chiefs Council
- National Social Housing Fire Safety Group
- Royal Institution of Chartered Surveyors
- Scottish Government
- Society of Façade Engineering

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Relationship with other publications

This PAS supplements the recommendations given in PAS 79-2, although the two documents can be used independently and a knowledge of PAS 79-2 is not a prerequisite for using PAS 9980.

This PAS is not intended to constitute a textbook on construction of external walls and cladding systems, and it is not to be regarded as a substitute for relevant knowledge of fire safety principles in the design of such construction. In carrying out a fire risk appraisal of external wall construction and cladding, there is likely to be a need for reference to other codes of practice and guidance documents, a number of which are listed in the Bibliography.

Information about this document

This PAS is particularly intended for use by competent fire engineers and other competent building professionals tasked with advising on the fire risk of external wall construction of existing blocks of flats. However, it is expected that the key outputs of this appraisal will also be useful to those for whom such appraisals are carried out and those who make decisions based upon the outcome of the appraisal. Typically, this will include:

- advice agencies;
- architects;
- architectural technologists;
- building owners/landlords (and others with legal or functional responsibilities for management of external walls and cladding);
- building surveyors;
- contractors;
- façade engineers;

- fire and rescue authorities;
- fire risk assessors;
- insurers;
- local housing authorities;
- managing agents or facility managers;
- project managers; and
- valuers and mortgage lenders.

This PAS makes extensive reference to Government guidance on the fire safety requirements of various versions of the Building Regulations ([1], [2], [3], [4], [5], [6], [7]) in England and Wales, namely Approved Document B (ADB). In the current version of ADB ([8], [9]), which is split into two volumes, blocks of flats fall within the scope of Volume 1 [8]. However, given that this PAS relates to existing blocks of flats, where there is reference to ADB, it often relates to the guidance in previous versions of ADB. From 2006, ADB was divided into two volumes ([10], [11]); prior to the 2019 edition, blocks of flats fell within the scope of Volume 2 [11], while from 2019, they were transferred to Volume 1 [8]. Prior to 2006, there was only a single volume of ADB ([12], [13], [14]), which therefore addressed blocks of flats within its scope.

Reference to classification to BR 135 [15] based on data from a BS 8414 test as a benchmark in ADB ([8], [9]) in relation to external fire spread (for combustible external wall construction and cladding) appeared in many earlier versions of ADB as a means of satisfying the functional Requirement B4(1) of the Building Regulations 2010 [7]. It is no longer accepted for “relevant buildings” in the current version of ADB ([8], [9]) due to changes to Regulation 7 of the Building Regulations 2010 [7]. Nevertheless, classification to BR 135 [15] remains an applicable benchmark for blocks of flats with a storey over 18 m built prior to 2019.

Technical guidance in the devolved administrations can be found on the relevant Government websites.

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- Figure A.9, Figure A.10 and Figure B.7: BRE Global, Bucknalls Lane, Watford, Herts, WD25 9XX;
- Figure B.3: Scottish Fire and Rescue Service, Westburn Drive, Cambuslang, G72 7NA;

- Figure B.4: London Borough of Hammersmith and Fulham, Town Hall, King Street, Hammersmith, London, W6 9JU;
- Figure B.5: London Fire Brigade, 169 Union Street, London, SE1 0LL;
- Figure B.6: Greater Manchester Fire and Rescue Service, 146 Bolton Road, Swinton, Manchester, M27 8US.

While future revisions of this PAS might include a broader range of residential buildings, the scope of this first version is limited, as described in Clause 1, primarily to multistorey blocks of flats. Nevertheless, the principles of the methodology set out in this PAS can be applied to a broader range of building types, including non-residential buildings, subject to appropriate use of the guidance and cognizance of the differences between such other buildings and multistorey, multi-occupied residential buildings.

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WARNING. This PAS refers to procedures, such as working at heights, that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Use of this document

As a code of practice, this PAS takes the form of recommendations and guidance. It is not to be quoted as if it were a specification. Users are expected to ensure that claims of compliance are not misleading.

Users may substitute any of the recommendations in this PAS with practices of equivalent or better outcome. Any user claiming compliance with this PAS is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this PAS that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

This PAS includes case studies based on commonly found types of external wall construction and its configuration on existing multistorey, multi-occupied residential buildings. However, these are only intended as worked examples for the purpose of illustrating the process followed in an assessment conducted in accordance with this PAS. They are not intended to be relied upon as “off the peg” generic solutions in the particular forms of external wall construction to which they refer.

Presentational conventions

The provisions of this PAS are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

The word “should” is used to express recommendations of this PAS. The word “may” is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word “can” is used to express possibility, e.g. a consequence of an action or an event.

Notes and commentaries are provided throughout the text of this PAS. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

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Compliance with a PAS cannot confer immunity from legal obligations.

Particular attention is drawn to the legislation described in the Introduction to this PAS and to guidance available from the Home Office, the Department for Levelling Up, Housing and Communities, and the devolved administrations.

0 Introduction

0.1 Background

The loss of 72 lives in the tragic fire at Grenfell Tower on 14 June 2017 brought the risk of fire spread over external walls into sharp focus. It was not the first time that combustible cladding had been a significant contributory factor in rapid fire spread over the external façades of a high-rise building; indeed, since June 2017, there have been a number of notable fires where this has occurred, both in the UK and overseas. However, the Grenfell Tower fire is exceptional in relation to the combination of rapid fire spread and loss of life. It is now known how this fire (which was unprecedented in the UK) occurred and gave rise to such a tragic outcome; much is being done to make sure that such an event never happens again.

While the combustible cladding panels on the outside of Grenfell Tower were a significant factor in the fire, they were not the only reason for the rapid spread of fire. From the Public Inquiry into the fire [Grenfell Tower Inquiry (www.grenfelltowerinquiry.org.uk)], it has become evident that other elements of the design and construction of the external walls were also contributory, most notably, the presence of combustible insulation, other combustible elements around window openings, and the absence of suitably located and properly installed cavity barriers. It is also relevant that some flat entrance doors were not self-closing.

The initial focus after the Grenfell Tower fire was on the type of cladding panel used, an aluminium composite material (ACM) with an unmodified polyethylene core. Considerable efforts were made to establish where it was present on other buildings and to arrange for its removal and replacement. However, the focus has broadened since then to encompass other combustible cladding materials. Other high-profile fires since the Grenfell Tower fire have prompted this, for example, a fire in student accommodation in Bolton on 15 November 2019, which involved a high pressure laminate (HPL) cladding system, and fires in Manchester (2017) and Barking (2019), which highlighted issues around the use of timber in cladding and on balconies. In addition, there has been a growing realization as to the extent of poor practice in the design and construction of external walls.

In England, the Ministry of Housing, Communities and Local Government (MHCLG) responded to the growing concern regarding external wall construction and fittings on tall residential buildings by issuing a series of Advice Notes, containing guidance on relevant fire safety considerations for those with responsibility for fire safety in these buildings.

Advice Note 11 [16] was aimed at conveying the findings and recommendations of the Government's programme of large-scale fire tests (in accordance with BS 8414) of ACM cladding panels, combined with different forms of insulation. This was the first MHCLG "Consolidated Advice Note", drawing together the information and recommendations set out in earlier Advice Notes.

This was followed by Advice Notes addressing:

- external wall insulation systems with a render or brick slip finish;
- external wall systems with cladding panels other than ACM;
- balconies;
- partial ACM cladding;
- spandrel panels; and
- HPL.

MHCLG (now DLUHC) revised and reissued the Consolidated Advice Note in January 2020 [17]. This version contained the content from all previous Advice Notes, updated and expanded in scope to also address buildings below 18 m in height. A supplementary note relating to this Consolidated Advice Note was issued in November 2020 [18]. Further information on the status of the advice notes can be found on the Government website at <https://www.gov.uk/government/publications/building-safety-advice-for-building-owners-including-fire-doors>.

Common to all of these Advice Notes was the recommendation that building owners seek professional advice on what further steps to take with respect to their external wall system. In particular, this applied when the external wall construction did not conform to the benchmark of classification to BR 135 [15] underpinning the advice. Benchmarks based on classification to BR 135 and others, based on compliance with guidance in Approved Document B (ADB) ([8], [9]) for new buildings, have created problems for owners of existing buildings, as external walls on these buildings cannot necessarily be expected to conform to such benchmarks. Nor can conformity be expected where the guidance has changed. However, there would have been an expectation at the time of build that construction of the external wall system would meet the relevant requirements current at that time.

In the past, the external wall construction of blocks of flats was not routinely included in the fire risk assessments (FRAs) required under the Regulatory Reform (Fire Safety) Order 2005 (the “Fire Safety Order”) [19]. The Fire Safety Act 2021 [20] has now established that external walls fall within the scope of the Fire Safety Order [19]. It follows, therefore, that any FRA of a multistorey, multi-occupied residential building needs to include consideration of the potential for fire spread via the external walls of the building.

However, despite the availability of wide-ranging Government guidance, the assessment of the fire risk associated with external walls has proved problematic. There has been a dearth of publicly available information on the fire performance of materials and systems used on the outside of buildings and there have been very few professionals with the necessary skills and experience. This has led to inconsistent outcomes. In some buildings, significant work to remediate “unsafe” cladding and other aspects of external wall construction has been undertaken to satisfy Government advice. In others, with similar cladding, some fire specialists have considered that no such work is necessary.

The above history is relevant to England. Different legislation and guidance applies in the devolved administrations of the United Kingdom. In Scotland and Northern Ireland, blocks of flats fall outside the legislation that is equivalent to the Fire Safety Order (other than in relation to maintenance of systems and equipment for use by, or the safety of, firefighters).

0.2 Fire risk assessments

It is against the background detailed in 0.1 that the need for specific guidance relating to fire risk appraisal of external wall construction on existing buildings (the “FRAEW”) has arisen.

It is recognized that the FRAEW to which this PAS refers is not necessarily within the competence of the typical fire risk assessor who carries out a typical FRA for a block of flats (e.g. an FRA carried out in accordance with PAS 79-2).

Equally, it is not implied that an FRAEW will be required for all high-rise (or low-rise) blocks of flats. In many cases, it will be manifestly obvious to a competent fire risk assessor that the risk to life from fire spread over external walls is not such as to warrant an FRAEW by a specialist; in these cases, the fire risk assessor will normally address compliance of external wall construction with the Fire Safety Order [19] as part of the FRA.

Examples of this are buildings in which the external wall construction can readily be confirmed as being of traditional masonry construction (i.e. external walls which comprise either two leaves of masonry or a solid masonry leaf), or cases in which it can, otherwise, readily be determined by a typical fire risk assessor (e.g. from the age of the building if it predates the mid-1960s, from an operation and maintenance manual, or an existing report by a competent person, based on a relevant BS 8414 test) that no FRAEW is necessary. However, although the age of a building can be a factor, care is needed in case combustible materials have been added to the external walls over time.

It is, therefore, expected that fire risk assessors will be judicious in their recommendations for an FRAEW by a specialist within the action plan of an FRA. Unnecessary recommendations by fire risk assessors for FRAEWs would make significant demand on the scarce resources available for FRAEWs, thereby diverting attention from buildings in which the public might be at serious risk and that actually do warrant an FRAEW.

For avoidance of doubt, it is not suggested that the fire risk assessor will ignore unusual, but visually obvious, material deficiencies, or design features that place residents or other occupants at undue risk. On the other hand, in determining that the risk to life from fire spread over external walls is not such as to warrant an FRAEW by a specialist, the fire risk assessor is not deemed to be confirming conformity of external wall construction to building regulations (past or present) or the Fire Safety Order [19].

In these circumstances, therefore, deficiencies in construction might well continue to be unrevealed. In the low-risk circumstances described above, experience has shown, over many years and in numerous traditionally constructed buildings, that the risk of loss of life from deficiencies in external wall construction is low. Consultations with the National Fire Chiefs Council (NFCC) at the time of drafting this PAS have confirmed that this is still the case. It is, therefore, not unreasonable in these cases for the fire risk assessor to assume conformity to the building regulations and applicable guidance that were current at the time of construction, unless there is evidence to the contrary.

0.3 Risk-based approach

Where an FRAEW is considered necessary, this PAS is intended to provide recommendations and guidance tailored to the particular risk posed by fire spread over external walls, and to provide tools for a competent person to carry out the FRAEW.

While this PAS includes criteria for determining the level of fire risk to life safety presented by particular types of external wall construction, the methodology outlined is intended only to assist in making comparisons and in assessing the relative risk of different types of materials, components, systems and configurations of external wall construction. Determination of absolute levels of safety is simply not possible at the time of publication of this PAS.

Building design varies considerably and no code of practice such as this PAS can ever provide guidance for all possible circumstances. Accordingly, although this PAS refers to specific materials, systems and configurations used in external wall construction, it cannot address all possible circumstances, and the general principles set out herein need to be applied carefully when considering other types of external wall construction that are not specifically addressed in this PAS.

While it is anticipated that this PAS will be of interest to a broad readership, its use in the fire risk appraisal of external wall construction and cladding requires particular skills, knowledge and experience, such that this is a matter for specialists. While, as noted above, it is not expected that the necessary skills will be possessed by typical fire risk assessors, equally, they will not be possessed by all fire engineers. Users of this PAS who carry out external wall FRAEWs are advised to consider whether they have the necessary competence before applying the recommendations of this PAS to a particular building.

However, the objective of this PAS is broader than simply providing recommendations and a recognized methodology for those who carry out the FRAEW. It is also intended to assist those receiving an FRAEW, and their other advisers, to understand the meaning of the risk rating determined by the methodology contained in this PAS, how the risk rating was derived, where it fits in the context of the building's FRA and the limitations that apply to it.

Although the methodology in this PAS seeks to apply a degree of quantitative, as well as qualitative, judgement, given the state of readily available knowledge and performance data, it follows that any FRAEW will inevitably be, to a large degree, subjective, requiring professional judgement from competent persons. Definitive fire performance of an actual external wall build-up can only be determined by large-scale test. This can lead, and has led, to some difficulties for organizations, their advisers and enforcing authorities, in accepting the outcomes of risk-based approaches.

There has been a distinct move in recent years towards "risk-proportionate" fire safety measures in buildings, rather than the more traditional "prescriptive" approach. However, concern arising from the Grenfell Tower fire has led some stakeholders to seek a more rigid application of the guidance that supports building regulations, without full consideration of risk. Indeed, this has sometimes led to the practice of judging existing buildings against strict compliance with the guidance in the current version of ADB ([8], [9]) and, indeed, the requirements in Regulation 7 of the Building Regulations 2010 (as amended) [7], which is clearly inappropriate as these are concerned with new buildings/building work.

For some stakeholders, there is no appetite to consider a risk-based approach and, for these stakeholders, the only satisfactory outcome is certainty in the performance of external walls in fire, with zero risk to life as the principal objective. The methodology in this PAS cannot be applied when such a view prevails. It is, therefore, assumed that this PAS will only be used in circumstances where a risk-based approach, implemented by competent professionals, is deemed acceptable to relevant interested parties, including those in devolved administrations.

0.4 Objectives of this PAS

The objectives of this PAS are:

- a) to provide competent fire engineers and other competent building professionals with a methodology for appraising and assessing the scope for, and risk from, fire spread via external wall construction and cladding, such that the outcome can be used to inform a building's FRA;
- b) to assist external wall assessors in communicating clearly the results of an FRAEW, such that recipients can understand the process and methodology applied, and to understand the findings;
- c) to assist other professionals in reviewing an FRAEW and in understanding the risk of external fire spread in the context of the building's fire strategy and fire safety arrangements;
- d) to promote better understanding of fire risks associated with external walls and the limitations of what can, and cannot, be achieved in any FRAEW, in contrast with ensuring conformity of new construction to the standards for new buildings;
- e) to enable common relevant terminology to be adopted by those who carry out FRAEWs;
- f) to promote consistency in FRAEWs, and to provide a pragmatic and risk-proportionate approach in an FRAEW;
- g) to establish a satisfactory basis for documentation of FRAEWs;
- h) to enable consistent training in carrying out an FRAEW and thus facilitate more entrants into the profession of carrying out FRAEWs; and
- i) to satisfy professional indemnity (PI) insurers that there is a national standard that underpins consistency in carrying out FRAEWs.

This PAS takes into account the rationale originally set out in the 2020 version of the MHCLG Consolidated Advice Note [17]¹⁾. However, it expands on that advice by providing a tool for appraisal of the likely fire performance of external walls and assessment of the risk associated with external fire spread in the context of the use, occupancy and fire safety arrangements of the building.

The risk-based methodology outlined in this PAS is intended to provide a structured approach to the FRAEW. The outcome of the FRAEW is a determination of whether the external wall construction is acceptable or whether remedial action is necessary to replace some or all of the components of the external wall build-up, or to address shortcomings, such as the absence of cavity barriers.

¹⁾ In Scotland, guidance similar to that provided in the Consolidated Advice Note was published in August 2021 as the Scottish Advice Note [21], and this remains current.

0.5 Structure of this PAS

The PAS is structured so as to address the background to, and thinking behind, FRAEWs, as well as presenting guidance on a methodology to conduct such appraisals. It is consistent with the FRA methodology set out in PAS 79-2.

Each clause contains informative text in italics, giving commentary relating to the recommendations that then follow. Further informative text supporting the commentary and recommendations is contained in annexes. These provide further explanation on the subject or additional guidance.

The scope is set out in Clause 1 of the PAS, and this provides important information on those buildings to which the PAS applies and those it does not. References and terms, definitions and abbreviated terms are given in Clause 2 and Clause 3 respectively.

General issues for consideration before undertaking an FRAEW are set out in Clause 4.

In Clause 5, background information on the nature of fires involving external walls and the mechanisms of fire spread is discussed. This is followed in Clause 6 by discussion of the legislative context for FRAEWs. The principles and scope of FRAEWs are described in Clause 7, in which consideration is given to the benchmark for considering the risk posed by fires involving external walls.

The competence of those carrying out FRAEWs is discussed in Clause 8.

Clause 9 and Clause 10 relate to the information needed to conduct an FRAEW, including from surveys and inspections of the building. In Clause 11, the matter of how materials, systems and configurations of external walls perform in fire is considered, and in Clause 12, considerations relating to fully or partially clad buildings are discussed.

Clause 13 describes a methodology for basic assessments of the suitability of external walls. The circumstances in which a more in-depth assessment might be needed are set out in Clause 14.

Finally, in Clause 15 consideration is given to the content of FRAEW reports.

1 Scope

This PAS gives recommendations and guidance on undertaking a fire risk appraisal of external wall construction and cladding of an existing multistorey, multi-occupied residential building.

NOTE 1 For ease of reading, a fire risk appraisal of external wall construction and cladding is described in this PAS as a fire risk appraisal of external walls (FRAEW).

The purpose of a fire risk appraisal of external walls (FRAEW) is to assess the risk to occupants from a fire spreading over or within the external walls of the building, and to make a decision as to whether, in the specific circumstances of the building, remediation or other mitigating measures to address the risk are considered necessary. It is applicable where the risk is known, or suspected, to arise from the form of construction used for the external wall build-up, such as the presence of combustible materials. The outcome of an FRAEW is intended to inform fire risk assessments (FRAs) of multistorey, multi-occupied residential buildings.

NOTE 2 FRAEWs are particularly applicable to FRAs carried out in accordance with PAS 79-2, but they can be carried out independently of the PAS 79-2 FRA process.

NOTE 3 External walls of existing buildings that comprise only masonry or concrete construction, or in which combustible materials are limited to insulation within the cavity of double skin masonry walls, are usually considered to present an acceptable risk in terms of life safety, and an FRAEW is not considered necessary for these buildings.

NOTE 4 The reference to combustible materials does not include small quantities of combustible material that are likely to be present in most external wall build-ups, e.g. membranes, seals and gaskets, and that represent a negligible or inconsequential fire load.

This PAS also gives recommendations and guidance in relation to the competence of those completing FRAEWs.

This PAS relates to blocks of flats throughout the United Kingdom. It was developed primarily for those in England and, therefore, contains references to the legislation pertinent to buildings in England. However, it can also be applied in the devolved nations of the United Kingdom, subject to care being taken to apply its recommendations within the context of the appropriate regulatory regime and supporting guidance.

NOTE 5 The risk to occupants of new buildings from a fire spreading externally is controlled by building regulations. However, it cannot be assumed that external walls of newly constructed buildings present no risk, unless the external walls contain no, or negligible, combustible material. In England, buildings pre-dating the 2018 amendment to the Building Regulations 2010 [7] are deemed to be existing buildings within the scope of this PAS; in Wales, the equivalent change to the Building Regulations [22] in relation to the combustibility of external walls on relevant buildings was introduced in January 2020.

This PAS applies predominantly to multistorey blocks of flats, but also includes the following types of buildings if, from the perspective of general fire strategy and means of escape design, and specifically evacuation strategy, they are similar in nature to a purpose-built block of flats:

- a) student accommodation;
- b) sheltered and other specialized housing; and
- c) buildings converted into flats.

NOTE 6 Within this PAS, the term “flat” is used to describe a self-contained domestic dwelling within a building. Other terms, such as “apartment”, are commonly used to describe such accommodation. The term “flats” is intended to include those arranged on more than one storey, such as maisonettes or duplex apartments.

NOTE 7 This is also intended to include blocks of flats which are part of a mixed-use building with, for example, shops or offices below.

The approach set out in this PAS is intended to determine the need for any risk-proportionate actions in relation to external wall construction required to protect occupants of blocks of flats, including residents and their visitors, anyone working in the building and people in the immediate vicinity of the building.

This PAS addresses the risk from fire spread over the external walls of multistorey blocks of flats of any height.

It addresses situations in which there is a single wall type or a mixture of different wall types. It also addresses buildings that are partially clad, as well as those that are fully clad, in combustible materials.

Wall build-ups within the scope of this PAS include, but are not limited to:

- 1) external walls incorporating a rainscreen cladding system, with or without insulation within any associated cavity;
- 2) external thermal insulation composite systems (ETICS), particularly those comprising rendered insulation;
- 3) composite panels, including insulated core (“sandwich”) panels;
- 4) glazed façades with infill/spandrel panels;
- 5) substrates or backing walls, including concrete blockwork, brick, steel framing systems (SFSs), timber framing and structural insulated panels (SIPs); and
- 6) curtain walling.

It also covers attachments to the external walls of buildings.

This PAS does not address spread of fire from one building to another, the performance of external walls in terms of fire resistance, or the ability of the walls to maintain structural stability. It is not applicable to new buildings.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this PAS²⁾. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 4422, *Fire – Vocabulary*

BS EN ISO 13943, *Fire safety – Vocabulary*

²⁾ Documents that are referred to solely in an informative manner are listed in the Bibliography.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this PAS, the terms and definitions given in BS 4422, BS EN ISO 13943 and the following apply.

3.1.1 aluminium composite material (ACM)

two thin aluminium skins bonded together to a polyethylene or polyethylene/mineral core material

NOTE This PAS refers to different categories of ACM as follows.

- Category 1 ACM is one in which in screening tests based on BS EN ISO 1716, the calorific value is ≤ 3 MJ/kg.
- Category 2 ACM is one in which in screening tests based on BS EN ISO 1716, the calorific value is > 3 MJ/kg and ≤ 35 MJ/kg.
- Category 3 ACM is one in which in screening tests based on BS EN ISO 1716, the calorific value is > 35 MJ/kg.

These categories are instigated by DLUHC as part of the Government's building safety programme.

3.1.2 automatic opening vent (AOV)

vent that is part of a smoke control system, which opens automatically when smoke is detected by smoke detectors

3.1.3 cavity barriers

3.1.3.1 cavity barrier

product used to close or separate a concealed space, the purpose of which is to restrict the spread of smoke and/or fire

NOTE This includes both closed state (3.1.3.2) and open state (3.1.3.3) cavity barriers.

[SOURCE: BS 9414:2019, 3.10.2]

3.1.3.2 closed state cavity barrier

non-loadbearing element designed to provide fire separation within or at the edges of a concealed space (cavity) by forming a tight seal (possibly under compression) between the inner and outer surfaces of the cavity

[SOURCE: BS 9414:2019, 3.10.3, modified – reference to orientation removed]

3.1.3.3 open state cavity barrier

non-loadbearing element designed to provide fire separation in a concealed space (cavity), which is open to allow ventilation and drainage in the cold state, but which closes when exposed to a developing fire

[SOURCE BS 9414:2019, 3.10.4, modified – reference to orientation removed]

3.1.4 cladding

system of one or more components that are attached to, and might form part of the weatherproof covering of, the exterior of a building

NOTE Such systems are normally attached to the primary structure of a building to form non-structural, non-loadbearing external surfaces and can comprise a range of facing materials/cladding panels, including metal composite panels or non-loadbearing masonry, along with insulating materials, rendered insulation systems (ETICS) and insulated core sandwich panels, which are attached to a substrate. Combinations of, for example, cladding panels and insulation form cladding systems and such systems might include cavities, which can be ventilated or non-ventilated. The cladding system also encompasses the supporting rails and bracketry, as applicable, to attach the cladding to the building, and cavity barriers where applicable. Systems that constitute the entire thickness of the external wall, by definition, cease to be cladding systems and are the external wall, e.g. curtain walling.

3.1.5 combustible

not classed as A1 or A2 in accordance with BS EN 13501-1:2018, and not meeting the definitions for material of limited combustibility (3.1.27) or non-combustible (3.1.30)

3.1.6 combustion modified

<of a material> modified or specifically formulated to improve performance in fire

3.1.7 compartmentation

subdivision of a building by fire-resisting walls and/or floors for the purpose of limiting fire spread within the building

3.1.8 competent person

person, suitably trained and qualified by knowledge and practical experience, and provided with the necessary instructions, to enable the required task(s) to be carried out correctly

3.1.9 evacuation alert system for use by the fire and rescue service

system intended for installation in a building containing flats or maisonettes to enable the fire and rescue service to initiate an evacuation alert signal by means of evacuation alert devices within the flats or maisonettes, using manual controls incorporated within the control and indicating equipment

3.1.10 external wall construction

range of different forms of construction used for the entirety of the external walls of a building, from inside to outside, including both internal and external finishes

NOTE 1 *In the context of this PAS, external wall construction includes any cladding on the external wall (whether installed as a complete system at the time of construction or retrospectively through, for example, renovation) as well as the underlying wall construction, whether loadbearing or not.*

NOTE 2 *The current guidance in ADB ([8], [9]) refers to external walls as including all of the following:*

- anything located within any space forming part of the wall;
- any decoration or other finish applied to any external (but not internal) surface forming part of the wall;
- any windows and doors in the wall; and
- any part of a roof pitched at an angle of more than 70° to the horizontal if that part of the roof adjoins a space within the building to which persons have access, but not access only for the purpose of carrying out repairs or maintenance.

3.1.11 fire barrier

separating element that exhibits fire integrity or fire stability or thermal insulation, or a combination thereof, for a period of time under specified conditions

NOTE *A cavity barrier (3.1.3.1) is a fire barrier specific to concealed spaces (cavities) within the external wall.*

3.1.12 fire engineering

application of scientific and engineering principles to the protection of people, property and the environment from fire

NOTE *This is also known as fire safety engineering.*

3.1.13 fire hazard

source, situation or act with potential to result in a fire

NOTE *Examples of fire hazards include ignition sources, accumulation of waste that could be subject to ignition, and disposal of a lit cigarette close to combustible materials.*

3.1.14 fire load

quantity of heat that could be released by the complete combustion of all the combustible materials in a volume, including the facings of all bounding surfaces

3.1.15 fire resistance

ability of an item to fulfil for a stated period of time the required loadbearing capacity and/or integrity and/or thermal insulation, and/or other expected duty specified in a standard fire resistance test

NOTE *This is not the time that the item can withstand exposure to any specific real fire without loss of its required performance.*

3.1.16 fire risk

combination of the likelihood of the occurrence of fire and likely consequence(s) of a fire

NOTE *In the context of this PAS, the relevant consequences of a fire are those involving injury to people (number and severity of injuries), as opposed to damage to property.*

3.1.17 fire risk assessment (FRA)

process of identifying fire hazards and evaluating the risks to people arising from them, taking into account the adequacy of existing fire precautions, and deciding whether or not the fire risk is acceptable without further fire precautions

NOTE *Where the fire risk is not acceptable without further fire precautions, an FRA includes an action plan that sets out reasonably practicable measures to reduce the risk.*

3.1.18 fire stop

seal provided to close an imperfection of fit or design tolerance between elements or components to restrict the spread of fire and smoke

3.1.19 fire stopping

provision of a fire stop

NOTE *In the context of external wall construction, anything that connects compartment floors and walls onto the inside face of the external walls is fire stopping and would be expected to provide the same fire resistance as the floor/wall.*

3.1.20 fire strategy

set of fire safety objectives and the measures to be taken to meet those objectives

3.1.21 general needs

<of housing> intended for occupation by members of the general public and not solely or predominantly for occupation by a specific demographic

3.1.22 high-rise building

building with any storey with a floor located at not less than 18 m above ground level, or at least seven storeys (i.e. more than a ground plus five upper storeys), whichever is the lower

NOTE In this context, the height of the top storey is measured from the upper floor surface of the top floor (excluding roof-top plant areas and any uppermost storeys consisting exclusively of plant rooms) to ground level on the lowest side of the building.

3.1.23 infill panel

panel forming part of a curtain wall or window assembly system, excluding vision glazing

3.1.24 insulation

any material or product that is intended as, or capable of, significantly reducing the transfer of heat

NOTE Insulants which do not provide this function for the building as a result of the manner in which they have been installed (e.g. discrete sections of insulation which would fail to insulate as heat might pass through gaps between them) still fall within this definition of insulation, as they contribute to fire safety in the manner of an insulant in any event.

3.1.25 interim measure

temporary measure that is put in place to address an unacceptable risk to occupants of a building

3.1.26 material

substance, or mixture of substances, that is entirely homogenous

NOTE For example, aluminium and timber are both materials. For the purpose of reaction to fire testing, where a material forms a surface it is the entire thickness of that material which is the surface.

3.1.27 material of limited combustibility

either:

- a) a non-combustible material or product; or
- b) any material or homogenous product of density 300 kg/m³ or more, which, when tested in accordance with BS 476-11, does not flame and the rise in temperature on the furnace thermocouple is not more than 20 °C; or
- c) any product with a non-combustible core of 8 mm thick or more, having combustible facings (on one or both sides) not more than 0.5 mm thick; or
- d) a material or product classified as Class A2-s3, d2 in accordance with BS EN 13501-1:2018, when tested in accordance with BS EN ISO 1182 or BS EN ISO 1716 and BS EN 13823

NOTE This term is included here given its use in relation to materials used in, and standards applicable to, existing buildings. It is derived from guidance in previous versions of ADB ([10], [11], [12], [13], [14]), but this term is no longer in use in the current version of ADB ([8], [9]).

[SOURCE: BS 9991:2015, 3.45, modified]

3.1.28 mitigation measures

measures to reduce an identified risk until significant issues relating to the fire risk posed by the external wall construction and cladding are resolved

3.1.29 multistorey

<of blocks of flats> comprising at least a ground floor and one upper floor, with one or more separate dwellings on each storey

3.1.30 non-combustible

either:

- a) any material classified as Class A1 in accordance with BS EN 13501-1:2018; or
- b) products classified as non-combustible under BS 476-4:1970; or
- c) any material which when tested in accordance with BS 476-11, does not flame nor cause any rise in temperature on either the centre (specimen) or furnace thermocouples; or
- d) totally inorganic materials such as concrete, fired clay, ceramics, metals, plaster and masonry containing not more than 1% by weight or volume of organic material; or
- e) concrete bricks or blocks meeting BS EN 771-3:2003

NOTE This term is included here given its use in relation to materials used in, and standards applicable to, existing buildings. It is derived from guidance in previous versions of ADB ([10], [11], [12], [13], [14]), but this term is no longer in use in the current version of ADB ([8], [9]).

3.1.31 pre-occupation fire safety assessment

process of identifying fire precautions in a newly constructed or refurbished building, taking into account the approved fire strategy, and deciding whether or not the new or refurbished premises are likely to be fit for occupation

3.1.32 product

item that is formed of one or more materials

NOTE For example, painted aluminium or timber, ACM and manufactured boards which have a complex internal structure or densities which differ across their thickness, are all non-homogenous products. For the purpose of reaction to fire testing, only the surface material (such as paints/coatings, the aluminium sheet of ACM where this is not painted, or the portion of a product that is essentially the same as what is exposed at the surface) is deemed to be the surface. Some products are homogenous.

3.1.33 simultaneous evacuation

system of evacuation in which an entire building is evacuated immediately on receiving an evacuation signal (e.g. from a fire detection and fire alarm system) or an evacuation alert signal from an evacuation alert system for use by the fire and rescue service, or an instruction to evacuate (e.g. given verbally to the residents of each dwelling by firefighters)

3.1.34 spandrel panel

infill panel that is located between the sill of a window and the head of the window below, or that spans the floor slab area in a curtain wall system

NOTE A spandrel panel commonly spans a compartment floor boundary and, therefore, is significant in terms of the scope for the fire to bypass fire barriers between floors.

3.1.35 stay put strategy

strategy normally adopted in blocks of flats and maisonettes whereby, when a fire occurs in a flat or maisonette, the occupants of that dwelling evacuate, but occupants of all other dwellings can safely remain in their dwellings unless directly affected by heat and smoke or otherwise directed to leave by the fire and rescue service

NOTE 1 In a building with a stay put strategy, residents can leave their flats at any time if they wish and are able to do so (e.g. if they feel unsafe), but to do so might, under some circumstances, place them at greater risk than remaining within their flats.

NOTE 2 "Stay put" is sometimes referred to as "defend in place" or "stay safe".

3.1.36 substrate

construction onto which other materials or products are attached or applied

NOTE In the case of a cladding system, its substrates typically include masonry and lightweight framing systems, such as an SFS.

3.1.37 surface

outside part or uppermost layer

NOTE This definition is particularly important in the context of reaction to fire tests [see definitions for materials (3.1.26) and products (3.1.32), and Annex A].

3.1.38 thermoplastic material

polymer that can be melted and recast almost indefinitely

3.1.39 waking watch

system whereby suitably trained persons continually patrol all floors and the exterior perimeter of the building in order to detect a fire, raise the alarm, and carry out the role of evacuation management

3.2 Abbreviated terms

For the purposes of this PAS, the following abbreviated terms apply.

ACM	aluminium composite material
ADB	<i>The Building Regulations 2010 – Approved Document B: Fire safety</i>
	NOTE The abbreviation "ADB" is used for all editions of Approved Document B; the bibliographic references indicate which edition is relevant at any given point.
AOV	automatic opening vent
CCM	copper composite material
CLT	cross-laminated timber
CP	cement particle
DPC	damp-proof course
EPS	expanded polystyrene
ETICS	external thermal insulation composite system
FRA	fire risk assessment
FRAEW	fire risk appraisal of external walls
HPL	high pressure laminate
HRR	heat release rate
IRMP	integrated risk management plan
MCM	metal composite material
OSB	oriented strand board
PIR	polyisocyanurate
PUR	polyurethane
SIP	structural insulated panel
SFS	steel framing system
XPS	extruded polystyrene
ZCM	zinc composite material

4 General issues for consideration before undertaking an FRAEW

COMMENTARY ON CLAUSE 4

The following are general issues for consideration before undertaking an FRAEW.

- a) This PAS is narrower in scope than the 2020 version of the MHCLG Consolidated Advice Note [17] (and equivalent guidance in Scotland). While the multistorey, multi-occupied residential buildings, to which the MHCLG Consolidated Advice Note [17] referred, were primarily purpose-built³⁾ blocks of flats, its scope also included all buildings that include more than one dwelling and all buildings that have a room for residential purposes. The Consolidated Advice Note [17] also applied to overnight patient accommodation (e.g. hospitals).
- b) An FRAEW is not specifically intended to address the safety of firefighters in the event of a fire spreading over the external walls, given that there were no express requirements within the relevant building regulations to address this when the buildings were built⁴⁾, albeit there was the requirement to meet the functional Requirement B4(1), which would have reduced the risk to occupants and firefighters alike. Nor is this within the scope of the Fire Safety Order [19]. However, it would be of significant value and is considered best practice to inform the local fire and rescue service of any findings of an FRAEW where external fire spread is likely to be more rapid than is normally expected. This would allow operational risk information to be reviewed and updated. Means of escape for relevant persons are also often a means of access for firefighters.
- c) An FRAEW is not specifically intended to address protection of property (the premises and their contents) or the environment, or to address protection against the consequences of a fire, such as the need for the building to be vacated and the occupants rehoused. However, it is undoubtedly the case that external walls that adequately resist the spread of fire such as to safeguard occupants will also, to a large degree, help to limit fire damage and disruption.
- d) This PAS addresses the risk from fire spread over the external walls of multistorey blocks of flats of any height and not just those over 18 m; while, for many years, within the supporting guidance to building regulations, more stringent fire performance has been specified for buildings over 18 m in height, the fundamental requirement for external walls adequately to resist fire spread applies irrespective of height.
- e) No specific definition of an external wall was previously included in building regulations or relevant editions of ADB, although a definition was introduced when the Building Regulations 2010 [7] were amended in 2018. The effect of the amendment is that all components from the wallpaper or other finish on the face of the wall internally within the building (but not including the wallpaper or other finish) to the facing of the external wall on the outside of the building are now to be considered part of the external wall construction for the purpose of the Building Regulations. However, such a definition was not applied in any UK guidance before this time, and as a result it is not uncommon to encounter combustible materials within the external wall construction, in particular the inner leaf/backing wall. Given that this PAS applies to existing buildings pre-dating the 2018 amendment to the Building Regulations 2010, use of this PAS assumes that remediation of these inner leaf/backing walls is, in the majority of cases, unlikely to be risk-proportionate.
- f) This PAS does not apply to the design of new buildings or to the snagging of newly constructed buildings prior to occupation. Similarly, it is not intended to inform pre-occupation fire safety assessments (see 3.1.31). Accordingly, it is not intended to constitute an alternative solution to meeting the requirements for fire performance of external walls of new buildings.
- g) A report prepared in accordance with this PAS is not intended as an alternative to the EWS1 form [23], which is for valuation purposes only, although it might possibly serve as a suitable report to support or inform an EWS1 form.

³⁾ Including buildings originally in use for other purposes but subject to alteration and redesign for use as flats.

⁴⁾ There are no recommendations in ADB relating to the mechanical performance of external wall construction to protect firefighters from falling debris, early collapse of the cladding or fire spread by burning debris. In addition, there are no express criteria within the guidance given in the BRE publication BR 135 [15] to assess these matters.

- h) *Use of this PAS is likely to give rise to the most definitive assessment if the person carrying out the FRAEW works in collaboration with a suitable contractor appointed by the client to carry out opening up works, and with other professionals, such as a building surveyor/architect and/or façade engineer. While the PAS is based on this premise, it can equally be applied where there are different arrangements. However, it is not expected that fire engineers would carry out opening up work, etc., but might subcontract such work.*
- i) *It is inevitable that more, and greater, knowledge relating to the fire performance of materials, components and systems and how they are configured in external wall construction is likely to come to light beyond the publication date of this PAS. Where more definitive information on fire performance data relied upon in an FRAEW becomes available, e.g. results from relevant BS 8414 tests completed subsequent to the FRAEW, it is expected that such information ought to take precedence. This might, in some cases, prompt the need for a review of the findings of an FRAEW.*
- j) *FRAEWs conducted in accordance with this PAS are not intended to be used as a means to audit design or construction of buildings against any applicable regulations or guidance (e.g. with the intention of establishing failure of particular parties to meet contractual obligations at the time of construction), nor to support litigation in relation to compliance with building regulations (as opposed to risk).*
- f) it can only be based on available industry knowledge at the time of the FRAEW and, more definitive information on the fire performance of external wall construction might come to light subsequently.

4.2 Before accepting a commission for an FRAEW, persons engaged to conduct it should establish that:

- a) the building is within the scope of this PAS;
- b) the purpose of the FRAEW is to inform the building's FRA;
- c) a risk-based approach is required, and not one based on:
 - 1) strict compliance with guidance to building regulations (current or otherwise); or
 - 2) an unrealistic attempt to establish zero risk;
- d) the objective of assessing the fire risk is to address the safety of occupants; and
- e) they have the necessary competence to address the risks posed by the particular wall build-ups on the building (see Clause 8).

4.3 Persons conducting FRAEWs should endeavour to ensure that clients are made aware of the constraints, limitations and caveats that will apply to an FRAEW conducted in accordance with this PAS.

4.4 Persons conducting FRAEWs should inform the client that, if more definitive information on the fire performance data relied upon in an FRAEW becomes available subsequent to the FRAEW, such information should take precedence. The potential need to carry out a review of the findings of an FRAEW in the light of such new information should be emphasized.

4.1 Before accepting a commission for an FRAEW, the external wall assessor should inform the person commissioning the FRAEW of its inherent limitations, and, in particular, the following:

- a) it is intended primarily to inform the building's FRA;
- b) it cannot warrant absolute safety, as it will be risk-based and therefore reliant on professional judgement by competent persons;
- c) it might not be possible to identify the full scope of work needed as part of the FRAEW from the outset, as the conclusion might be that a further inspection or in-depth technical assessment is needed (which might necessitate the involvement of other professionals);
- d) it is not specifically intended to address protection of firefighters;
- e) it is not intended to address property protection; and

5 Principles of external fire spread

COMMENTARY ON CLAUSE 5

Although the Grenfell Tower fire has brought back into sharp focus the serious consequences of an uncontrolled fire spreading over the external walls of a building, the risks posed by such fire spread were well understood prior to this. Indeed, lessons learned from previous, notable fires had progressively led to tighter restrictions in relation to the fire performance of the materials that can be used as part of external wall construction and cladding. Why the tragedy at Grenfell Tower occurred despite these restrictions is, at the time of publication of this PAS, still under investigation by the Public Inquiry and a Metropolitan Police Service investigation into the fire.

This PAS draws on the lessons learned from previous fires involving unexpected and significant external fire spread. It pays particular attention to the rapid fire spread that can occur in some external wall construction and cladding and, in particular, highlights the potential of cavities within, for example, rainscreen cladding systems to exacerbate vertical fire spread.

It is recognized that external fires also result in significant smoke spread. While the effects of such smoke can be considered, to a degree, in terms of the consequences (such as on the propensity to affect escape routes if a cladding fire were in close proximity to staircase smoke vents, for example), the restrictions on fire performance of external wall materials have not previously sought to directly control smoke production.

The mechanisms for fire spread on the outside of a building and, in particular, the role of cavities in the wall build-up, are generally well understood. The risks posed by fire spread over the external walls of building are clearly summarized in BR 135 [15], for example. Further discussion on the mechanisms for such fire spread is provided in Annex B.

It is important that external wall assessors are cognizant of the mechanisms of fire spread via the external walls of buildings and the implications of fire that have occurred by this route. This is part of possessing the necessary competency to conduct an FRAEW (see Clause 8). It is essential to understanding the basis of risk-based benchmark criteria.

For a building to be considered acceptably safe, the time required for fire to spread externally from one compartment to another, or from one storey to another, needs to be sufficiently long so as to allow for safe escape and the intervention of the fire and rescue service; measures needed to support safe escape and intervention from the fire and rescue service vary, depending upon the particular building, and its size, use and location.

In general, the time required for a fire to grow to flashover, for flames to emit from windows, reach windows above and ignite the contents of rooms, is usually sufficient for this purpose. The need, therefore, is for the external wall construction of buildings not to accelerate the speed of fire spread to an extent that is unsafe.

Utilizing materials that are of limited combustibility or are non-combustible, or have, in combinations reflecting the specific wall build on a building, been subject to BS 8414 large-scale fire tests, and, as a result, been classified in accordance with the criteria in BR 135 [15], have been the ways relied upon to result in this outcome. However, as discussed elsewhere in this PAS, these are not practical benchmarks that can be applied to many existing buildings.

The implications from the history of fires involving significant external fire spread, highlighted in this clause, and the mechanisms of such fire spread, suggest that the basis of subjective benchmark criteria to be used when assessing the fire risk posed by external walls of existing blocks of flats needs to be:

- that fire spread is likely to result in only limited secondary fires and/or either occur at a rate within expectations for a building of this height, or at a higher but still tolerable rate, given the circumstances at the building in question; and/or
- that occupants in places to which fire has spread are not unduly harmed, or prevented from escaping, by the time such secondary fires occur; and/or
- that secondary fires do not compromise the communal means of escape before those needing to use the escape routes have left the building; and/or
- that fire and rescue service intervention is likely to be effective in avoiding undue secondary fires, or in ensuring that occupants at risk are not prevented from escaping or can be rescued.

This is discussed further in Clause 7.

5.1 External wall assessors should be knowledgeable in relation to the history of notable fires involving significant external fire spread and the lessons learned.

5.2 External wall assessors should understand the various mechanisms of fire spread giving rise to fires involving external wall construction and cladding.

5.3 External wall assessors should have an in-depth understanding of the basis of controls and restrictions contained in standards and guidance relating to external fire spread.

5.4 External wall assessors should understand what provisions are required within external walls to prevent fire spreading from compartment to compartment, either horizontally or vertically.

5.5 When adopting a risk-based approach to determining whether an existing block of flats is safe, in terms of external fire spread, external wall assessors should recognize and take account of:

- a) the combustibility and fire performance of external wall construction and cladding;
- b) the likelihood of secondary fires;
- c) whether a secondary fire is likely to result in direct harm to occupants or prevent them escaping;
- d) the role of fire and rescue service intervention, its effectiveness and its limitations;
- e) the time it might take for adverse consequences to occur and whether this can be mitigated by, for example, suitable fire safety design; and
- f) the extent and effectiveness of fire safety management for the building.

6 Legislative context

COMMENTARY ON CLAUSE 6

In the case of existing buildings, the context in which the fire risk posed by external wall construction is to be considered is the ongoing legislative control applicable to occupied buildings. Cognizance of the requirements of building regulations and the recommendations of supporting guidance, and the differences between what is applicable now to new buildings and what would have been applicable at the time of construction of the building under consideration, is also important. The legislative context to FRAEWs is discussed further in Annex C.

The risk-based approach advocated in this PAS meets the fundamental underlying philosophy underpinning the Fire Safety Order [19]. Accordingly, an FRAEW is intended to support the building's FRA in establishing the level of risk and the preventive and protective measures needed to satisfy the Fire Safety Order [19].

It is inevitable that there will be an iterative process whereby an FRAEW is commissioned as a consequence of a building's FRA, but the outcome of the FRAEW requires the FRA to be reviewed and revised in the light of the findings of the FRAEW.

In providing professional advice on external walls and how to meet an appropriate standard of fire safety for existing blocks of flats, external wall assessors need to understand the legislative context that applies and in particular that of the Fire Safety Order [19]. This is particularly important in relation to the guidance given in Clause 7 and Clause 13 on:

- underlying criteria for a benchmark when assessing whether external walls present an undue risk of fire spread;*
- a framework and rationale for a risk-based approach to determine whether walls on an existing building meet an appropriate standard of fire safety;*
- determining the circumstances in which the risk is high and there is a need to take remedial action to mitigate an unsafe building;*
- determining the circumstances in which, notwithstanding the presence of combustible material in the external walls and cladding, there is no need to take remedial action as the risk is low; and*

- determining the circumstances in which, notwithstanding a heightened risk of fire spread compared to a low-risk building, the residual risk presented by the presence of combustible material in the external walls and cladding is tolerable and again, there is no need to take any significant remedial action.*

Where it has been determined that action is necessary to mitigate the risk, the measures that can be taken to reduce the risk are likely to vary. It might, at one extreme, be necessary to remove and replace all combustible elements of the external walls. In some circumstances, partial removal and replacement might suffice to address the life safety risk, e.g. removal of combustible cladding which would allow fire to spread into escape routes. In others, normally limited to low-rise blocks, a more proportionate and cost-effective alternative to replacing existing cladding, or carrying out works to address design shortcomings and deficiencies in workmanship, might be to consider changing the evacuation strategy.

In cases where the risk posed by combustible cladding and external wall construction is perceived as severe, interim measures will often involve a waking watch, for which guidance is available [24]. If the cladding cannot be removed within a period of a few months, a more realistic alternative is to provide a fire alarm system with sufficient automatic fire detection that is capable of alerting all residents. This is usually only intended as a temporary solution. Where a permanent change in evacuation strategy is recommended as a long-term solution, it is important that all parties, especially residents, are fully aware of the disadvantages as well as the advantages of this, including the disruption that can result from false alarms and, as a result, the potential for residents to disregard alarm warnings.

The need for interim measures, such as those highlighted in sector-specific guidance on temporary changes to a simultaneous evacuation strategy in purpose-built blocks of flats [24], might also need to be considered, depending upon how long it will take to implement more permanent mitigation measures.

While this PAS is not a guide to all of the mitigation measures available and the circumstances in which they can be employed, it is important that persons undertaking the FRAEW are capable of advising on the suitability of such measures. Ultimately, it is expected that the responsible person, or person in control of the premises under the Fire Safety Order [19], in conjunction with the fire risk assessor and other professional advisers, will determine the most appropriate measures to mitigate risk in the circumstances. Nevertheless, persons carrying out the FRAEW need to be able to give due consideration to practicality and cost, suitability to the circumstances, and effectiveness and maintainability of any such measures, in order to be able to be satisfied that an appropriate standard of fire safety can be met, given the risk posed by fire spread as determined in the FRAEW.

Using tests of proportionality and the benefit gained from the preventive and protective measures taken in response to risk is fundamental to the Fire Safety Order [19]. This, in turn, allows consideration of cost. While cost is unlikely to be a fully determinative factor, it cannot be dismissed in the context of building fire safety. Legal determinations in criminal court cases brought under the Fire Safety Order routinely use cost–benefit considerations to test whether something is proportionate and “reasonably practicable”. Given the high costs incurred in remedial action to remove and replace combustible cladding, it is important to establish that this is a risk-proportionate measure, especially when the fire risk posed by external wall construction and cladding is set in the context of other risk factors and fire safety features of the building.

Prior to the amendment of the Fire Safety Order [19] by the Fire Safety Act 2021 [20], it was considered necessary to use the powers under the Housing Act 2004 (as amended) [25] to enforce requirements for remediation of hazardous cladding by use of the housing health and safety rating system (HHSRS). It is anticipated that, following the introduction of the Fire Safety Act 2021 [20], it might now be more appropriate to use the powers granted by the Fire Safety Order [19] for this purpose. Accordingly, in this PAS, the focus is on conformity to the Fire Safety Order [19], and the underlying principles of the Order, rather than the alternative approach adopted under the Housing Act 2004 (as amended) [25].

6.1 External wall assessors should understand the relationship between the FRAEW and the building’s FRA, including the fact that an outcome of an FRAEW could require that an FRA be reviewed and revised depending upon the findings in the FRAEW.

NOTE *The urgency of this depends on the findings of the FRAEW.*

6.2 Failure of a building to meet the benchmarks given in regulations and guidance applicable to external wall construction, both currently and at the time when the building was built, should not be used as the sole basis for determining the outcome of the FRAEW.

6.3 The FRAEW should adopt a risk-based approach. It should include not only the fire behaviour of the materials, components and systems within the external walls, but also other risk factors, such as how the façades are configured on the building, the fire hazards in and around the building and the fire safety features of the building.

6.4 External wall assessors should take into account the principle of proportionality when formulating an opinion on the risk and the appropriate mitigation measures in response to that risk, including considerations of benefit gained, practicality and cost.

NOTE *The requirements of the Fire Safety Order [19] are based on measures that are “reasonably practicable”, i.e. that the cost, time and effort in eliminating a hazard are not grossly disproportionate to the risk created by the hazard.*

6.5 External wall assessors should be competent to advise on the suitability of any measures they recommend to mitigate the risk, including practicality and cost, suitability to the circumstances, effectiveness and maintainability. This should include any interim measures recommended.

7 Principles and scope of the fire risk appraisal of external walls (FRAEW)

COMMENTARY ON CLAUSE 7

a) Background

The methodology in this PAS is aimed at providing a pragmatic basis for addressing situations in which, in the absence of evidence from large-scale fire testing, the exact fire performance of the particular external wall construction and cladding on an existing building cannot be proven.

The fundamental basis of this PAS is that it is risk-based, not compliance-based. It cannot establish absolute safety, but can only categorize risk on a relative basis.

Accordingly, the benchmark criteria used in this PAS refer to first principles, based on an analysis of the problem of external wall fires as discussed in Clause 5 and Annex B. This takes into account not only whether the rate at which fire might spread is likely to be unduly rapid, but also the consequences in terms of secondary fires, and the implications for escape by occupants, given the likely mitigation resulting from the fire safety features in the building and the ability of the fire and rescue service to intervene effectively in time. This means the criteria are inevitably subjective and reliant on the use of professional judgement by competent persons.

While this is relative to the known performance of external wall construction in real fires, and in the various fire test methods (small, intermediate and large-scale) applied to materials, components and systems with which external walls are constructed, it is also relative to the context in which the combustible material is present. It therefore takes account of the scale and extent to which such combustible cladding panels and other components are present on the building, e.g. whether there is full or only partial coverage of combustible cladding. It also takes into account the consequences of a fire and the fire strategy that underpins the fire safety design of the building.

This philosophy fits with the approach to risk assessment in the context of the legislative regime for ongoing control of existing buildings under the Fire Safety Order [19]. The FRAEW is intended to complement the FRA, as, ultimately, it is within the scope of the FRA produced under the Fire Safety Order [19] that the fire risk posed by external wall construction and cladding is to be considered.

The findings of an FRAEW are specifically intended to assist the building's fire risk assessor with that consideration. The rationale set out in this clause stipulates that the building's fire strategy and various aspects of the fire safety design are taken into account, in conjunction with fire hazards that could result in façade fires. Accordingly, to assist in the building's FRA or its review, it is imperative that the external wall assessor's understanding of these matters and any assumptions made are explicitly stated in the FRAEW report. This is so that an FRAEW serves to inform the building's fire risk assessment and aids decision-making with regard to any necessary action to mitigate the risk, including interim measures that need to be implemented within defined timescales.

The ultimate aim of the FRAEW is, therefore, to position the fire risk posed by the external wall construction and cladding on a scale of relative risk from "low" to "high". From this, it is determined whether action is necessary to address a level of risk that is considered unacceptable. On a relative scale, "low" risk would equate to construction that is considered to be acceptable. The extreme of "low" risk at one end would equate to the likely fire performance of a double skin masonry wall (each leaf at least 75 mm thick), with its excellent level of fire performance. At the other extreme, "high" risk would equate to the fire performance of a cladding system with Category 3 ACM, which is generally regarded as unacceptable. However, to determine risk in the context of this PAS, it is normally necessary to consider more than just fire performance. Factors relating to the consequences of fire spread need to be taken into account; indeed, with the possible exception of fire performance equivalent to Category 3 ACM, these factors might outweigh the concerns regarding fire performance.

For avoidance of doubt, while it can be stated that compliance with the BR 135 [15] benchmark in the guidance in ADB ([8], [9]) will usually result in a "low" risk on this relative scale, it is not the case that failure to demonstrate such compliance automatically means the risk level cannot be tolerable, or is always unacceptable. It is the basic premise of this PAS that judgements on risk need to be made in the absence of evidence of compliance with the BR 135 benchmark. Fundamental to this

is that the specific circumstances of the particular building being assessed need to be considered, holistically, when assessing risk. Even where there is evidence of compliance with the BR 135 benchmark, there might be other factors that influence the risk, such as significant combustible material present on features such as balconies. When considered in context, these might detract from viewing the building as “low” risk.

It is also important to understand that, although this methodology utilizes values for physical properties of materials and fire performance data, any consideration of risk in the context of external wall construction and cladding will be largely subjective, given the state of knowledge of, and ability to predict, how certain materials behave in fire, requiring use of professional judgement by competent persons.

As discussed in Annex D, compliance with the Building Regulations [7] can be achieved by means of a fire-engineered solution, which might be a risk-based approach. Such a solution is likely to contain elements of the risk-based approach described in this PAS. However, new-build projects afford the opportunity to achieve certainty over the fire performance of external wall materials, systems and configurations. Accordingly, in terms of approval under the Building Regulations [7], the test applied by a building control body as to whether a particular fire-engineered solution is acceptable is likely to be more stringent than the methodology set out in this PAS. In summary: acceptable risk, in the context of this PAS, might not be equivalent to acceptable risk in the case of the fire-engineered solution for the design of a new building.

b) Risk-based benchmark criteria

In the context of a risk-based approach, as outlined in this PAS, the risk in question is the combination of:

- the likelihood of undue speed of fire spread over the external walls of the building; and
- the likely consequences, namely the resultant occurrence and extent of secondary fires on other floor levels; and
- the likely consequences in terms of evacuation before the onset of untenable conditions⁵⁾ in the escape routes, whether evacuation is intended to occur immediately on the warning of fire or, in the case of a stay put strategy, at some point during the course of the fire; and

- the likelihood of effective intervention by the fire and rescue service at a point before all of the above occur.

External fire spread from a flat on one storey to another flat on the storey above, bypassing compartmentation, might cause the occupants of the upper flat to be directly affected by heat and smoke and force them to evacuate their flat. However, this mechanism of fire spread cannot ever be totally precluded even with the use of fire-resisting glazing for windows, which would also need to be permanently fixed shut, as fire resistance can only ever be afforded for a finite period of time. A fundamental premise of controls on external walls under building regulations and supporting guidance has always been that the possibility of such fire spread is accepted, provided that the risk to life safety remains at an acceptable level, but it is not expected to occur at such speed that intervention by the fire and rescue service cannot be effective.

Although this form of fire spread occasionally occurs, it does not generally happen on a large scale or lead to death or serious injury of people beyond the flat of fire origin; even if fire spreads into a flat, there would normally still be a safe means of escape available for occupants to use. As discussed in Annex B, the Grenfell Tower fire was an extreme case, where an external fire did spread into other flats with disastrous results; secondary fires in an unexpectedly large number of flats occurred, with the additional consequence that the means of escape were also compromised (as a result of smoke and fire in staircase lobbies on multiple levels and, ultimately, untenable conditions within the staircase itself). This occurred at such speed that fire and rescue service intervention to fight the fire and rescue the occupants was impeded to the point that it was, ultimately, no longer possible to save lives.

Other cases of notable fires involving external fire spread are also discussed in Annex B. However, these show that, while fires can spread extensively over the external walls, and, in some cases, cause secondary fires, this has rarely resulted in casualties beyond the flat of fire origin.

While, to some degree, secondary fires on at least the floor above that of fire origin are to be anticipated, the extent to which secondary fires occur beyond this is a good indication of whether or not the fire performance of the external walls is adequate.

⁵⁾ Tenability criteria in the context of a fire-engineered solution are usually based on factors such as temperature, visibility, toxicity and levels of radiant heat.

Therefore, the following are all, singly or in combination, indicative of a situation which is demonstrably unsafe:

- extremely rapid external fire spread;
- fire spread that gives rise to widespread secondary fires, resulting in occupants being unduly harmed or prevented from escaping;
- fire that spreads in such a way that the communal means of escape are compromised before occupants can safely use them to escape; and
- the inability of fire and rescue service intervention to prevent the above and avoid undue harm to occupants.

The corollary is that the consequences of an external fire set out below are not unsafe and can form the basis of acceptability criteria for a risk-based approach:

- fire spread that results in only limited secondary fires, and/or either occurs at a rate within expectations for a building of this height, or at a faster but nevertheless tolerable rate, given the circumstances at the building in question; and/or
- occupants in locations to which fire has spread are not unduly harmed or prevented from escaping before such secondary fires occur; and/or
- secondary fires do not compromise the communal means of escape before those needing to use the escape routes have left the building; and/or
- fire and rescue service intervention is likely to be effective in avoiding undue secondary fires, or in ensuring that occupants at risk are able to be rescued.

In this PAS, the above have been adopted as the basis of the benchmark with which to judge an existing building's external wall construction.

However, given the variables that can apply to the ability of the fire and rescue service to respond to a fire and the difficulties of tackling a fire involving external wall construction when operating at ground level using typically available equipment, it is important that external wall assessors are circumspect in relying on fire and rescue service intervention, particularly as a compensation for other adverse risk features. Annex E contains guidance on these and other considerations that can influence effective fire and rescue service intervention.

c) Rating the risk

As stated in item a) above, the approach of this PAS is to rate fire risk on a relative scale from "low" risk to "high" risk. The methodology is not intended to be prescriptive and other available approaches might be more definitive or quantitative.

Clause 13 contains a methodology for conducting a basic level assessment of the fire risk posed by external wall construction and cladding on existing blocks of flats. It is broad ranging and relatively simplistic in its approach, but is intended to serve the purpose of eliminating from further action, as far as possible, those buildings where it can be readily demonstrated that the risk is low or, even if not low, still tolerable.

One of the outcomes from the approach set out in this PAS can be that, either early in the investigation of the building, even before any site-based inspection has taken place, or later at the conclusion of the basic level assessment described in Clause 13, it is evident that further and more in-depth technical assessment is warranted, to reach a conclusion on whether the fire risk is tolerable.

This might occur because of:

- the complexity of the external wall construction and cladding, or the difficulty in commenting on its fire performance without specialist knowledge of the form of cladding used and its behaviour in fire, e.g. ETICS; and/or
- the presence of deficiencies in the construction of the walls, poor workmanship, deterioration in the components of the wall build-up, or other deficiencies, such as the absence of cavity barriers where expected, whether by design or error; and/or
- an outcome of the basic level of assessment such that it is not possible to conclude anything other than the risk rating is high or, at best, at the upper end of the medium scale, requiring further investigation to refine the assessment of risk.

The in-depth technical assessment required might involve fire engineering analysis as described in Clause 14. Equally, it might involve conducting fire tests as an option, in order to gain a better understanding of how the walls will perform in fire. Given that classification to BR 135 [15] is not a practical benchmark against which to judge existing buildings, and that there would not necessarily be the documentation needed to achieve BR 135 classification, it is not expected that assessments made in accordance with this PAS will routinely recommend that BS 8414 tests be conducted. Nevertheless, that option will always remain and might, in some circumstances, be the only way of resolving the risk posed by particular wall build-ups on an existing building.

The terms “high risk” and “low risk” are largely defined by the consequences that follow, i.e. whether there is a need for remedial action or not (or, in some cases, whether further investigation and in-depth analysis is needed). Further refinement of the risk rating within the risk scale (see Clause 13) is not precluded, but where additional risk outcomes are used, the parameters associated with them need to be given.

For example, very high risk could be equated to the presence of ACM cladding panels with an unmodified polyethylene core. However, it is important that all aspects of the FRAEW, including considerations relating to façade configuration and fire strategy/fire hazards, are included when using additional risk outcomes, and not simply the burning behaviour of the materials, components and systems that make up the external walls.

It is necessary to take into account all the factors that influence the likelihood of fire spread, the rate of spread, the ultimate extent of spread and their consequences. This enables the relative risk posed by external fire spread to be identified.

The fire risk posed by external wall construction and cladding is considered to be influenced most by factors falling under three broad headings as follows:

- fire performance;
- façade configuration; and
- fire strategy/fire hazards (including limitations of fire and rescue service intervention).

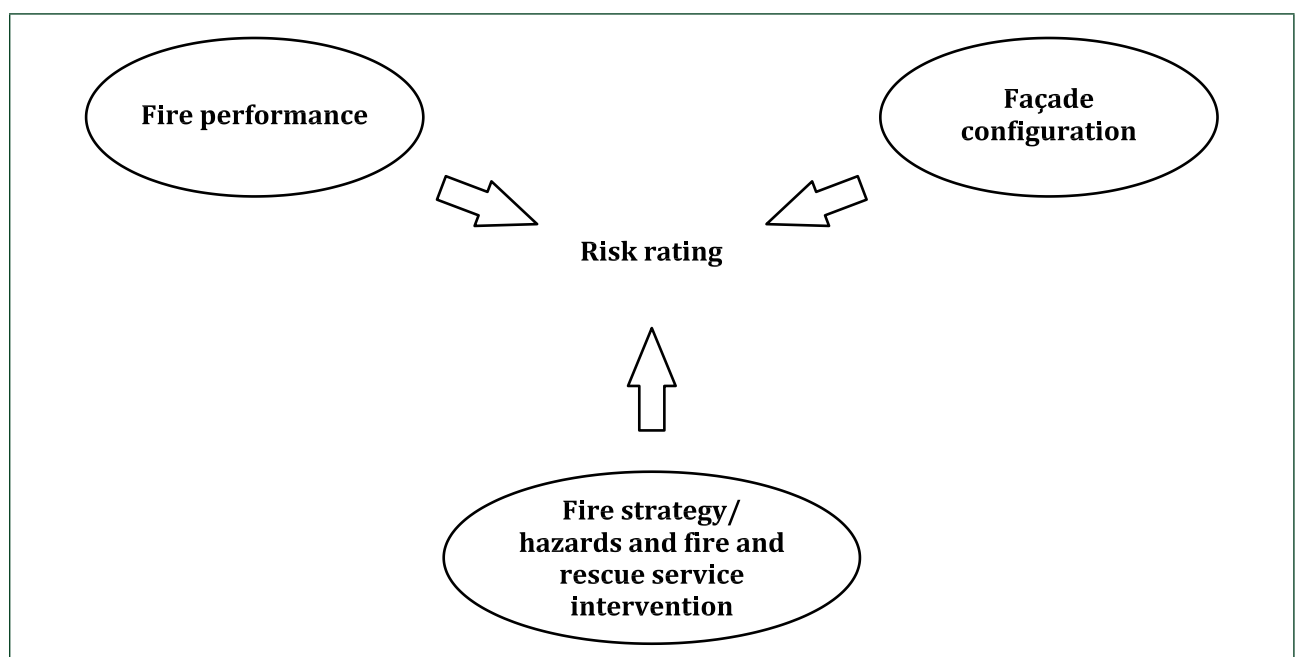
This is illustrated in Figure 1.

1) **Fire performance risk factors** are those influencing the likely speed and extent of fire spread by virtue of the fundamental properties, and fire behaviour, of the materials, components and systems comprising the external wall construction, how they are configured together and the quality of their installation within the wall build-ups on the building. Commentary on fire performance, including the applicable standards relating to the behaviour of construction products in fire and the relative ranking of different materials, components and systems used in external wall construction is provided in Clause 11.

2) **Façade configuration risk factors** are those factors influencing the likely speed and extent of fire spread by virtue of, for example:

- the extent to which the building is covered by combustible cladding and external wall construction (e.g. partially clad or fully clad);
- the continuity of combustible cladding sections and their orientation (e.g. horizontal or vertical);
- the presence or otherwise of continuous cavities and how they are protected against undue fire spread via the cavity;
- the extent of openings in the external building envelope that would allow ignition of the cladding from flaming combustion originating inside the building and entry routes back in; and

Figure 1 – Key considerations in arriving at a risk rating for external walls



- the location of the cladding in relation to the potential for fires of external origin to ignite the cladding.

Commentary on façade configuration is provided in Clause 12.

3) Risk factors arising from fire strategy/fire hazards (including limitations of fire and rescue intervention) are those which influence the ability of occupants to escape once fire occurs and spreads via the external wall construction to other parts of the building. It also includes those that influence the ability of the fire and rescue service to intervene effectively. Such factors relate to elements of the fire safety design of the building, including:

- evacuation strategy, which in most blocks of flats revolves around the “stay put” principle;
- escape route design and the protection afforded to staircases and other parts of the routes used by occupants to leave the building in the event of fire;
- potential challenges for some residents to evacuate independently in the event of fire (e.g. in specialized housing);
- compartmentation, both between flats, and between flats and the common parts;
- smoke control arrangements supporting the means of escape and/or firefighting facilities;
- fire detection and fire alarm systems and arrangements for alerting residents;

NOTE In blocks of flats, there is usually no communal fire alarm system to trigger simultaneous evacuation; evacuation alert systems for use by the fire and rescue service are in their infancy at the time of publication of this PAS. Guidance on evacuation alert systems for use by the fire and rescue service is given in BS 8629. An evacuation alert system is not intended to be installed as a risk mitigation measure.

- fire suppression systems;
- the height of the building where it affects the time needed to escape from the building and the ability for firefighters to operate quickly and efficiently; and
- access and facilities for use by the fire and rescue service in fighting a fire.

FRA (such as those undertaken in accordance with PAS 79-2) are expected to address day-to-day ongoing control of fire hazards in a building. Accordingly, consideration of such matters within PAS 9980 is limited. Nevertheless, the methodology described in Clause 13 includes reference to certain features of a building that can give rise to the potential for fire to ignite combustible material within the external walls. For example, if a fire were to occur on a balcony, especially one which has combustible decking, due to the use of a barbecue, such a fire could give rise to direct flame impingement on the external walls or spread to other balconies. Such hazards need to be considered, albeit the extent to which controls can be applied is outside the scope of this PAS.

This again highlights the iterative nature of the relationship between an FRAEW and the building’s FRA.

Where fire protection systems or equipment, e.g. rising mains, have been taken into account in the FRAEW, it is assumed that they are working correctly; it is further assumed the building’s FRA would have checked the records of testing and maintenance of such systems.

A table of examples of the various risk factors arising from consideration of the fire strategy/ fire hazards that can influence judgement of the fire risk posed by the external wall construction is included in Annex F. This includes those relating to fire and rescue service intervention (see also Annex E).

A simple risk rating is adopted in this PAS, in which the outcome from the assessment will be that the risk is either “low”, “medium” or “high”.

This is not to suggest that the process of determining the outcome is necessarily simple. Rather it is intended to aid decision-making by focusing on those buildings in which the risk is less clear cut and more in-depth assessment might be needed.

In simple terms, positioning the risk level on a scale of “low” to “high” risk is ultimately dependent on addressing the following questions.

- Is external spread likely to be within normal expectations based on the methodology in this PAS and taking into account the consequence of such fire spread?
- If external spread is likely to be more rapid than normally expected, is the likely rate of spread clearly unacceptable in terms of life safety based on the methodology in this PAS, again taking into account the consequences?

Normal expectations of tolerable external fire spread, based on the methodology set out in this PAS, are that people will be able to escape or be rescued by the fire and rescue service before being harmed.

An affirmative answer to i) would support the conclusion that the fire risk posed by the external wall construction and cladding is considered sufficiently low not to warrant any action.

An affirmative answer to ii) would support the conclusion that the fire risk posed by the external wall construction and cladding is too high, with the consequence that action is necessary to address this risk. However, it does not follow that the only course of action is to remove and replace the combustible elements of the external wall construction. It might be that, to conclude this, it is necessary and indeed appropriate, first to conduct a more in-depth level of technical assessment. Equally, there might be circumstances where the alternative of commissioning a large-scale fire test in accordance with BS 8414 is the most appropriate way forward.

Some form of remediation works to the external façades might ultimately be necessary, but equally, in some circumstances, a more proportionate response might be improvements or alterations to the fire safety design and fire strategy in the building. For example, in some cases, this could be retrofitting sprinklers into the block, or, in some cases, albeit rarely, changing from a stay put strategy to an immediate, simultaneous evacuation strategy by introducing a fire detection and fire alarm system, although these approaches might have limitations (see also Annex G).

Where neither i) nor ii) can be answered in the affirmative, the risk sits somewhere in between "high" and "low" and, hence, is deemed "medium" risk. Such a "medium" risk outcome poses two further questions.

- iii) If external spread is likely to be more rapid than normally expected, is the heightened risk from external fire spread tolerable in terms of life safety, based on the methodology in this PAS, again taking into account the consequences?
- iv) Is further action needed to determine where the risk level sits?

It is anticipated that, given the limitations in the current state of knowledge and ability to predict fire behaviour, many FRAEWs will need to assume a higher risk than would otherwise be the case. In some cases, this could lead to a recommendation to tolerate, for a period of time, the assumed heightened risk from external fire spread. However, it follows that the risk needs to be kept under review, which will involve periodically revisiting the FRAEW, particularly if new information and knowledge emerge on the fire performance of materials used in the external wall construction and cladding.

The need to refine the appraisal of fire risk to give a more conclusive outcome is likely to be necessary when, for example:

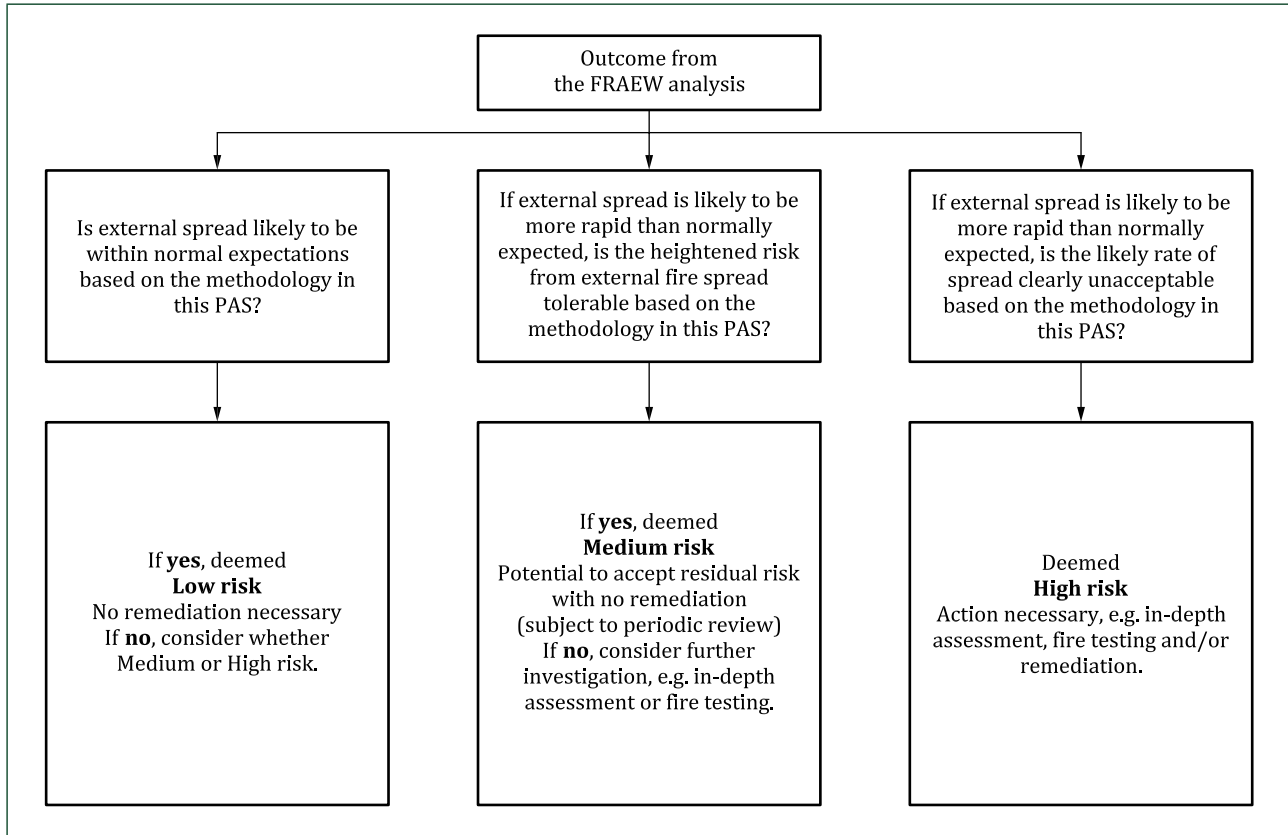
- the conclusion is highly dependent on the fact that the wall build-up is similar, but not an exact match, to one classified to BR 135 [15], based on BS 8414 test data, but meeting the pass criteria in BR 135 for this build-up is known to be particularly susceptible to changes in the parameters of the wall construction; or
- through intrusive inspection, deficiencies in the external wall construction have been found to be present on a scale that is of concern in terms of the potential influence on the outcome of the assessment.

This could warrant either conducting an in-depth level of technical assessment, for example, using fire engineering analysis (Clause 14) or, possibly, some form of ad-hoc fire testing or even, in some cases, a large-scale fire test in accordance with BS 8414.

The potential risk outcomes are summarized in Figure 2.

The fact that an external wall assessor carrying out an FRAEW using the basic level of assessment described in Clause 13 might conclude that a further in-depth technical assessment is needed does not imply failure on the part of the assessor. It is a valid conclusion and might rightly reflect acknowledgement by the assessor of the limits of their competence. That such a potential conclusion could be reached ought to be agreed with the client at the outset of the FRAEW.

Figure 2 – Risk outcomes in relation to expectations of the rate of fire spread over the external walls



d) Blocks of flats below 18 m

As discussed in Clause 6, having an understanding of the requirements and standards applicable at the time of construction, and how these have changed over time, helps to build up a picture of the expectations for the performance of a building's external walls in the event of fire, and how this is influenced by the type, height and use of the building. For buildings with a top storey less than 18 m in height, traditionally, there have been no restrictions on the combustibility of the external wall construction, and only in limited circumstances any requirements relating to the reaction to fire classification of surfaces. It is inherently possible, therefore, that where elements of the external walls are combustible, external fire spread would occur at a much more rapid rate than on buildings over 18 m in height, where restrictions on the classifications of surfaces and combustibility of the walls were in place at the time of construction.

This is still the situation that applies in the case of new buildings with a top storey below 18 m in height constructed in accordance with ADB ([8], [9]), albeit that the imperative in functional Requirement B4(1) to ensure that the external walls of the building adequately resist the spread of fire over the walls is just as applicable to low-rise buildings as it is to those over 18 m in height. At the time of publication of this PAS, ADB ([8], [9]) continues to place no restrictions on combustibility, and again, only very limited controls on reaction to fire classification of surfaces of buildings less than 18 m in height.

This inherent acceptance of much more rapid fire spread over the external walls is, nevertheless, clearly predicated on the understanding that there would not be an unacceptable risk to occupants and that other aspects, such as cavity protection in the wall build-up, where applicable, and adequate access and other facilities for the fire and rescue service are present, to the extent necessary, to enable effective intervention.

On this basis, it could be argued that an assessment of the fire risk posed by external walls of low-rise blocks of flats (buildings with a top storey below 18 m in height) ought ordinarily to place the building in the “low” risk category. However, with current knowledge of the burning behaviour of certain materials and how the configuration of these on the building can promote rapid fire spread at a rate much greater than previously anticipated for low-rise buildings, it is possible that an external wall assessor might place the risk in the “medium risk” category, albeit still considering the risk tolerable.

The likelihood of rapid fire spread (e.g. of the same order experienced in fires where Category 3 ACM is present or there is excessive use of timber or other combustible materials, configured in such a way as to promote unusually rapid and extensive fire spread) was not previously anticipated in the case of low-rise buildings. Accordingly, the potential for such rapid fire spread, even in the case of a low-rise building, would result in the conclusion that the risk is unacceptably high. Issues around deficiencies in the construction of the walls might also lead an external wall assessor to conclude that further and more in-depth technical assessment might be necessary to refine the risk. Concerns regarding effective intervention by the fire and rescue service might also lead to this conclusion.

7.1 The findings of the FRA, where available, should be taken into account in carrying out the FRAEW. Similarly, the outcome of the basic level of assessment for an FRAEW, as set out in Clause 13, should be used to inform the building’s FRA. It should be documented accordingly, such that the fire and rescue authority and other stakeholders can see evidence of suitable and sufficient consideration of the fire risk posed by the external walls.

7.2 Where the FRAEW establishes an immediate risk to life, the external wall assessor should notify the responsible person as soon as possible, giving details of mitigating measures that might be appropriate. It is necessarily the case that, if there is an immediate risk to life, there will be significant findings in the FRAEW, and the external wall assessor should therefore recommend that a review of the building’s FRA be carried out, taking into account the FRAEW’s findings and recommendations on the necessity for, urgency of, and nature of, interim measures that are considered appropriate.

7.3 Buildings determined to be “low” risk, following a basic level of assessment, should be eliminated from further consideration in relation to the fire risk posed by the external walls of the building.

7.4 Where a “medium” risk outcome is established but the risk is nevertheless considered to be tolerable, the FRAEW should be kept under review at a frequency determined by the external wall assessor. While it does not follow that, in conducting a review, the FRAEW needs to be repeated, it should, at least, include reviewing any updated or new information and knowledge relating to the fire performance of materials used in the external wall construction and cladding, to determine whether it has any bearing on the outcome of the original FRAEW. The external wall assessor should recommend that the action plan within the building’s FRA identifies the need for such a review.

7.5 Where a “medium” risk is established in which it is not possible to conclude that the risk can be tolerated, or where there is a “high” risk outcome, the external wall assessor should determine the value of conducting a more in-depth technical assessment, such as one based on fire engineering analysis, as set out in Clause 14, in order to establish a more definitive risk rating. Such an in-depth technical assessment should be recommended to the client where deemed appropriate.

7.6 The external wall assessor should determine whether fire testing, either in conjunction with, or as an alternative to, a further in-depth technical assessment is likely to be more effective at resolving outstanding uncertainty as to the risk, and the nature and extent of measures appropriate to mitigate the risk or remediate the external walls.

7.7 External wall assessors should make their clients aware, at the outset, that there will be circumstances, based on the outcome of the FRAEW’s basic level of assessment, in which, in order to be more definitive as to the level of risk, there is a need to extend the assessment by further investigation and in-depth technical assessment.

7.8 Where fire testing and/or further in-depth technical assessment are considered to be appropriate, external wall assessors should have the necessary competence either to conduct such tests/assessments themselves, or to identify situations where there is a need to involve other professionals and advise the client accordingly (see Clause 8).

7.9 Where it is concluded, following such further in-depth technical assessment or other means of further investigation, such as fire testing, that the risk is still unacceptable, the external wall assessor should make the client and the fire risk assessor fully aware of the meaning of the outcome, so that an appropriate action plan can be formulated to mitigate the risk or undertake remediation works. This action plan should take into account the need for prompt action in the cases of significant concern, which might mean introduction of interim measures such as a temporary change to a simultaneous evacuation strategy while remediation is carried out.

7.10 In determining the level of risk, external wall assessors should understand the limitations of fire and rescue service intervention, and avoid over-reliance on such intervention to compensate for adverse features of the external wall construction in relation to its performance in fire. There should be particular cognizance of factors that might be detrimental to intervention being effective, e.g. access restrictions for firefighting vehicles.

NOTE *Guidance on matters that influence the effectiveness of fire and rescue service intervention is given in Annex E, and some specific risk factors to be considered are discussed in Annex B.*

8 Competence of external wall assessors

COMMENTARY ON CLAUSE 8

It is essential that persons conducting FRAEWs are competent, in order to give building owners, occupiers, enforcing authorities and other stakeholders confidence in the use of a risk-based approach and in the outcome of the assessment.

Professionally ethical behaviour needs to be at the forefront of implementation of this PAS. The focus of the recommendations and guidance in this PAS is life safety. However, commercial and financial concerns have a significant influence on the attitude of clients and other stakeholders to the FRAEW and to those carrying it out. Consequently, it is likely that professionals carrying out the work will occasionally come under pressure to provide an outcome that suits a client's commercial, financial or legal position. This might manifest itself as pressure to confirm that everything is compliant, usually by reference to Building Regulations [7] and the supporting guidance in ADB ([8], [9]).

Conversely, the building owner might have an interest in future-proofing the value of the building asset against new Building Regulations [7] and, where engaged in a claim against another party or applying for funding, a client might pressure the professional to exaggerate risks to bolster the client's position.

As set out in Clause 6 and in the methodology in Clause 13, this PAS sets out a risk-based approach. It does not purport to be a means of using compliance with the Building Regulations [7] as the sole basis of determining whether a building is adequately safe with respect to external fire spread.

External wall assessors need to avoid influence on their decision-making by such pressures and need to, essentially, regard themselves as making an expert decision based on evidence that they need to be satisfied is sufficiently reliable to support the conclusions they make.

As with any professional service, external wall assessors need to be mindful that the standard of behaviour which has been followed could ultimately be tested in a court of law. The user of this PAS is advised to approach FRAEWs with that in mind.

Since the Grenfell Tower fire, competence has been a major consideration in changes to the way buildings will be built and maintained in future. Because professionally ethical behaviour is of such importance, this PAS includes recommendations on competence. This reflects the position taken in Issue 2 of the "Setting the Bar" report [26], which makes recommendations on assurance of competence and ethical practice.⁶⁾

Whilst it is recognized that professional body memberships and professional qualifications do not guarantee ethical behaviour and competency, they do provide responsible persons and others with control of buildings with confidence regarding the competence of those engaged to carry out FRAEWs. This does not mean that those without such memberships and qualifications lack competence in carrying out an FRAEW; it is simply that there is no independent verification of their competence.

It is not uncommon for external walls to be examined by building surveyors, architects, façade engineers and others in order to establish factual information on the materials, components and systems forming the external walls and to determine the method of construction and standard of workmanship. However, an FRAEW completed in accordance with this PAS goes much further than simply establishing factual information; it requires interpretation of this information to formulate an opinion on the fire risk posed by the external walls. This requires not only an understanding of the fire behaviour and fire performance of materials, components and systems forming the external walls of blocks of flats, but also an understanding of fire hazards and the fire safety features applicable to blocks of flats, including the design principles of compartmentation, means of escape, smoke control systems, fire detection and fire alarm provisions (to the extent relevant), etc.

An external wall assessor, therefore, needs to possess knowledge of the fire strategy considerations and regulatory framework underpinning the fire safety design of such buildings.

⁶⁾ At the time of publication of this PAS, a suite of standards is in preparation relating to competence in the built environment. This includes PAS 8673, which deals with competence requirements for the new role of Building Safety Manager.

This does not preclude building surveyors, architects, façade engineers and others from conducting the necessary tasks to gather factual information on what the external walls on the building comprise, whether as part of a team in conjunction with a fire engineer or fire safety professional, or separately. However, they need to be able to demonstrate the necessary competence appropriate to carrying out this task.

It does not follow that all fire engineers will have the necessary skills, knowledge and experience to undertake FRAEWs, even at the basic level required by the methodology in Clause 13, let alone a more in-depth technical assessment, particularly one involving fire engineering analysis as discussed in Clause 14. It is important that those commissioning FRAEWs seek evidence of competence with respect to those assessing the fire risk posed by external wall construction and cladding. In particular, clients need to establish that the external wall assessor has the necessary competence to match the level of assessment required.

Guidance on relevant skills, knowledge and experience for the different roles of external wall assessors, based on the National Qualifications Framework⁷⁾, is given in Annex H.

Clause 13 provides details of the methodology for consideration of the fire risk presented by external wall constructions; the guidance envisages that there might be a need to escalate the process from a basic level of assessment to one requiring more in-depth technical assessment. Initial inspection to identify the form of external wall construction could, to begin with, be approached as a means simply to filter out buildings of negligible risk where the amount of combustible material is inconsequential (e.g. enabling initial assessment activity to be undertaken according to this PAS by a suitable surveyor or other building professional). It would then be that person's responsibility to involve fire safety professionals (see Annex H) if it becomes apparent, from initial investigations, that the cladding is not of a form of construction that can be considered as representing a negligible risk, according to this PAS.

It is likely that those carrying out FRAEWs in accordance with this PAS will be required by clients to have an appropriate level of professional indemnity insurance that includes advice on external wall construction within the scope of its cover.

It is expected that external wall assessors will consider adopting at least an internal peer review as part of their quality assurance process for producing FRAEWs.

8.1 External wall assessors should determine that they have adequate and relevant competence to undertake the FRAEW, and have sufficient knowledge, skills and experience in relation to fire safety of external walls to be able to complete an assessment at the level required.

NOTE *External wall assessors undertaking the basic assessment methodology, as described in Clause 13, are advised to consider the desirability of holding professional qualifications. Suitable professional qualifications are likely to comprise relevant membership of a professional body that:*

- has a field of interest that includes the fire performance of building construction; and*
- has policies and procedures that are subject to accreditation and/or audit by a certification body accredited by UKAS, the Engineering Council or equivalent; and*
- has a whistleblowing policy, code of professional conduct and disciplinary procedure for its members; and*
- requires a person applying for admission to full member grade to have a minimum Level 4 qualification⁷⁾ in a science, engineering or construction-related subject.*

8.2 External wall assessors should be able to demonstrate evidence of competence to the client with respect to assessing the fire risk posed by external wall construction and cladding, including experience in conducting investigations into the fire safety of external wall construction and cladding.

8.3 External wall assessors should understand how materials used in external walls behave in fire and should have a knowledge of the fire performance standards required for such materials. They should also be able to understand the fire strategy considerations for such buildings and be able to make judgements regarding fire hazards and fire safety features that will influence the outcome of an FRAEW. Companies engaged in conducting FRAEWs should employ people who possess such skills, knowledge and experience, or engage with others who do.

⁷⁾ <https://www.gov.uk/what-different-qualification-levels-mean/list-of-qualification-levels>

8.4 External wall assessors carrying out information gathering, including intrusive inspection, should, at least, possess relevant skill, knowledge and experience in surveying or façade engineering, to enable an appropriate inspection of the building to be completed. They should be competent to determine the methods of construction and to identify, in sufficient detail, those aspects of the nature of the construction that are relevant to the carrying out of an FRAEW.

8.5 It is not suggested in this PAS that persons other than fire engineers cannot conduct FRAEWs in accordance with the basic assessment methodology set out in Clause **13**; however, such persons should be competent to appraise and assess the nature of the construction of the external walls in terms of their fire performance and provide an opinion on the risk. They should have an adequate level of knowledge, including on the fire performance standards relating to behaviour in fire of external wall materials and cladding systems, and on matters relating to fire strategy and fire safety design. They should have an understanding of, and experience in, applying a risk-based approach, e.g. through knowledge of, or practice in conducting, FRAs of buildings.

8.6 External wall assessors undertaking an in-depth technical assessment, such as one using fire engineering analysis, as described in Clause **14**, should have relevant experience in fire safety and the fire performance of external wall construction and cladding at a level necessary for such analysis.

NOTE *External wall assessors undertaking an in-depth technical assessment, such as one using fire engineering analysis, as described in Clause **14**, are advised to consider the desirability of holding professional qualifications. Relevant professional qualifications in this case are likely to include those described in the Note to **8.1**, together with the person being a chartered engineer registered with the Engineering Council (such as a person achieving that registration through a suitable professional body that ensures that the person has sufficient knowledge of the principles of fire engineering).*

8.7 External wall assessors should understand the limits of their competence and only undertake assessments at the level appropriate to their ability. They should advise clients when there is a need to involve others as a consequence of the complexity of the external wall construction, concerns regarding particular forms of construction and cladding over which they are unable to make judgements, or where in-depth technical assessment is required and this is outside their level of competence. They should make clear to clients at the outset that an outcome of an FRAEW might be a recommendation to undertake a more in-depth technical assessment of the type described in Clause **14**, and whether or not they have the necessary competence to conduct such an assessment.

8.8 External wall assessors should carry out appropriate continuing professional development in relation to the fire risk posed by external wall construction and cladding, so that they can demonstrate that they are aware of the latest research, test methods and knowledge on fire behaviour of external wall materials, components and systems and how they are configured on buildings.

9 Information required for completion of the FRAEW

COMMENTARY ON CLAUSE 9

As set out in Clause 13, in order to conduct an FRAEW, it is necessary to obtain as full a picture as possible as to the composition of the external wall construction and cladding, and how the walls have been constructed.

This includes details of the materials, components and systems forming the external walls and how they have been configured on the building.

Once the facts regarding the construction of the walls and the materials used have been established to the extent possible, further information can be sought as to their known fire performance.

Part of the process of establishing the facts is to assess how closely the walls appear to meet, and conform to, the relevant building regulations, guidance and standards that were applicable at the time of construction, and those that currently apply. From this, judgement can then be made as to the significance of any departure from accepted guidelines.

However, it is not implied that existing buildings can be expected to meet current building regulations and supporting guidance, nor is this a sole determinant of whether an existing building is safe in terms of the fire risk posed by the external walls. Nor is it implied that a detailed gap analysis needs to be undertaken between the standards that apply now and those that applied at the time the building was constructed. Nevertheless, the extent to which a building conformed to building regulations, guidance and standards at the time of construction is important for context when considering the risk. Only with a clear understanding of what the intention was, in terms of conformity at the time, can the significance of the differences in current expectations be considered.

Key aspects of the information gathering needed for an FRAEW are:

- conducting a document study;
- completing on-site verification;
- establishing likely performance; and
- reviewing test data.

These are discussed further in Annex I.

External wall assessors might utilize the resources, skills, expertise and knowledge of others such as contractors, architects, surveyors and façade engineers to assist in undertaking a document study, conducting on-site verification and establishing what is known on the likely performance of materials and components that have been installed on the building, as well as the method of construction.

Fire safety specialists undertaking FRAEWs are likely to need such resources or additional expertise where the design of the wall construction and cladding systems is particularly complex, where the scale of the task is beyond their resources, or where the construction techniques involved are highly specialized. In such cases, the external wall assessor would be expected to take responsibility for the input of others to ensure that the tasks required to enable all necessary information needed for the FRAEW are clearly defined and delegated, and that the expectations placed on the output of others are clearly understood by them. The external wall assessor would be expected to ensure that others assisting them in this way are suitably competent (see Clause 8).

It is also likely that external wall assessors will be presented with reports of investigations carried out by others prior to the FRAEW being commissioned. Such investigations could be conducted by, for example, the client's own in-house professionals, or an organization commissioned by the building developer, building contractor or other interested party.

It is important that, when presented with such reports and information, external wall assessors consider the extent to which these can be relied upon, and what steps might be necessary to establish the veracity of the information provided and how comprehensive it is. It would not be expected that an external wall assessor would simply complete their assessment, based solely on a desktop exercise using a third party's report of this kind and without at least an element of visual inspection of the building. Indeed, it would not be expected that a report such as this on the materials and components used in the construction would identify all of the relevant risk factors to be considered in an assessment when following the methodology set out in Clause 13.

Similarly, while the building's FRA is, where available, clearly a relevant source of information on the fire safety design and fire strategy for the building, an external wall assessor would be expected to verify key information from this where it is critical to the FRAEW and its outcome.

9.1 External wall assessors should conduct a study, where possible, of all original documents relevant to the building's construction and performance in fire, and of its FRA. On-site verification should be carried out to establish the veracity of the information, the extent of which should be determined by the quality and extent of the documentation available.

9.2 Where details on the composition of the external walls and the methods of construction used cannot be established from documentation and initial on-site verification work, the extent of site survey and inspection should be increased accordingly (see Clause 10).

9.3 Manufacturers' technical literature and other readily available sources of fire performance test results and classifications should be scrutinized as part of establishing what is known about the fire performance of individual materials, components and cladding systems forming part of the external walls. The limits of applicability of test results and classifications should be established. Where appropriate depending upon the criticality of this information or the depth of information needed, primary evidence, including fire test laboratory reports and classification reports, should be scrutinized.

NOTE *It is also important to understand whether the systems and products have been installed in accordance with the manufacturer's technical literature, albeit that not all deviations from manufacturers' literature might be significant.*

9.4 Where others, with the necessary resources or specialist knowledge, are engaged to assist an external wall assessor in gathering information, the external wall assessor should retain overall responsibility for verifying that all necessary and relevant information is produced to enable the FRAEW to be completed. When engaging others to assist in this way, the external wall assessor should verify that they are competent to undertake the tasks delegated to them and that the expectations in terms of the output of others are clearly defined.

9.5 Where presented with reports of investigations carried out by others who have been commissioned separately to, and not as part of, the FRAEW process to provide information, external wall assessors should determine the extent to which the information can be relied upon, and what steps are necessary to establish the accuracy and completeness of the information in such reports. External wall assessors should not absolve themselves of the responsibility to verify, to the extent reasonable and necessary, the veracity of the information from others upon which they rely to complete the FRAEW.

10 The FRAEW site survey and inspection

COMMENTARY ON CLAUSE 10

No matter how comprehensive the original design information for the external walls on a building might be, it can only ever show what was intended to be constructed. What has actually been built can be quite different. Product substitution is not uncommon, and sometimes there are highly significant differences in fire performance between products selected for use in the construction of the buildings and those that have actually been used.

Site survey and inspection is, therefore, a vital part of establishing factual information on the composition of the external wall construction and cladding and how the walls have been constructed.

The extent of site survey and inspection required in order to complete an FRAEW will vary. This is determined by the nature and extent of the information required, which, in turn, is dependent on the outcome of the initial information gathering stage and study of available drawings and other documents (see Clause 9). Site survey and inspection can serve different purposes, and is likely to include some, or all, of the following:

- removal of components to confirm the wall build-up and the exact materials and products used. This would aim to establish the manufacturer and details of which of its products have been used;
- sampling of materials and components for small-scale testing to determine basic fire performance parameters such as combustibility (calorific potential), or the reaction to fire classification of the product in accordance with BS EN 13501-1;
- exposure of walls at key locations to establish the presence of cavity barriers, where appropriate, the methods of construction used, the standard of workmanship, the condition of components and any evidence of deterioration of the cladding system. This would include not only the facings, insulation, etc., but also the fixings and supports; and
- verification that the construction as built matches the design information or any other documents viewed as part of the document study (see Clause 9).

Where limited site investigations show that the installation deviates from the design described in the specification and drawings, it is likely that further, more detailed, analysis of the materials and components used will be needed in order to establish their likely performance.

This might involve testing and analysis of the physical and/or chemical properties of a material or components in order to establish:

- the physical characteristics of materials that are unidentified, or unbranded, and for which there is no reliable technical information, in order to compare performance with that of materials specified but not used; and
- the performance or reaction to fire of a material or component, to enable an assessment of any risk associated with the use of the material or component, in association with other materials and components, either within a system under consideration, or for use in a proposed system.

This requires the removal of material from the building for testing and analysis by a testing establishment. Testing of this type can be time-consuming and expensive.

In many cases, it is expected that relatively limited inspection and opening up (on-site verification) will suffice to establish key factual information on the type of cladding and the method of construction. However, the findings from this limited sampling might dictate that further opening up is undertaken and the sampling increased.

The degree of sampling needed in a site survey and inspection for the purpose of establishing the fire risk posed by the external walls cannot be stipulated in this PAS. The external wall assessor needs to make a judgement as to what is appropriate, in the particular circumstances of the building under assessment. Flexibility to expand upon the sample size needs to be agreed with the client and included in the scope of the FRAEW.

The degree of sampling is likely to be influenced by a number of factors, including:

- the extent of, and quality of, documentary information on the construction of the external walls, such as specifications and drawings, from the time the building was built or overlaid;
- the size of the building;
- the number and complexity of the cladding systems present;
- accessibility to remove cladding components and/or take samples; and
- the findings from the initial site survey and inspection.

In planning for sampling, it is expected that proposed locations for sampling and other relevant information needed by those conducting the investigation work would be recorded ahead of carrying out the investigation. This is likely to be useful when communicating with clients, residents and others as to the scope of the investigation.

Persons undertaking site survey and inspection work would be expected to have the necessary survey skills and knowledge of external wall construction to conduct, or direct others in, the investigations required to ensure that, when components of walls are removed and samples taken, undue damage is avoided and the appropriate repairs can be made.

Where external wall assessors are presented with reports of investigations carried out by others prior to the FRAEW being commissioned, these can also influence the degree to which a site survey and inspection needs to be carried out as part of the FRAEW.

The external wall assessor needs to make a judgement on the extent to which they will rely on the work of others. This depends upon the external wall assessor's perception of the quality of the work carried out and whether it is likely to be sufficient in terms of what it has addressed and its scope.

It is unlikely that an external wall assessor could rely completely on a third party's report without satisfying themselves of the veracity of the information it contains. It is expected that there will be, at least, an element of visual inspection of the building to ensure that the third party's report is comprehensive in its description and treatment of the external walls on the building. Some degree of opening up is reasonable in these circumstances. However, this would be expected to be limited in extent.

Further commentary on the FRAEW site survey and inspection can be found in Annex J. This relates specifically to:

- *considerations of methods of construction and workmanship; and*
- *invasive investigation and sampling.*

10.1 Site surveys and inspections of external walls for an FRAEW should be planned such as to minimize the need for opening up work and maximize the benefit where such work is required. Plans for opening up might need to be communicated to various parties and this should be taken into account when documenting such plans.

NOTE *Any opening up can result in costly repairs, or other negative consequences, hence the need to avoid undue removal of cladding and exposure of the wall construction.*

10.2 An appropriate number of inspection locations should be established, taking into account the purpose of the opening up work and factors such as:

- a) the extent of, and quality of, documentary information on the construction of the external walls, such as specifications and drawings, from the time the building was built or overlaid;
- b) the size of the building;
- c) the number and complexity of the cladding systems present; and
- d) accessibility to remove cladding components and/or take samples.

10.3 Flexibility to expand upon the number of inspection locations should be agreed with the client and included in the scope of the FRAEW, if the findings from the initial site survey and inspection suggest this is necessary to determine factual information on the cladding system and wall build-up, or to investigate concerns relating to workmanship, deficiencies and deterioration.

10.4 Where presented with reports of investigations carried out by others prior to the FRAEW being commissioned, external wall assessors should plan the inspection so that it can assist in establishing the veracity of the information they contain to the extent considered necessary.

NOTE *Wholesale repetition of opening up work conducted by others is unlikely to be necessary, but expansion on the sample size, as agreed with the client, might be appropriate if limited opening up has identified significant shortfalls in the quality and accuracy of the findings of previous investigations.*

10.5 Persons undertaking site survey and inspection work should be competent to conduct, or direct others in, the investigations required. They should have appropriate skills, knowledge and experience, when removing components of walls and taking samples, to avoid undue damage and enable appropriate repairs to be made.

10.6 Persons undertaking site survey and inspections should accurately record their findings in a form suitable for inclusion in an FRAEW report, including plans and photographic evidence where appropriate. The findings should be presented in such a way as to enable persons scrutinizing the report to be able to determine:

- a) the locations in which opening up took place, and from which samples of materials and components have been removed in order to identify the make and manufacturer, etc.;
- b) the identity of samples removed for testing, and locations from where they were taken;
- c) the nature and extent of deficiencies, deterioration of products and workmanship issues identified, and the locations where they were observed; and
- d) differences between what is found in reality and the building's original design.

11 Fire performance of different external wall materials, systems and configurations

COMMENTARY ON CLAUSE 11

In Clause 7, benchmark criteria are set out that are considered appropriate for use in a methodology aimed at assessing the fire risk posed by the construction and cladding of external walls on existing buildings. These are necessarily subjective, requiring professional judgement by competent persons in their application. However, the aim is to evaluate existing buildings from first principles on the basis of the particular set of facts and conditions that apply.

Having identified that the external walls contain combustible material, the external wall assessor needs to refine their understanding of how this material, whether in isolation or in combination, will cause the walls to perform in fire. As part of this, they need to establish the quantity of the material, its location within the wall build-up and, as far as possible, its behaviour in fire.

While it is not possible to quantify the performance of the particular form of external wall construction on the building being assessed, the rationale behind the methodology set out in Clause 13 is that all the available information on fire performance can be accumulated, with a view to determining what can be gleaned regarding the possible rate of fire spread and its consequences.

The inherent limitations of this approach, and the uncertainty that, inevitably, has to be accepted as part of it, are recognized. However, simply concluding that a material or component is combustible does not enable a measured assessment to be made of the fire risk posed by the external walls on a building, or decisions regarding what is appropriate action in response.

It is expected that an external wall assessor will attempt to build up as complete a picture as possible of the known fire performance indicators for the materials, components and systems forming the external walls in order to make, as far as reasonably possible, a judgement on the relative risk the walls pose in terms of external fire spread.

Ultimately, the aim of this is to rank the fire performance of the external walls under assessment, even if only broadly, on a relative scale that, at one end, includes the excellent level of fire performance from a double skin masonry wall (each leaf at least 75 mm), to, at the other end, the generally unacceptable level of fire performance of Category 3 ACM. This assists in providing context for considering whether the walls provide an acceptable level of fire performance.

The ranking of fire performance needs, to the extent possible, to take into account the outcome of small, intermediate and large-scale fire tests where these give directly relevant results.

Basic information on how materials burn and react when exposed to heat sources and flames needs to be taken into account, using properties such as:

- ease of ignition;
- combustibility;
- heat released (calorific potential);
- rate of heat release;
- propensity to produce smoke; and
- propensity to produce burning droplets.

Some of this information can be used directly in the basic assessment methodology to determine the suitability of external walls on existing blocks of flats, set out in Clause 13. Examples of factors utilizing test data and performance classifications are included in Annex K, which gives a table of positive, negative and neutral risk factors that form the basis of the assessment methodology. This includes information and classifications based on fire tests; it also includes other factors that are likely to influence fire performance (such as the method of fixing of facings) albeit many such considerations cannot be anything other than subjective in terms of their contribution in a basic assessment approach.

When considering the complexity of external wall construction and cladding, there are significant limitations of information and classifications based, in particular, on small-scale tests. Indeed, the necessity for, and development of, the test methods within the BS 8414 series of standards for large-scale fire tests of cladding systems came from recognition of the limitations of small-scale test data and classification, and of the need not to treat materials and components in isolation, but to determine how, in combination, they might perform.

Although of direct and particular relevance, even these test methods have important limitations. For example, they are not intended to be applicable to glazed systems, curtain walling or timber-framed construction, although, in principle, the methodology can be used to test some cladding systems that are outside the scope of these standards.

Annex A contains a description of many of the applicable fire tests and how the results are used as part of performance classification systems, including large-scale BS 8414 tests and the classification criteria in BR 135 [15].

Although current guidance in ADB refers only to European tests in relation to fire performance parameters, existing blocks of flats are likely to have been built either prior to the adoption of these standards, or might have relied on classifications based on national test methods. Accordingly, there is also reference to the previous national classifications in Annex A; these are relevant when considering the performance of materials and products used in external walls of existing buildings.

It is particularly important to understand the basis of the Class 0 classification for linings used in relation to surfaces of external walls. This has been used extensively in the past as a fire performance parameter, even though, since the publication of the 2019 edition of ADB ([8], [9]), only the European classification system is featured.

Annex L provides information on common components in different types of cladding systems when considering the generic fire properties of external wall materials, systems and configurations. It describes the basis of performance typically obtained from various types of products. However, while these descriptions might be reasonably relied on where no product-specific information is available, where product-specific information enables products to be identified, then their product-specific information takes precedence over the information in this annex.

Annex M provides further commentary relating to fire performance considerations of different external wall materials, systems and configurations.

The scope for a fire involving the external walls to circumvent the compartmentation in a building is an important consideration and is also discussed in Annex L and Annex N, in which situations in which this can be a factor are highlighted.

As stated elsewhere, large-scale testing is not a practical means to establish fire performance of external walls of existing buildings and, therefore, is not part of the methodology of basic assessments described in Clause 13. Nevertheless, there might be circumstances in which conclusions cannot be drawn, using this methodology, on the risk posed by the external walls of a building. Further investigation might be needed to resolve or refine the risk rating and, as well as in-depth technical assessment, this could involve fire testing, including large-scale BS 8414 tests. However, for avoidance of doubt, it is not expected that this would be a routine outcome from an FRAEW conducted in accordance with this PAS.

11.1 When an external wall assessor has identified that combustible material is present, they should then establish the significance of that material on the likely rate of fire spread, based on an understanding of the quantity of the material, its location within the wall build-up and its behaviour in fire.

11.2 The FRAEW should establish, to the extent possible, all available indicators of the fire performance of the materials, components and systems forming the external walls of the building under assessment. Where available, information that enables the performance of external walls to be determined, by comparison to known forms of construction that are considered to give rise to either acceptable risk or unacceptable risk, should be used to place the anticipated performance of the walls in context.

12 Considerations for fully and partially clad buildings

COMMENTARY ON CLAUSE 12

In the context of a risk-based approach, as outlined in this PAS, appraisal of the fire risk posed by external wall construction and cladding is based on more than simply determining the presence of combustible material and evaluating the likely rate of fire spread.

While drawing comparisons to other forms of construction that are known to be acceptable or, equally, that give rise to unacceptably rapid fire spread, which is an important step in the process (as discussed in Clause 11), it is equally as important to consider the consequences of such fire spread.

The resultant occurrence of secondary fires, on other floor levels, as a result of such fire spread, is of particular importance. Similarly, the consequences, in terms of occupants being able to evacuate in time in the event of fire spread into other flats, or into the escape routes from the building, as well as the likelihood of effective intervention by the fire and rescue service, are important considerations.

The influence of risk factors relating to the building's fire safety design and evacuation strategy is set out in Clause 7. In the present clause, consideration is given to the configuration of combustible external wall construction and cladding on the façades of the building, how this might influence the scope for unduly extensive fire spread over the external walls, and the likelihood of it spreading back into the building. These considerations relate to aspects of façade configuration.

Particular considerations include:

- *the position of the cladding and, especially, the height of the cladding above ground level, and its impact on the scope for ignition of the cladding by an external fire (e.g. a fire involving a parked vehicle or waste skip);*
- *the vertical extent of the cladding (and, therefore, how much of the building would be exposed to vertical fire spread upwards, which is likely to occur at a faster rate than fire spreading horizontally, to window openings or other routes for fire to spread back into the building);*
- *the potential scope for fire to spread downwards (e.g. from falling debris) by ignition of exposed combustible elements of the walls below;*
- *the horizontal extent of the cladding (although horizontal fire spread will be much slower than that in the vertical plane);*
- *the scope for fire to bypass compartment floors and walls (in particular, where cladding extends over a compartment boundary);*
- *the presence and extent of cavities (in particular, where these run continuously over a façade without, for example, being broken by a projecting floor slab, and to what extent there is protection by cavity barriers/stops to limit the scope for fire spread via such cavities);*
- *the presence of combustible infill/spandrel panels (in particular, whether these will give rise to a fire cascading vertically from one panel to another up the building, and whether they are in line with window openings or offset sufficiently to reduce the scope for fire to spread to the window);*
- *the sections of walls set back from the remainder of the walls below, as commonly found with penthouse flats or blocks of flats built on a podium (in particular, by being set back from the building's wall edge, there is limited scope for direct flame impingement on the cladding from a fire breaking out of a window on a projecting lower level);*
- *overhanging cladding, resulting from floor level changes with a larger floor plate, such that the wall of upper levels project out from those of lower levels (in particular, where the soffit of the overhang provides scope for flames from a window to spread horizontally before rising from the edge of the overhang and exacerbating vertical flame spread, especially where the construction of the soffit itself comprises combustible material);*
- *the proximity of the windows of flats to the cladding (and the extent to which this gives rise to scope for secondary fires on other levels, due to fire spreading back into the building);*
- *the proximity of windows in escape routes to the cladding (and the extent to which this gives rise to scope for fire to spread back into the building that could compromise the use of the route for escape);*
- *the proximity to AOVs and other components of smoke control systems protecting the means of escape;*
- *the presence of ventilation openings and other openings for services (and the extent to which these could provide a route for fire spread back into the building); and*

- the presence of balconies and other attachments (and whether these will interrupt and limit cavities, deflect flames away from the cladding or exacerbate flame spread due to being combustible themselves).

Consideration of all of the above can lead to a specific set of risk factors for a building that can be used in the overall assessment of the fire risk. This is set out in Clause 13.

Some of these will positively influence the outcome. This would occur where there are factors capable of, for example, minimizing the likelihood of early ignition of the cladding (e.g. because there are no windows opening onto the cladding, or it starts at a level sufficiently high enough from the ground to avoid being ignited from an external fire, such as from a vehicle parked underneath), how far fire can spread (e.g. because there are no continuous sections of cladding extending vertically to multiple levels above), and whether it can lead to fire spread back into the building (e.g. because the distance of windows from the combustible cladding is sufficient to avoid the potential for the windows to be attacked by flames).

Equally, some might negatively influence the outcome. Examples of negative risk factors include cladding that is close to the ground and, therefore, more exposed to external fires, or cladding that is widespread in coverage with no break in the extent of cavities afforded by, say, changes in the shape or form of the external walls.

How façade configuration factors can influence judgement over the fire risk posed by the external wall construction is discussed in Clause 13, with examples of various such factors included in Annex N. Attaching weight to these factors, whether they are positive or negative in regard to the fire risk, and how significant each one is, is a matter of judgement on the part of the external wall assessor and, often, it is not possible to utilize any quantifiable measure. Nor, indeed, is this PAS able to set quantitative limits for most of these factors. It follows that, inherently, this will lead to subjectivity. Suitable competence to make such judgements is, therefore, paramount (see Clause 8).

The height of the building is also included as a risk factor. The extent to which a building's external walls pose a risk is inherently limited if the number of storeys is limited.

As discussed in Clause 7, for buildings less than 18 m in height, traditionally, there have been no restrictions on the combustibility of the external wall construction and, only in limited circumstances, any requirements relating to the reaction to fire classification of surfaces. It is inherently possible, therefore, that external fire spread would occur in such buildings at a rate that is more rapid, and with more secondary fires, than on buildings over 18 m in height, to which restrictions

on the classifications of surfaces and combustibility of the walls have applied. However, cavity barrier provision has been, and still is, an important measure in restricting the speed and extent of fire spread in these circumstances.

Buildings below 18 m in height typically comprise a ground floor plus up to five upper floors. In the case of a high-rise building with only partial cladding, if only the first six floors of the building were clad with combustible cladding, this is not materially different, in terms of external fire spread, from the same cladding on a low-rise building. On the other hand, if only the top six storeys of a high-rise building were clad with the same cladding, the situation would be different because of the difficulty of fighting a fire involving the cladding at that height. This exemplifies the need for consideration of the potential for firefighting by the fire and rescue service; even in low rise buildings the difficulties of tackling a fire involving external wall construction when operating at ground level using typically available equipment need to be recognized (see Annex E).

It is recognized that the trigger height of 18 m can be considered, to a degree, arbitrary and, to some, is viewed as inappropriate as a determinative factor as to whether buildings with external walls with combustible cladding are adequately safe. Indeed, with changes to ADB ([8], [9]) since the Grenfell Tower fire, such trigger heights have been revisited and different heights applied to various fire safety requirements for new buildings. Nevertheless, 18 m would have been used as the base line for the requirements and standards applied to the construction of many existing blocks of flats. It is unreasonable, in the context of the risk-based approach in this PAS, to disregard the importance this has had in terms of the extent to which external wall construction and cladding are combustible on such buildings, and the underlying acceptance that such requirements and standards were sufficient, and indeed might still be sufficient, to ensure the safety of those occupying such buildings.

12.1 Risk factors relating to the configuration of façades should be determined, in order to establish the context in which combustible external wall construction and cladding can give rise, not only to an undue rate of fire spread, but also to consequences in terms of the likelihood of secondary fires elsewhere in the building.

12.2 The influence of these risk factors should be taken into account as part of the structured approach to establishing a relative risk rating for the building, as set out in Clause 13. Appropriate weight should be attached to each one, by virtue of whether it has scope to influence the outcome positively or negatively.

13 Methodology for basic assessment of the suitability of existing external wall construction

COMMENTARY ON CLAUSE 13

a) Methodology

The FRAEW needs to follow a structured approach to determine an outcome with respect to the fire risk posed by the external wall construction.

This approach needs to seek to demonstrate to those commissioning the FRAEW and those, such as enforcing authorities, also relying upon its findings, that all reasonably practicable efforts have been made to determine and take fully into account:

- the likely performance of the external walls in a fire and how rapidly fire might spread, given the state of knowledge of, and ability to predict the fire behaviour of, the materials, components and systems used and how they are configured to form the cladding and external wall build-ups on the building;
- how the fire would develop and spread, when considering the actual configuration of the cladding, etc., on the façades of the particular building, taking all factors relevant to this into account, such as the extent of the cladding and its location on the building; and
- how such a fire could directly, or indirectly, cause harm to the occupants and impact on their ability to escape in time, given all of the features of the fire safety design of the building, the fire hazards relating to ignition of the cladding and the likely effectiveness of intervention by the fire and rescue service (see Annex E).

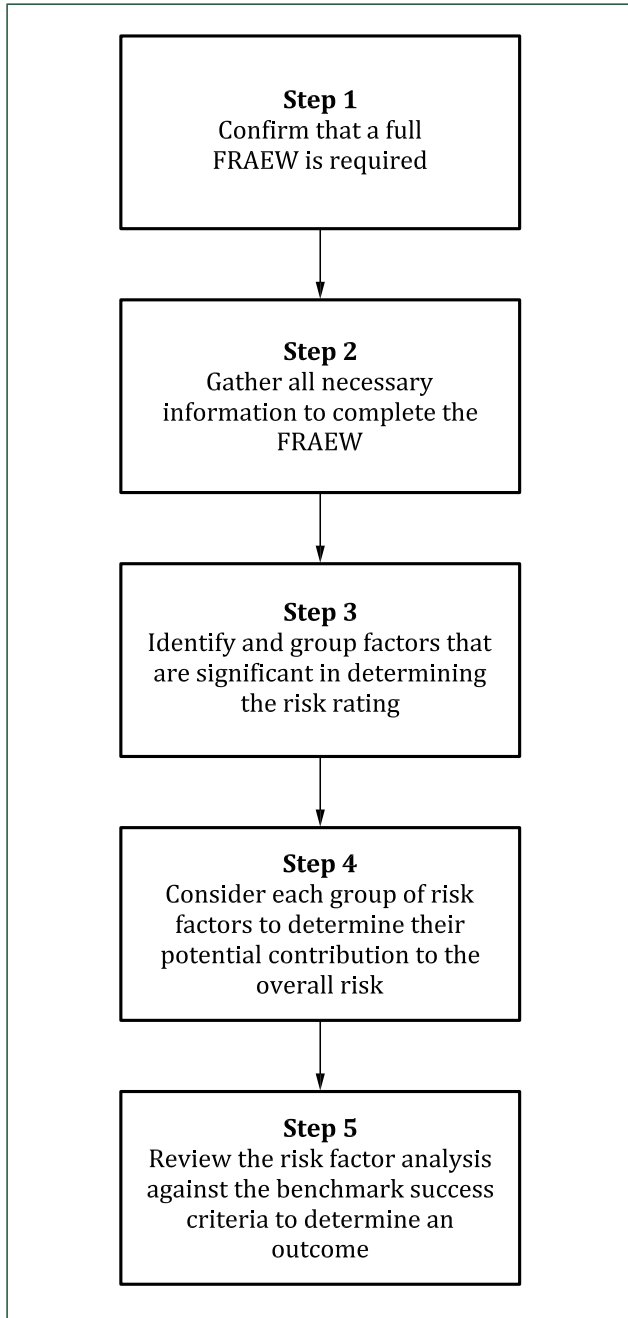
The principles behind the approach described above, and upon which the methodology set out below is based, are given in Clause 7.

The methodology set out below is intended as a basic level of assessment. It is expected that such an assessment would be feasible for a large proportion of existing blocks of flats. However, it is recognized that there will be circumstances in which further investigation, and more in-depth technical assessment, is warranted, in order to reach a conclusion on whether the fire risk posed by the external wall construction on a particular building is tolerable (see Clause 7).

The approach to a basic level of assessment, as set out below, comprises five steps, as illustrated in Figure 3. While these are described as discrete stages, this is only to illustrate the principle, and it is recognized that, in reality, one step might not follow the other in sequence. For example, it might not be possible to confirm that the walls require a full FRAEW until Step 2 is conducted, as the information upon which to assess whether, for example, the quantity of combustible material is inconsequential, might not be available until intrusive inspection is carried out. Equally, there might be sufficient information on what the cladding system comprises at the start of the assessment that it is possible to conclude, without formally going through the other steps, that in-depth technical assessment is necessary and that continuing with this basic level of assessment would not be conclusive.

The content of each of these steps is described below.

Figure 3 – Five step approach to the basic level of assessment



b) Step 1

FRAEWs are likely to be commissioned at different stages in the overall process by which the fire risk posed by external wall construction on an existing building is evaluated.

For example, it might be that the FRAEW is required because investigations, commissioned by a building owner in response to the Government advice, either from documentary evidence or from intrusive inspection or both, have identified that there is combustible material present, but the person carrying out the investigation is not competent to advise on the implications for the safety of occupants.

Equally, it might be commissioned due to a concern raised by a fire risk assessor when carrying out the building’s FRA or because the assessor made a generic recommendation in the absence of any definitive knowledge of the external wall construction.

However, knowledge of the materials, systems and configuration of cladding and external wall construction is likely to vary at this stage. In some cases, combustible material will be known to be present, but, in others, it might only be suspected, and, even where present, it might be so small in quantity for it to be inconsequential. It therefore follows that, where possible, and to avoid unnecessary effort and cost in proceeding further with the FRAEW, a first step is to confirm that an FRAEW conducted in accordance with this PAS is required.

In the unlikely scenario that, at this late stage, evidence comes to light that the external walls have been classified to BR 135 [15], this would mean that an FRAEW would not be necessary, unless again there are any other factors that might have a negative bearing on the risk, e.g. where excessive use of timber in balcony construction could lead to significant fire spread or there is concern regarding the adequacy of cavity barrier provision or quality of workmanship (see below).

It is inevitable that some combustible components are present in the build-up of any external wall. Typically, these include components such as:

- seals and gaskets;
- sealants;
- fixings;
- breather membranes;
- vapour control layers, including membranes around windows; and
- backer rods.

These can include intumescent materials and plastic wrapped cavity barriers. They can also include window frames and certain types of glass (e.g. laminated glass, which is not completely non-combustible). In the case of double skin, masonry or concrete cavity walls (at least 75 mm thick), combustible materials can even include polymeric or other insulation.

Traditionally, such combustible components have been seen as inconsequential in terms of their contribution to the heat released and/or the potential for fire development and spread. This is still the case for external walls on new buildings.

It is also inevitable, when considering existing buildings, that other components might also be found to be combustible. The following are relevant examples of common practice in building construction that give rise to this:

- use of timber battens to support facings such as zinc, copper and HPL; and
- use of plywood to provide support to, and a rigid backing for, facings, including aluminium.

Judgement is required as to whether the use of such components results in quantities of combustible material that are significant in terms of the contribution to the heat released and the potential for fire development and spread.

Use of a synthetic rubber membrane around a window is very different to the use of the similar material as a vapour control layer over the entire façade. Plywood backing to a metal facing, when used for infill panels fixed to batons on a concrete substrate, is very different to plywood facing onto a continuous cavity extending over the full height of the façade. Similarly, even use of an ACM or an HPL as a facing for a portico, as part of a window reveal or as a feature band on the building, can often be of such limited extent as to preclude consideration if no other combustible material is present on the façades.

In practice, there are likely to be cases where the quantity of combustible material within the external wall construction, or on the façades, is so small that it can be discounted. In these cases, it is not necessary to conduct an FRAEW.

However, a case might need to be made to justify this conclusion, to satisfy enforcing authorities and others relying upon the outcome of the FRAEW when making decisions as to what, if any, action is needed to mitigate a perceived, or suspected, potential risk to occupants. This is not expected to require a detailed report, but simply an appropriate statement as to why the quantity of combustible material is inconsequential.

Small quantities of combustible material are unlikely to need further consideration if:

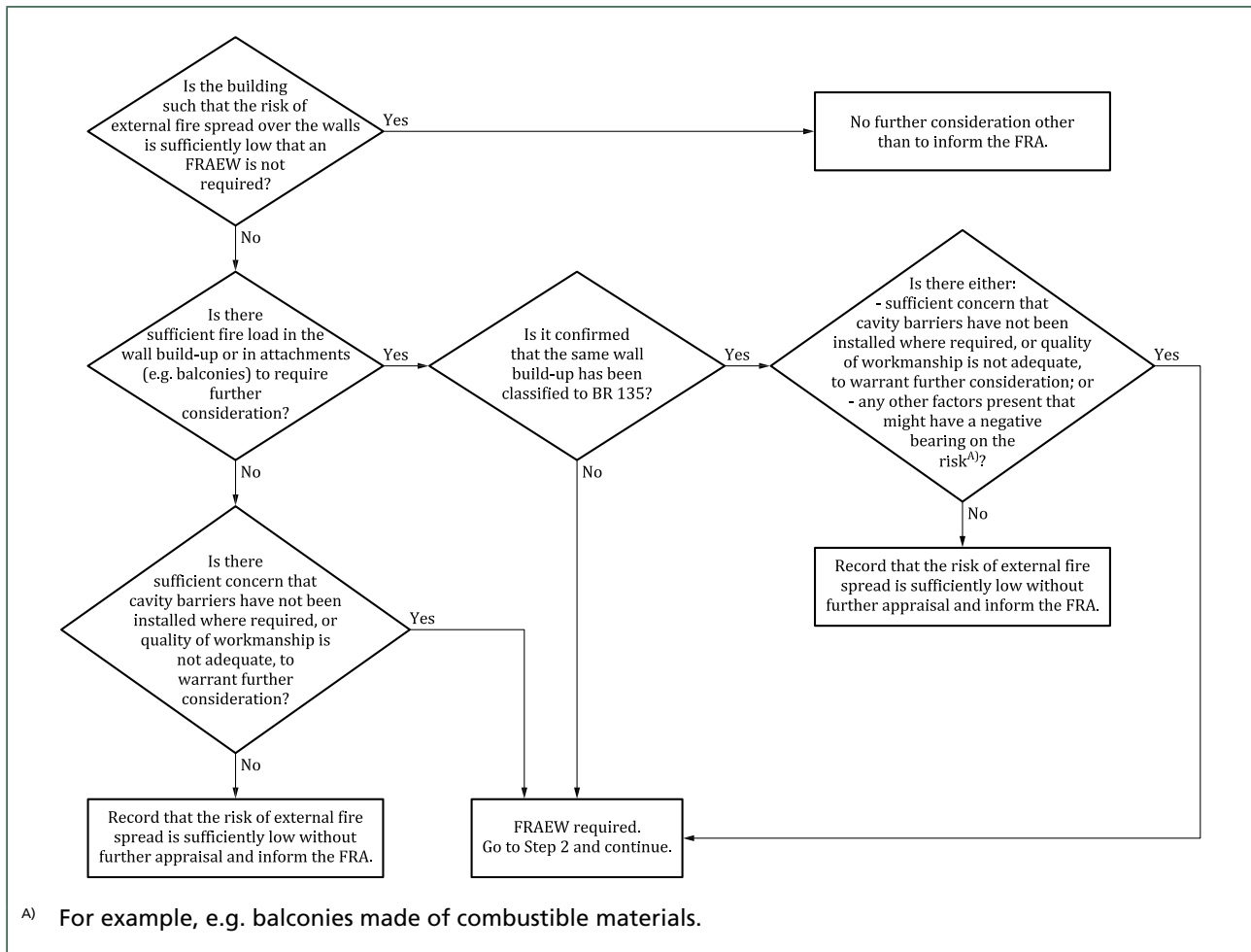
- they are not used in conjunction with a polymeric insulation, either as a backing to, or in combination with, the combustible component, or separately as insulation within a cavity; and
- they are only present where other main components, such as the cladding or insulation, are essentially non-combustible; and
- they do not form a complete framing and support system, e.g. timber battens when used in isolation, rather than an extensive support system; and
- they are not present in conjunction with combustible sheathing [other than, for example, Class B cement particle (CP) boards], within the wall build-up.

Even in the case of a building in which the external walls are inherently low risk by virtue of the above, concern that the quality of construction might be poor or that there are insufficient cavity barriers, or that they are missing, might suggest an FRAEW is still warranted or, if not an FRAEW in its entirety, a form of risk-based appraisal following the principles set out in this PAS. However, the extent to which this is investigated in an effort to determine whether such concern is valid would itself be expected to be risk-based, to avoid taking an overly conservative approach, especially in low-rise buildings.

Similarly, there could be features of the building which give rise to the potential for fire spread over the external walls even in the circumstances described above, such as the presence of, and configuration of, significant quantities of combustible material associated with balconies and other attachments. Where there is sufficient concern as to the adverse impact this could have, an FRAEW might still be an appropriate means of addressing the risk this creates.

Step 1 is illustrated in Figure 4.

Figure 4 – Process for determining whether a full FRAEW is required



c) Step 2

In the event that it is confirmed that an FRAEW is required, the next step is to gather all relevant information on the building and its external wall construction. This needs to cover:

- the different types of external wall build-up and attachment (e.g. balconies);
- what materials, components and systems have been used and how they are configured on the building (i.e. a definitive picture of the wall build-up from internal linings within the accommodation to the outer external facing of the façade). This includes identifying the type and location of cavity barriers, or their absence in locations where they would normally be expected;

- the extent of the cladding on each elevation, such as whether it extends over the entire façade or only partially covers the building, whether it has openings in the façade for windows (e.g. continuous cavities or broken cavities), the scope for a fire involving the external walls to circumvent the compartmentation in the building and any other relevant factors that might influence the ability of fire to spread over the external walls; and
- the building’s fire strategy⁸⁾.

It is anticipated that this will be determined by a combination of the following:

- review of all relevant and available documentary evidence (see Clause 9);
- visual inspection of the building (see Clause 10); and

⁸⁾ This is not to imply that a formal fire strategy document of the type prepared, for example, in support of a building regulations application will be available or should be commissioned if unavailable. Rather, it is shorthand for determining the fire safety design features of the building that might be pertinent to the FRAEW and the evacuation strategy (i.e. “stay put”, immediate simultaneous evacuation or a variation thereof) and relevant fire hazards that could give rise to, or exacerbate, the potential for ignition of the cladding and other components of the external walls.

- opening up and intrusive inspection of the external walls (see Clause 10).

It is possible that after this step it will be clearly evident, without detailed further appraisal of the fire risk, that the quantities of combustible material in the wall build-up are inconsequential. In these circumstances, it is not necessary to continue the FRAEW, but again, the case might need to be made, to justify this conclusion, to satisfy enforcing authorities and others relying upon the outcome of the FRAEW.

d) Step 3

Using the information gained on the building and its external wall construction, the third step is to determine and collate, from knowledge of the external wall construction and the building's fire safety features and attributes, the factors that are influential and relevant to the risk posed by fire spread over the external walls.

A range of considerations for each of the above are set out in the examples given in Annex K (relating to fire performance risk factors), Annex N (relating to façade configuration risk factors) and Annex F [relating to fire the risk factors arising from consideration of the strategy/fire hazards, including the limitations of fire and rescue service intervention (see also Annex E)].

For each group, the likely influence of each of these risk factors needs to be taken into account when assessing their contribution in terms of achieving the success criteria determined from the benchmark for external fire spread (see Clause 7).

- 1) *In the case of the factors relating to the fire performance of the materials, components and systems, and how they are configured together on the façades of the building, the influence could be:*
 - i) *positive, such as to limit significantly the scope for rapid fire spread;*
 - ii) *negative, such as notably to exacerbate or promote the scope for rapid fire spread; or*
 - iii) *neither, because the influence is neither definitely positive nor definitely negative, or they are characteristic of factors that result in fire spread that is within normal expectations, and, as a result, they can be deemed neutral in this respect.*

Inherent in such an analysis is that weighting of these factors can be applied, not always in a quantifiable manner but, nevertheless, by qualitative judgement as to their relative impact on fire spread.

- 2) *In the case of the factors relating to the configuration of the façades and the extent and location of the combustible cladding and other materials in the external walls, the influence could be:*

- i) *positive, such as to limit significantly the scope for secondary fires to result from fire spread;*
- ii) *negative, such as notably to exacerbate or promote the scope for secondary fires; or*
- iii) *neither, because the influence is neither definitely positive nor definitely negative, or they are characteristic of factors that result in scope for secondary fires to occur that is within normal expectations, and, as a result, they can be deemed neutral in this respect.*

Again, inherent in such an analysis is that weighting of these factors can be applied, not always in a quantifiable manner but, nevertheless, by qualitative judgement as to their relative impact, in this case, on the likelihood of secondary fires.

- 3) *In the case of the factors relating to the fire strategy for the building, the influence could be:*

- i) *positive, such as to increase significantly the ability of occupants to remain safely in the building or, if necessary, to escape if fire spreads, via the external wall construction, to other parts of the building;*
- ii) *negative, such as notably to exacerbate or promote the potential for harm to occupants because occupants might not be able to remain in the building safely, or escape in time if fire spreads, via the external wall construction, to other parts of the building; or*
- iii) *neither, because the influence is neither definitely positive nor definitely negative, or they are characteristic of factors that impact on the safety of people in the building when there is external fire spread that is within normal expectations, and, as a result, they can be deemed neutral in this respect.*

Again, inherent in such an analysis is that weighting of these factors can be applied, not always in a quantifiable manner but, nevertheless, by qualitative judgement as to their relative impact on the likelihood of people remaining in, or escaping from, the building safely.

General consideration of how fires might start and spread to involve external wall construction and cladding is discussed in Clause 5. Risk factors relating to specific fire hazards and particular sources of ignition would also need to be considered as these might be significant in terms for their influence on some of the risk factors identified by the above analysis.

Similarly, risk factors relating to fire and rescue service intervention would need to be considered.

Where a risk factor is marked with an asterisk (*) in the tables in Annex K, Annex N and Annex F, this indicates that it is notably more of a positive influence. For example, facings of brick, which are at least 75 mm thick, give the wall greater potential to achieve better fire performance relative to a wall faced with clay tiles. Hence, the 75 mm masonry is shown with an *. Similarly, by way of example, while HPL combined with polymeric foam insulation is listed as a negative risk factor, Class B HPL combined with polymeric foam insulation is shown with an * as it gives the wall greater potential to achieve better fire performance relative to a wall with Class C HPL and polymeric foam insulation.

e) Step 4

This step requires consideration of the influence that the various positive, negative and neutral risk factors have on the perception of where the overall risk lies for each group of factors. This is then used in Step 5 to overlay the findings, for each group, on a risk scale to establish where the overall risk lies, when all of the three key considerations are taken into account. On such a scale, it would be expected to start with an assumption, as a base line, that the risk is "high" due to the presence of combustible material in the external wall construction and to reposition that risk elsewhere on the scale and potentially towards the "low" end, as further information is determined and its significance is considered.

For each group, weight can be attached by virtue of the number of such factors. For example:

- dominance of significant positive factors is likely to add to the weight attached to an overall conclusion that the outcome is suggestive of a "low" risk in relation to external fire spread (i.e. a high probability of the success criteria being met); or

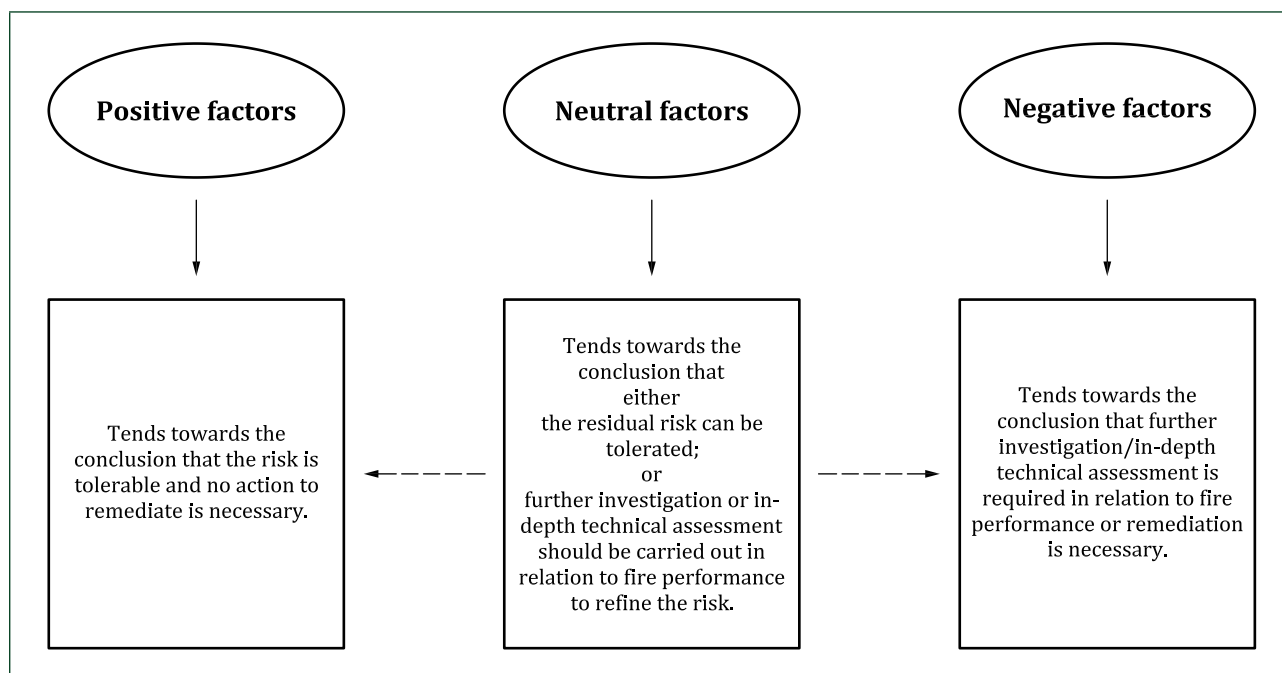
- dominance of significant negative factors leads to the opposite conclusion, namely that it is likely to add weight to the overall conclusion that the outcome is suggestive of a "high" risk in relation to external fire spread (i.e. a high probability of failure to meet the success criteria) and there is a strong case to justify remediation or other action.

A dominance of neutral factors, or a broad spread of factors, could suggest the risk is somewhere between the "high" and "low" risk as described above and, therefore, possibly in the middle of the scale and a "medium" risk. This adds weight to the overall conclusion that the external walls on the building could give rise to a fire risk within normal expectations, albeit that this is a conclusion that lacks the certainty afforded by known compliance with the BR 135 [15] benchmark. Equally, it might reflect that there is insufficient knowledge to quantify their influence on either a "low" risk or a "high" risk outcome. However, an outcome of "medium" risk is not to be taken as a default position in these circumstances; such an outcome needs to be based on reasonable evidence. In concluding that there is "medium" risk, there might be an element of uncertainty regarding the risk, which can either be tolerated or needs further refinement before reaching that conclusion. However, there needs to be sufficient certainty that the risk is not "high".

It is not intended that this be seen as an attempt to introduce quantification (i.e. that if the number of positive risk factors outweigh the number of negative factors the result is, therefore, "low" risk). Rather, a larger number simply demonstrates a stronger evidence base when drawing a conclusion. Equally, it follows that a single risk factor, be it positive or negative, might, if of such magnitude and significance, outweigh any number of opposite risk factors.

Ultimately, the aim of identifying the relevant risk factors and attaching weight to them is to determine the influence of each group of factors, in turn, on where this positions the overall fire risk posed by the external walls on the "high" to "low" risk scale. The potential outcome of the risk factor weighting is depicted in Figure 5.

Figure 5 – Possible outcome of risk factor weighting



f) Step 5

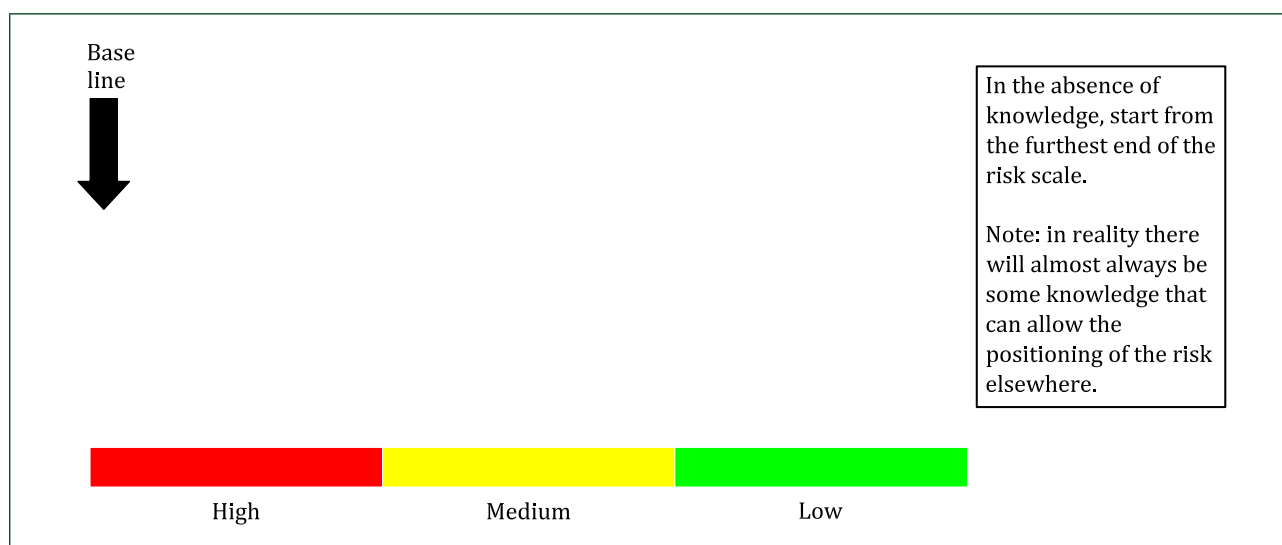
The final step involves overlaying the findings from Step 4, for each group, on the “high” to “low” risk scale to establish where this positions the overall risk.

As stated earlier, the outcome of this methodology is to determine, pragmatically, how the specific external wall construction on a particular building can be viewed in relation to the benchmark set out in this PAS.

The risk scale is expressed as the three risk outcomes, “high”, “medium” and “low” in a continuum, left to right, from “high” risk to “low” risk. Although not quantified, it is intended as a graded scale. For example, at the furthest left end of the “high” risk band, the risk is deemed to be the highest, reducing as the risk is positioned to the right of this.

This is illustrated in Figure 6.

Figure 6 – Starting point for applying the risk factors



This is a relative scale and the process of positioning where in a particular band the risk lies is necessarily subjective, requiring professional judgement by competent persons. It is, however, intended to illustrate the logic being used when risk factors and their influence are analysed and applied to the external walls of the building in question.

As a baseline, the highest risk of external fire spread on this scale equates to the extremely rapid fire spread seen in the fire at Grenfell Tower and in other fires involving similar cladding systems with metal composite material, particularly Category 3 ACM. The lowest risk would be brick or masonry inner and outer leaf of minimum 75 mm thickness with mineral wool insulation and cavity barriers around openings.

Risk factor analysis is intended to enable the positioning of the particular risk somewhere to the right of this baseline starting point. It is a three-stage process.

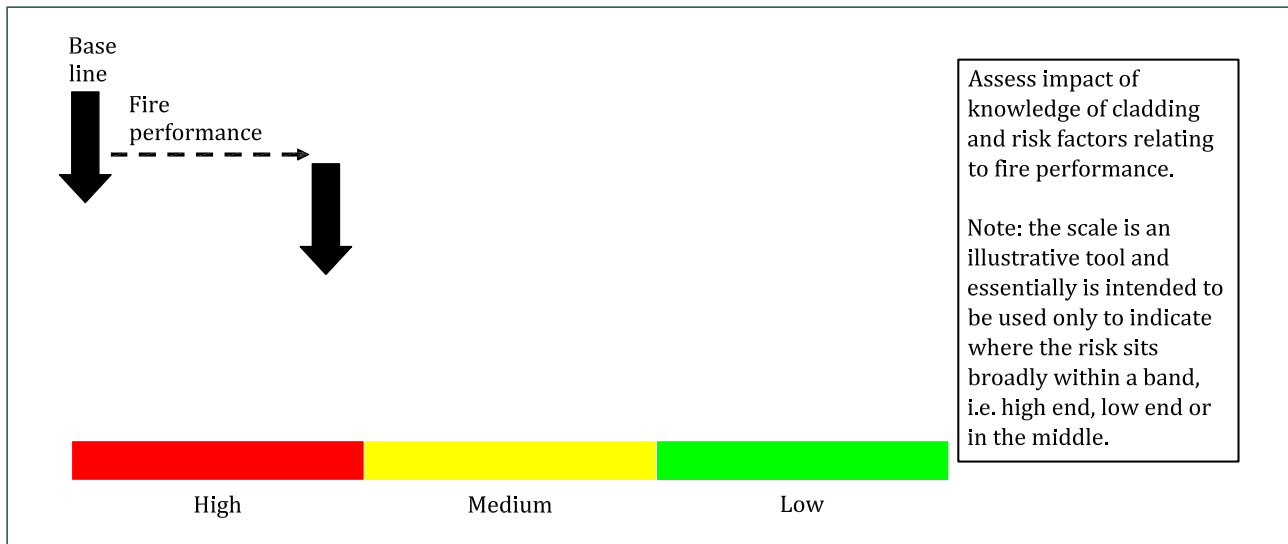
Starting with the fire performance risk factors, the external wall assessor might conclude that there is clearly sufficient potential for the risk of fire spread to be unduly rapid and it needs to continue to sit in the "high" risk band. Equally, the opinion of the

external wall assessor might be that there is sufficient evidence to suggest that, while the rate of fire spread might be higher than normal expectations, it is still tolerable; alternatively, the opinion might be that, at least, it is possible that this could be concluded if further consideration is given to refining its performance in fire. Under these circumstances, the risk rating would be moved to the "medium" risk band.

It is, perhaps, unlikely that, on the basis of consideration of fire performance factors alone, the risk would be considered as moved to the "low" risk band at this stage, although this is not precluded. This could apply if the quantity of combustible material is small, but given Step 1, it would have been expected that walls with inconsequential amounts of combustible material would not have been considered further for assessment.

This is illustrated in Figure 7, by way of an example, in which, following consideration of fire performance factors, the risk is still positioned in the "high" risk band. However, in this example, it is located at the lower end of the "high" risk band, reflecting the external wall assessor's perception that, although there will be an undue rate of fire spread, it will not be extremely rapid.

Figure 7 – Applying the risk factors – consideration of fire performance



Once fire performance factors have been taken into account, it is then necessary to overlay the findings from the review of façade configuration factors in order to determine the effect this has on where the risk now lies on the scale. This has the potential to move the risk rating towards the right on the scale and, potentially, out of the “high” risk band.

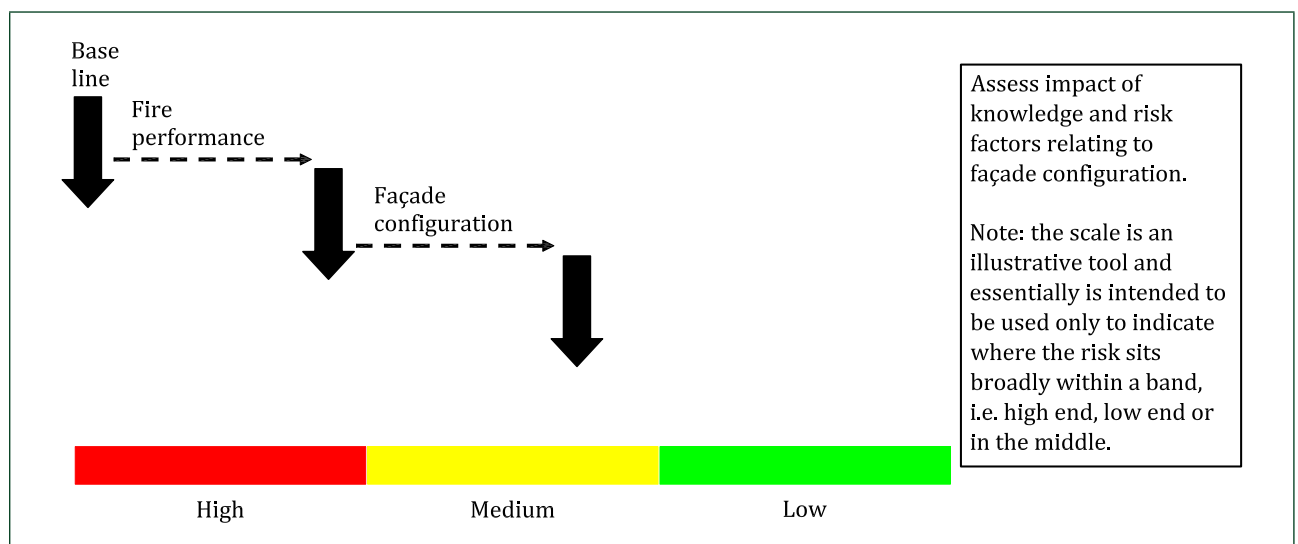
From this stage of the process, it might be possible, particularly where only limited parts of the façades have combustible external wall construction and cladding, to conclude that the risk falls at the “low” end. However, this might not be possible, particularly on fully clad buildings, and the risk rating might remain the same.

This is illustrated in Figure 8, by way of an example in which, following consideration of façade configuration factors, the risk has been repositioned into the “medium” risk band. However, in this

example, it is located at the middle of this band, reflecting the external wall assessor’s perception that, although there will not be an undue risk from fire spread over the external walls, it will still be heightened by comparison to normal expectations. That it cannot be placed further to the right towards the lower end to of the “medium” risk band, suggests that the external wall assessor is unable to conclude the heightened risk can be tolerated without further investigation.

In the case of buildings below 18 m, this step has the potential to reposition the risk rating for the majority of buildings and at least place them in the “medium” risk band. Indeed, subject to adequate cavity protection, where applicable, they might be placed in the “low” risk band. Equally, if any adverse factors are identified, buildings below 18 m might be placed in the “high” risk band.

Figure 8 – Applying the risk factors – consideration of façade configuration



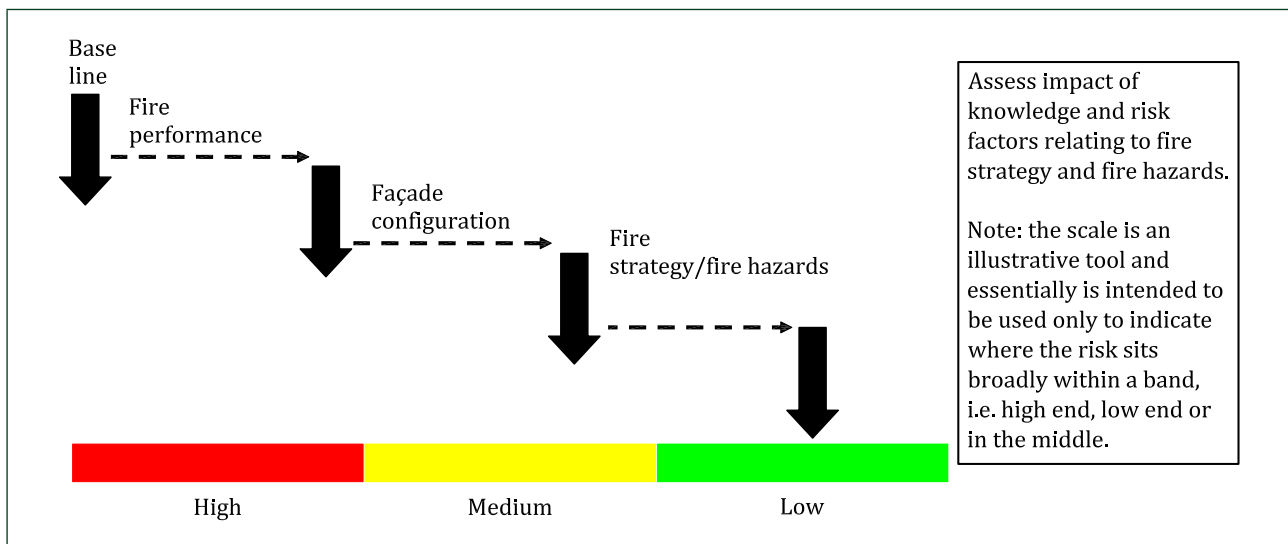
In the final stage of Step 5, the findings from the review of risk factors arising from consideration of the fire strategy and fire hazards (including limitations of fire and rescue service intervention) are overlaid, in order to determine the effect this has on where the risk finally lies on the scale. This, too, has the potential to move the risk rating towards the right on the scale and, potentially, out of the band it was in previously to a lower risk band.

For example, the particular circumstances ranging from the nature of the occupants, the evacuation strategy, the fire safety features in the building and the ability of the fire and rescue service to intervene to fight the fire and ensure people can reach safety outside might enable the risk rating to be moved from a "medium" risk to the "low" risk band.

This is illustrated in Figure 9, by way of an example in which, following consideration of the risk factors arising from the fire strategy/fire hazards (including limitations of fire and rescue service intervention), the risk has been repositioned into the "low" risk band. This is an example whereby such factors significantly influenced the conclusion on the overall risk, such as to outweigh the conclusions on the anticipated rate and extent of fire spread over the walls determined in the previous stages.

It could equally be the case that it is not possible to move the risk rating to a lower risk band, or, where it has been moved to a lower band when façade configuration has been considered, that fire strategy considerations are such that the risk rating has to move back to a higher risk. This might, for example, occur when there are significant issues in relation to fire and rescue service access and the ability to fight a fire involving the external cladding.

Figure 9 – Applying the risk factors – consideration of fire strategy/fire hazards



With any form of retrospective appraisal of the fire risk posed by the external walls of existing buildings, it is inevitable that there are limitations in what can be achieved. These can arise where, for example, there has been reliance on sampling in intrusive inspections, missing or incomplete information from documented sources, the absence of fire performance test data on materials (whether individually or as composites), components or systems that make up the external walls, etc.

Presumptions that, because of experience of poor common practice across the sector, buildings cannot be considered to be built satisfactorily unless survey information suggests otherwise will lead to undue conservatism and, potentially, unnecessary and costly work to establish a level of certainty that is not normally warranted by the risk.

In FRAEW reports, it is necessary to record where such limitations apply and to highlight the potential uncertainty that can arise, as a result, on the weight attached to certain risk factors and the conclusions that can be drawn from them. It is important that such limitations of uncertainties in, and caveats to, the appraisal of the external wall construction and the assessment of fire risk are documented in the FRAEW report; this is not only to limit the liability of the external wall assessors, but also to assist those interpreting the outcome, and making decisions based on the outcome, of the FRAEW.

Due to such uncertainty, there is scope for new or further information to come to light that might, potentially, change the outcome of the appraisal of fire risk. Taking a conservative approach where such uncertainty exists is a way of accommodating this possibility. However, it is reasonable to expect that clients, enforcing authorities and other stakeholders will avoid imposing conditions and restrictions on the terms within which an FRAEW is carried out, such that external wall assessors would be forced to adopt an overly conservative approach. This would be detrimental to a risk-based assessment and would potentially restrict the willingness of external wall assessors to express opinions on risk because of a fear of undue exposure to liability.

It is important that FRAEW reports include a caveat to reflect the potential for new information to come to light, including from fire testing carried out on forms of external wall construction that are similar to those covered in the FRAEW. This is an inherent possibility in any subjective assessment.

Periodic review of FRAEWs is essential where the conclusion is that the risk rating is “medium”, but can be tolerated without any form of remedial action being taken. Periodic review is unlikely to be necessary where there has been sufficient confidence to record a low risk outcome.

g) Case studies

Annex O contains a number of case studies with worked examples illustrating the use of the methodology described above.

These are solely intended to illustrate the application of the framework and rationale set out in this clause. They do not purport to provide generic solutions to the particular forms of external wall construction, which, by virtue of the principles within this PAS, can only be considered in the particular circumstances of the building under assessment and by taking into account all relevant risk factors.

After each case study, some examples are included to indicate how differences in the wall build-up or risk factors might influence the outcome.

13.1 It should be verified, from what is known of the materials used within the external wall build-up, that the external walls under consideration are within the scope of an FRAEW.

NOTE *Where it is evident that the nature and extent of combustible components are inconsequential, in terms of their contribution to the heat that would be released and the potential for fire development and spread, no further consideration is necessary.*

13.2 The FRAEW should follow a structured approach in order to determine an outcome with respect to the fire risk posed by the external wall construction. It should demonstrate that all reasonably practicable efforts have been made to fully determine and take into account:

- a) the likely performance of the external walls in a fire;
- b) how the fire would start, develop and spread when taking into account all relevant factors relating to the configuration of the cladding, etc. on the façades; and
- c) how such a fire could directly, or indirectly, cause harm to the occupants and impact on their ability to escape in time.

13.3 All relevant information on the building and its external walls and attachments should be established by means of, to the extent necessary, document review, visual inspection and intrusive inspection (see Clause 9 and Clause 10).

13.4 All the relevant risk factors should be identified and evaluated in terms of their impact, individually and collectively, on the overall risk, whether that be positive, negative, or neither, but nevertheless still pertinent with regard to the risk.

13.5 The factors relating to fire performance, façade configuration and fire strategy/fire hazards, and their impact, should be evaluated together and their relative importance determined, in order to provide an overall, holistic assessment of the fire risk posed by the external wall construction and cladding on the building under appraisal.

13.6 The risk factors should be weighted, according to their relative importance (see 13.5), in order to determine how significant they are, collectively, in establishing whether each of the benchmark criteria in Clause 7 have been met.

13.7 The approach taken should enable a conclusion to be made as to whether the external walls on each of the building's elevations, or parts of the walls, depending upon the configuration of the cladding, present:

- a) a "high" risk, requiring remedial action to remove and replace the cladding system, or take any such other remedial action as necessary, to reduce the risk to occupants to a tolerable level; or
- b) a "medium" risk (see 13.9); or
- c) a "low" risk, not requiring any form of remedial action, given that the likelihood of fire spread and the consequences for the safety of occupants are clearly within benchmark expectations (see Clause 7 for commentary on risk-based benchmark criteria).

13.8 The external wall assessor should highlight where there is the potential for further investigation, whether by more in-depth technical assessment or fire testing, to lower the risk rating for external walls deemed "high" risk.

13.9 Where, based on the available evidence, it is possible to conclude that the risk is not "high", but, equally, it is not possible to conclude that it is "low", adopting a "medium" risk rating is likely to be necessary. In these cases, the appraisal of fire risk should seek to determine which of the following can be concluded:

- a) that there is a potentially heightened risk, but, nevertheless, there is scope for the residual risk this leaves, if no action is taken, to be tolerable when considered in the broader context of the building's FRA; or
- b) there is a potentially heightened risk, the magnitude of which is such that further investigation is needed, whether, for example, by more in-depth technical assessment or fire testing, to refine the appraisal of fire risk and give a more conclusive outcome.

14 Application of fire engineering analysis as part of further technical assessment

COMMENTARY ON CLAUSE 14

As explained in Clause 7, the basis of the framework and rationale described in this PAS is an approach that positions the perceived risk posed by external wall construction and cladding on an existing block of flats on a relative scale of “low” to “high” risk. Clause 13 contains a methodology for conducting a basic level assessment to determine that risk rating. It is broad ranging and relatively simplistic in its approach, but is intended to serve the purpose of eliminating, as far as possible, those buildings where it can be readily demonstrated that the risk is low or, even if not low, still tolerable.

Early on in the investigation of the building, in some cases even before any site-based inspection has taken place, or at a later stage, including at the conclusion of the basic level assessment described in Clause 13, it might be evident that further and more in-depth technical assessment is warranted, in order to reach a conclusion on whether the fire risk posed by the external wall construction on a particular building is tolerable (see Clause 7).

This might involve, as an option, conducting fire tests in order to gain a better understanding of how the walls will perform in fire. However, large-scale tests, in accordance with BS 8414, while always remaining an option, are not considered a practical proposition for routinely determining the fire risk posed by external walls on an existing block of flats.

In preparing this PAS, consideration has been given as to whether an in-depth technical assessment, using fire engineering analysis, could enable further refinement of the risk posed by external walls on existing buildings. In this connection, fire engineering analysis refers to use of available fire performance data, knowledge of performance of different forms of construction, and context in relation to the extent of cladding and consideration of the consequences of fire spread and the risk this then poses.

Accordingly, in Annex G, the basis of such an assessment is described, along with the considerations that would need to be taken into account in such an approach.

BS 9414 considers the fire performance of external cladding systems in relation to application of results from BS 8414-1 and BS 8414-2 tests. However, while an in-depth technical assessment of the nature described in Annex G might give consideration to the results from

BS 8414 tests, where relevant and available, as well as detailed consideration of reaction to fire classifications and other fire test data, it does not purport to be an assessment-in-lieu-of-test. That is beyond the scope of this PAS.

The level of competence necessary to conduct an in-depth technical assessment using fire engineering analysis is considered greater than that required for the basic level assessment described in Clause 13. This is discussed in Clause 8. External wall assessors need to ensure that they have that level of competence to be able to conduct such an assessment, and be able to demonstrate this to their clients and, where appropriate, enforcing authorities and other stakeholders.

14.1 Where it is not possible to conclude, from an FRAEW conducted in accordance with Clause 13, that a “medium” risk is tolerable, or where the conclusion of the FRAEW is that the fire risk posed by the external walls is “high” risk, external wall assessors should determine whether more in-depth technical assessment would enable the risk to be refined.

NOTE This might enable the risk to be considered as “low”, or, even if not low, as heightened compared with normal expectations, but, nevertheless, tolerable. Equally, it might confirm that the risk is “high” and add weight to the decision to remediate the walls by removal and replacement of cladding.

14.2 If it is determined that a more in-depth technical assessment is necessary, external wall assessors should advise clients on the nature of such assessment. The scope for in-depth technical assessment using fire engineering analysis should also be determined.

NOTE For example, where concerns over the particular nature of the cladding, or the complexity of the wall construction, lead the external wall assessor to this conclusion, it would be appropriate to recommend that further specialist advice be sought. In other cases, it might be appropriate to recommend fire testing.

14.3 Where an in-depth technical assessment using fire engineering analysis is undertaken, it should be carried out by a person with the appropriate level of competence.

NOTE Annex G gives guidance on carrying out an in-depth technical assessment using fire engineering analysis.

15 Scope and format of the FRAEW report

COMMENTARY ON CLAUSE 15

FRAEWs need not follow a prescribed format, and this PAS does not contain a pro-forma for a report.

However, it is important that the reports include sufficient information for their scope and purpose to be clear to those reading them; reports need to provide an explanation as to the process followed in arriving at a rating for the fire risk posed by the external walls and the basis of the risk.

It is necessary in FRAEW reports to record where limitations and constraints applied in assessing the risk, and to highlight the potential uncertainty that can arise, as a result, on the weight attached to certain risk factors and the conclusions that can be drawn from them. Ensuring that such limitations of, uncertainties in, and caveats to, the appraisal of the external wall construction and the assessment of fire risk are documented in the FRAEW report is essential, not only for limiting the liability of the external wall assessors, but also for the understanding of those interpreting the outcome and making decisions based on the outcome of the FRAEW.

A typical report is likely to include some or all of the elements below, including an introduction confirming the FRAEW's scope and client requirements and setting out specific constraints, limitations and caveats that have applied. It is also expected that reports would include a declaration of the external wall assessor's competence in relation to FRAEWs, and an executive summary, which would provide a succinct overview, highlight the key findings and state the overall risk rating.

FRAEW reports are expected to include all relevant factual information, including:

- *a basic description of the building, including key information, such as:*
 - *location;*
 - *height above ground;*
 - *size, including number of flats;*
 - *type of occupancy;*
 - *type of construction (but only in brief, so as to understand the context of the external wall construction and cladding present on the building);*
 - *age and likely design code applied at the time of construction or renovation;*
- *a description of the external wall construction and cladding on the building and, where there is more than one cladding system or variants to the same cladding system, each wall build-up. Ideally, extracts from available drawings will be included, or sketches to illustrate the build-ups present, but it is not expected that an external wall assessor would prepare drawings for the purpose of an FRAEW;*
- *a description of the building in terms of its fire strategy and fire safety design, also highlighting any inherent vulnerability to fire hazards that are relevant to ignition of the cladding by external fires (e.g. proximity of vehicles to the building). This needs to include basic detail on, amongst other things, the means of escape design, evacuation strategy, fire and rescue service access arrangements and facilities for firefighting; and*
- *the findings from the document review and site survey and inspection.*

The report would then be expected to include sections addressing:

- *consideration of, and commentary on, factors relating to fire performance and how these factors influence the risk;*
- *consideration of, and commentary on, factors relating to façade configuration and how these factors influence the risk;*
- *consideration of, and commentary on, factors relating to the fire safety design and fire strategy for the building, including fire hazards and fire and rescue service response, and how these factors influence the risk; and*
- *conclusion on overall assessment of the risk and the determination of the need for remedial action, with specific recommendations, where necessary.*

The report would be expected to include drawings or photographs to convey where different cladding systems are present on a building, the extent of their coverage, proximity of windows and other openings, whether there are setbacks or overhangs on the building, and any other relevant details illustrating how the cladding systems are configured on the façades. Details of drawings, documents and other evidence that has been reviewed would be expected to be included.

The detail presented depends on the size and complexity of the building, but, in relation to the site survey and inspection, it would be expected to include:

- *details of the number and location of sampling points, preferably referenced on elevation drawings, where available, or on photographs of the building's façades;*
- *references to samples removed for testing and the locations from where they were taken; and*
- *photographs to support the findings, and to convey the nature and extent of deficiencies, deterioration of products and workmanship issues identified by the inspection.*

15.1 FRAEW reports should make clear their purpose and their relationship to the building's FRA. They should state that an FRAEW is intended to inform the building's FRA, and that its findings are to be interpreted in the context of the ongoing legislative control over the building under the Fire Safety Order [19].

15.2 The assessor's determination of competence to use and apply this PAS to the building for which the FRAEW has been commissioned should be documented within the FRAEW report.

15.3 The report should clearly state that the FRAEW addresses life safety only in relation to the appraisal of the external walls of the building. It should also highlight that, in considering risk, this is only in relation to the threat to the occupants in the building and not in terms of property damage or other potential objectives, such as safety of firefighters.

NOTE *Notwithstanding this, it would be of significant value and is considered best practice for building owners to inform the local fire and rescue service of any findings of an FRAEW where external fire spread is likely to be significantly more rapid than is normally expected. This would allow operational risk information to be reviewed and updated.*

15.4 The report should clearly state that the FRAEW is not aimed at confirming compliance with building regulations, either at the time of construction, or currently.

NOTE *It is expected that the report will cite any standards and guidance that supported the building regulations at the time when the building was constructed (e.g. ADB), as a reference point (see also Annex P).*

15.5 The report should clearly state that an FRAEW cannot provide certainty and, being risk-based, it is, therefore, to a degree, reliant on professional judgement in its assessment and in the conclusions drawn.

15.6 The report should make clear the constraints and limitations that have applied in conducting the FRAEW and arriving at a risk rating. Where appropriate, suitable caveats should be included, for example, in relation to:

- a) the extent of sampling carried out;
- b) the accuracy of information upon which it has been necessary to rely, especially where it has not been possible to verify the information through site survey and inspection;
- c) the extent of the content and detail within the report; and
- d) the limitations at the time of the FRAEW of available knowledge on the fire performance of the materials, products and systems forming the external walls of the building.

15.7 The report should set out, as a minimum:

- a) an executive summary giving the key findings and overall assessment of the risk rating;
- b) a basic factual description of the building, including external wall construction (with drawings or photographs as appropriate);
- c) a description of the building in terms of its fire strategy and fire safety design, to the extent that these can be ascertained;
- d) details of the site survey and inspection;
- e) the necessity for, urgency of, and nature of any interim measures that are considered appropriate; and
- f) recommendations on remedial action considered necessary, with a suitable time frame that takes into account both the nature of the works required for remediation and the recommended interim measures [see item e)].

15.8 The report should state that the FRAEW is to be reviewed:

- a) if significant changes/repairs have been made to the external wall; and/or
- b) in the event of a fire incident, if the fire involved the external wall construction; and/or
- c) if there are any circumstances, depending upon the nature of the construction, the extent of available knowledge in relation to the particular materials, components and systems used on the building or the degree of uncertainty over the findings, that suggest review is appropriate. In these cases, the report should include a clear explanation as to why periodic review is necessary and include a suggested review date.

***NOTE** It is not expected that every FRAEW will need a periodic review where the above criteria have not been met, especially in cases where the risk rating is deemed to be "low".*

15.9 The report should highlight that, if more definitive information becomes available subsequent to the FRAEW on how particular external wall materials, components and systems behave in fire, or there are changes in the fire performance data relied upon in an FRAEW, such information will be expected to take precedence.

15.10 Every FRAEW report should demonstrate that appropriate consideration has been given to all factors that could influence the fire risk posed by the external wall construction and cladding, including:

- a) the performance of the materials, components and systems forming the external wall construction of the building in relation to their behaviour in fire. This should include aspects such as the potential for ignition, the rate with which heat is released and the overall quantity released, along with the ease with which flames can propagate and spread over the surface and within the wall build-up. This should take into account not only the nature and extent of those elements that are combustible, but also their location within the wall build-up where this might influence the overall combustion process;

- b) the configuration of cladding systems and other external wall build-ups on the façades of the building, including whether there is partial or full coverage, the presence or otherwise of windows, vents and other openings through which fire could spread, and the proximity of the cladding in relation to windows onto escape routes. The type, location and condition of cavity barriers, where relevant, should also be included and, for example, the presence of balconies with combustible components that might aggravate the development and spread of fire; and
- c) relevant aspects of the fire safety design of the building, including the evacuation strategy, means of escape design, compartmentation, etc., as well as hazards that could possibly lead to fires involving the external walls. As part of this, the nature of the accommodation and the impact that the occupant profile might have on evacuation time should be taken into account. It should also include the ability of, and any limitations of, the fire and rescue service to intervene effectively to fight the fire, and to ensure that residents leave safely before the onset of untenable conditions in the flats and in the common parts used for escape.

15.11 It is not expected that the weight attached to these factors can be quantified, but the significance attached to these factors, particularly where they positively or negatively influence the overall perception of the risk, should be made clear.

15.12 FRAEW reports should contain an explanation of the basis for the outcome and the risk rating that is deemed to apply. The explanation should relate to the benchmark criteria described in Clause 7.

15.13 Where the outcome of the FRAEW is that the external wall construction is “high” risk, the FRAEW report should state clearly why:

- a) extremely rapid external fire spread is likely to occur; and/or
- b) fire spread is likely to give rise to widespread secondary fires resulting in occupants being significantly harmed or prevented from escaping; and/or
- c) fire is likely to spread in such a way that the communal means of escape will be compromised before occupants can safely use them to escape; and/or
- d) fire and rescue services are unlikely to be able to intervene effectively to enable occupants to reach safety in time.

NOTE *This reflects the consequences in terms of the cost, time and effort required to remove and replace cladding systems and otherwise remediate the external walls.*

15.14 Where the outcome of the FRAEW is that the external wall construction is “low” risk, or where it is “medium” risk but the heightened risk of fire spread is, nevertheless, considered tolerable, given that people will continue to occupy the building without any action being taken to otherwise improve the fire performance of the external walls, the FRAEW report should state clearly why:

- a) fire spread is likely to be at a rate within expectations for a building of this height, or at a greater, but nevertheless, tolerable rate, given the circumstances at the building in question; and/or
- b) fire spread is unlikely to give rise to widespread secondary fires resulting in occupants being significantly harmed or prevented from escaping; and/or
- c) fire is unlikely to spread in such a way that the communal means of escape will be compromised before occupants can safely use them to escape; and/or
- d) the fire and rescue service are likely to be able to intervene effectively to enable occupants to reach safety in time.

15.15 Where the FRAEW concludes that it is not possible to be definitive regarding whether or not the risk is tolerable, the reasons for this conclusion should be given in the report. The report should also state whether or not further, more in-depth technical assessment or further investigation by, for example, fire testing might be likely to assist in resolving the risk.

Annex A (informative)

Small, intermediate and large-scale fire tests for external wall construction

A.1 Small-scale reaction to fire tests

COMMENTARY ON A.1

The following tests are presented with national tests first, in ascending order of severity/achievable performance/classification, followed by European tests, also in ascending order of severity/achievable performance/classification.

Since its 2019 edition, ADB ([8], [9]) has only recommended European tests, but existing buildings constructed since the 1990s might rely upon national tests.

A.1.1 BS 476-7 – Surface spread of flame

The BS 476-7 surface spread of flame test uses a radiant panel with a pilot flame ignition source to measure the speed at which flame spreads across the surface of a product.

Specimens are mounted into a water-cooled steel frame specimen holder such that the edges of the specimen are protected. The specimen holder is on a swing mechanism so that, at the start of the test, it swings into position perpendicular to the surface of the radiant panel (see Figure A.1).

The radiant panel is made from porous refractory type burner block. Premixed natural gas and air (or propane and air) is introduced from the rear of the panel so that it diffuses through to the front. The mixture burns inside the panel, emitting heat radiation. The radiation is most intense nearest the panel and decreases over distance, as shown in Figure A.2.

A pilot flame is provided which projects a flame onto the bottom corner of the specimen, nearest the radiant panel (see Figure A.1).

Tests are run for 10 min, with the pilot flame ignited for the first minute only. The extent of flame spread along a reference line (approximately one third up from the bottom of the specimen) is measured and recorded.

A class is assigned to the product depending on the extent of flame spread after 1.5 min and 10 min. Class 1 is awarded for the least flame spread whereas Class 4 is awarded for the most flame spread.

Table A.1 sets out the classification criteria. One specimen in a sample is permitted to exceed any of the limits by 25 mm or less with the sample still being classified to that class.

Achieving Class 1 can go towards achieving Class 0, although this is not defined within this PAS but within earlier versions of ADB.

The advantage of the BS 476-7 test is that it is relatively inexpensive to conduct compared with the equivalent European tests (BS EN 13823 in particular). However, its principal weakness, insofar as it has been applied to external wall construction under statutory guidance, is that it only exposes the surfaces of products, with their edges being protected by the water-cooled specimen holder. Any reliance on the results of a BS 476-7 test, when applied to external wall construction, therefore needs to be treated with caution (see **A.1.6**).

Figure A.1 – BS 476-7 test apparatus with specimen holder in position for test and containing a blank specimen



Figure A.2 – Plot of radiation over distance from the BS 476-7 radiant panel with positions of classes along the sample indicated (final positions at the end of the test)

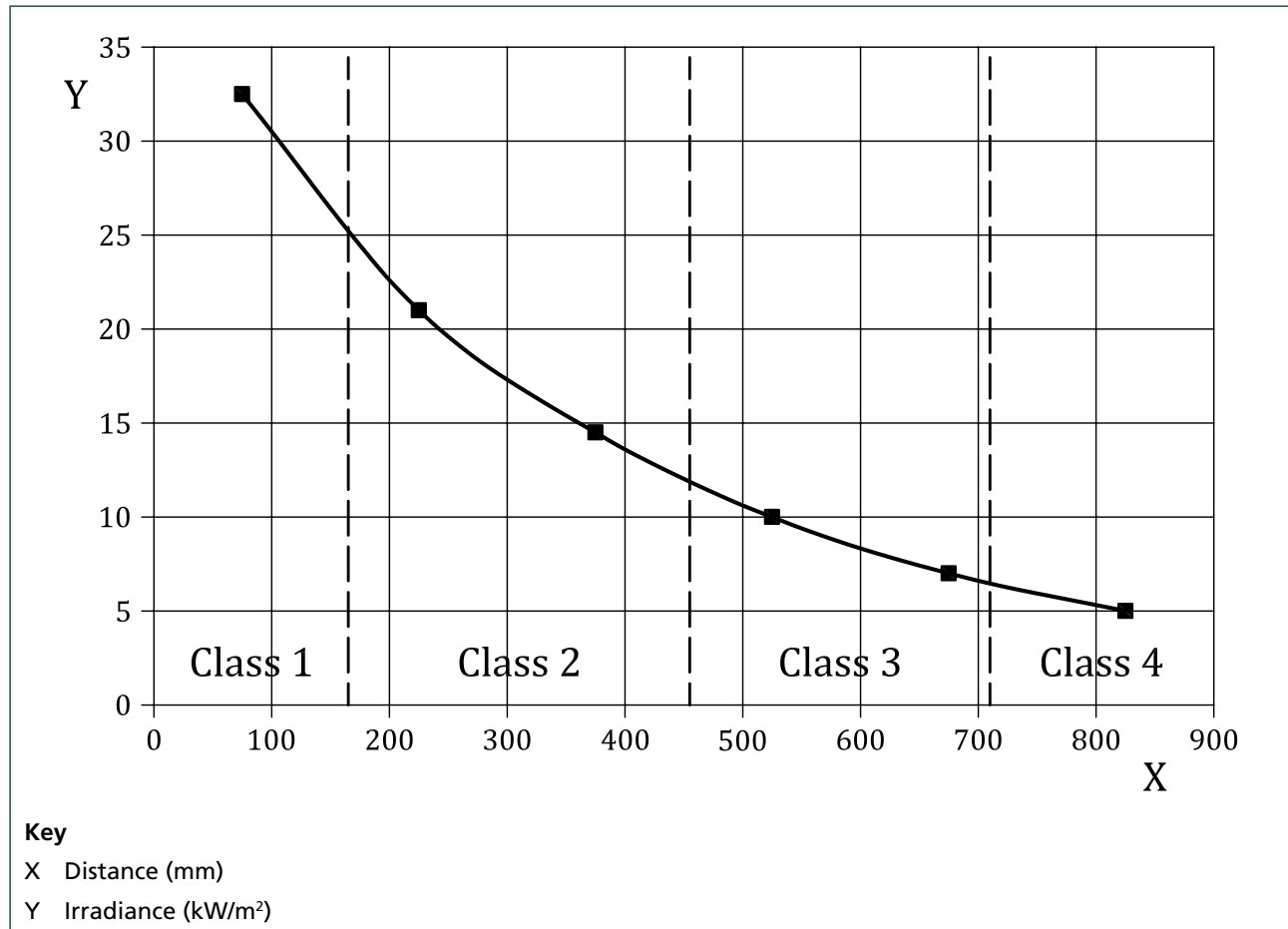


Table A.1 – Classification of spread of flame

Classification	Spread of flame at 1.5 min		Final spread of flame limit	
	Limit mm	Limit for one specimen in sample mm	Limit mm	Limit for one specimen in sample mm
Class 1	165	165 + 25	165	165 + 25
Class 2	215	215 + 25	455	455 + 45
Class 3	265	265 + 25	710	710 + 75
Class 4	Exceeding the limits for class 3		Exceeding the limits for class 3	

A.1.2 BS 476-6 – Fire propagation

The BS 476-6 fire propagation test uses a furnace with both gas burners and electrical heating elements to measure qualitatively the quantity of energy released by a product when exposed to fire.

Specimens are mounted into a frame which is then mounted onto the front of the furnace, at which time the furnace is cold (see Figure A.3). The furnace is then switched on and the temperature of gases leaving the furnace through a flue at the top are measured over a period of 20 min. These temperature measurements are compared with a baseline set of temperature measurements recorded with a non-combustible board inserted in place of the specimen. The differences between the temperatures achieved with the specimen and the temperatures achieved with the non-combustible board are then used to calculate a set of sub-indices and an overall index of fire propagation. The hotter the temperatures recorded with the specimen in place, the higher the index.

Achieving a fire propagation index (I) of 12 or less and sub-index (i₁) of 6 or less can go towards achieving Class 0, although this is not defined within this PAS but within earlier versions of ADB.

The advantage of the BS 476-6 test is that it is relatively inexpensive to conduct compared with the equivalent European tests (BS EN 13823 in particular). However, its principal weakness, insofar as it has been applied to external wall construction under statutory guidance, is that it only exposes the surfaces of products, with their edges being protected by the specimen holder. The standard also does not call for joints to be incorporated into test specimens. Any reliance on the results of a BS 476-6 test, when applied to external wall construction, therefore needs to be treated with caution (see A.1.6).

A.1.3 BS 476-11 – Heat emission

The BS 476-11 heat emission test uses a barrel furnace to assess qualitatively the amount of heat energy released by a material. The barrel furnace is stabilized at 750 °C prior to the test being carried out. The test is started by dropping a sample, held within a wire cage, into the furnace.

The temperature of the furnace and of the centre of the specimen are recorded and the test continues until:

- the specimen temperature drops back to the furnace temperature after attaining a higher temperature than the furnace; or
- the temperature of the specimen is decreasing steadily having reached a peak that was less than the furnace temperature; or
- after 2 h of test running.

The maximum and final (end of test) temperatures of the furnace and specimen are both recorded. The density, initial mass and mass of the specimen is recorded and any sustained flaming (flames that are continuous for more than 5 s) are also recorded.

The test does not have any classification or pass/fail criteria. ADB ([8], [9]) states that materials subjected to this test can be deemed to be of limited combustibility provided that they either:

- have a density of 300 kg/m³ or more; and
 - do not flame during the test; and
 - do not cause the furnace thermocouple to record a temperature rise more than 20 °C above the starting temperature; or
- have a density of less than 300 kg/m³; and
 - do not flame during the test for more than 10 s;
 - do not cause the centre (specimen) thermocouple to record a temperature rise of more than 35 °C above the starting temperature; and
 - do not cause the furnace thermocouple to record a temperature rise more than 25 °C above the starting temperature.

ADB ([8], [9]) also states that materials subjected to this test can be deemed to be non-combustible provided that they:

- do not flame; and
- do not cause any rise in either the centre (specimen) or furnace thermocouples.

The BS 476-11 test is only intended for the testing of homogenous materials which can be provided as a cylindrical specimen of 43 mm to 45 mm diameter and (50 ±2) mm height. This test is not suitable for the testing of materials with higher calorific values, in particular raw polymeric materials, as the temperature of the test can produce a violent reaction.

Figure A.3 – BS 476-6 test apparatus with specimen on bench in front of apparatus containing a blank specimen



Image courtesy of DCCH Experts LLP

A.1.4 BS 476-4 – Non-combustibility

The BS 476-4 non-combustibility test uses similar apparatus to the heat emission test: a barrel furnace operating at 750 °C in which a sample is dropped in a wire cage. As with the heat emission test, thermocouples record the temperature of the furnace and the centre of the sample. This test runs for 20 min from the time when the sample is dropped into the furnace.

Materials are deemed to be non-combustible according to this standard provided that they:

- do not cause either thermocouple to record a temperature rise more than 50 °C above the starting temperature; and
- do not cause flaming inside the furnace exceeding 10 s continuously during the test.

The BS 476-4 test is only intended for the testing of homogenous materials which can be provided as a specimen of 38 mm to 40 mm diameter and (50 ±3) mm height. This test is not suitable for the testing of materials with higher calorific values, in particular raw polymeric materials, as the temperature of the test can produce a violent reaction.

A.1.5 BS EN ISO 11925-2 – Small flame

The BS EN ISO 11925-2 small flame test exposes products to a standardized small flame while they are held in a prescribed specimen holder (flat sheet materials are held vertically) above two sheets of filter paper (see Figure A.4).

The test measures whether:

- ignition of the product occurs;
- the flaming of the product exceeds 150 mm above the application point;
- any flaming droplets or particles are produced that cause ignition of the filter paper; and
- there are any physical changes to the test specimen.

The test addresses the complexities of material and product shapes, layering, etc., by allowing for various exposure conditions to be used (for example, exposing the main face or the cut edge to flame). The specific exposure conditions relevant to construction products are set out in the classification standard, BS EN 13501-1 (see A.2.2).

The test does not include any classification or pass/fail criteria. Insofar as this test relates to compliance with the Building Regulations [7], the data produced by the test are then used for classification to BS EN 13501-1 (see A.2.2).

A.1.6 BS EN 13823 – Single burning item

The BS EN 13823 single burning item test exposes product assemblies to a standard burner. The product assemblies always comprise a minimum of two components held in a corner arrangement so that there is at least one joint at the corner junction, however the test standard allows for various end use conditions to be represented. The assembly can involve single products that are freestanding, glued to a substrate, or have a cavity between them and the substrate. Joints or channels in the product can be represented. If multiple products are to be used as an assembly (e.g. rainscreen and insulation), then the assembly of products can be tested. Ultimately, the test seeks to expose products to the burner in a manner that is representative of their end use condition.

The burner is situated in the corner at the base of the assembly (see Figure A.5) and the entire test is carried out within a test room beneath a calorimeter hood, which is a smoke extraction hood from which measurements are made of temperature, flow velocity, gas concentrations (oxygen and carbon dioxide) and light obscuration.

Product assemblies are assessed for production of heat energy, production of smoke, horizontal flame spread and burning droplets/particles falling from the specimen.

The test does not include any classification or pass/fail criteria. Insofar as this test relates to compliance with the Building Regulations [7], the data produced by the test are then used for classification to BS EN 13501-1 (see A.2.2).

A.1.7 BS EN ISO 1716 – Bomb calorimeter

The BS EN ISO 1716 bomb calorimeter test assesses materials for their energy content (calorific value). Materials are ground into a fine powder and placed into a crucible which is inserted into a bomb surrounded by a double lined jacket filled with water. The bomb is filled with oxygen and the contents of the bomb (material powder and oxygen) are ignited. The heat released by the bomb is calculated from the temperature rises induced in the water and the apparatus.

The test does not include any classification or pass/fail criteria. Insofar as this test relates to compliance with the Building Regulations [7], the data produced by the test are then used for classification to BS EN 13501-1 (see A.2.2).

Figure A.4 – BS EN ISO 11925-2 test apparatus with blank specimen in position for test



Image courtesy of DCCH Experts LLP

NOTE The aluminium foil tray beneath the specimen is used to hold the filter paper for establishing d2 subclass (see A.2.2) and the mirror to the right so that the operator can observe flaming to the rear of the specimen.

Figure A.5 – BS EN 13823 test apparatus with blank specimen in position for test



Image courtesy of DCCH Experts LLP

A.1.8 BS EN ISO 1182 – Non-combustibility

The BS EN ISO 1182 non-combustibility test uses similar apparatus to the national non-combustibility and heat emission tests: a barrel furnace operating at 750 °C in which a sample is dropped in a wire cage (see Figure A.6). The temperature of the furnace is recorded via thermocouple and the test is run for up to 1 h.

The initial and final mass of the sample are measured and recorded. The occurrence and duration of any flaming is recorded, with the flaming duration expressed as the sum of all periods of flaming. The initial, maximum and final temperatures of the furnace are recorded. Additional measurements can also be made within the centre of the specimen and on the surface of the specimen if required. This is determined by the specimen type.

The test does not include any classification or pass/fail criteria. Insofar as this test relates to compliance with the Building Regulations [7], the data produced by the test are then used for classification to BS EN 13501-1 (see A.2.2).

Figure A.6 – BS EN ISO 1182 test apparatus



Image courtesy of DCCH Experts LLP

A.2 Classification of test results

A.2.1 Class 0

Class 0 was defined within various editions of ADB until publication of the 2019 edition. If a product achieves Class 1 to a BS 476-7 test and an index (I) of 12 and sub-index (i,) of 6 in the BS 476-6 test, then the product was deemed, according to the preceding editions of ADB and the Building Regulations 1976 [3], to be Class 0. A product can also be deemed to be Class 0 if it or, in the case of a composite, its surface is composed throughout of materials of limited combustibility. A limited combustibility or non-combustible material to which a coating is applied cannot therefore be assumed to be Class 0, even if it continues to meet the definition for materials of limited combustibility.

The definition of Class 0 has evolved since it was first introduced in the Building Regulations 1965 [1]; previous definitions can be found in Annex P.

Historically, achieving Class 0 was taken to mean that the surface of a product both:

- has a low propensity to facilitate flame spread across its surface; and
- releases little heat energy when exposed to fire.

Class 0, and the tests BS 476-6 and BS 476-7, are all concerned with surfaces. Historically, ADB ([10], [11], [12], [13], [14]) treated Class 0 and Class B (under BS EN 13501-1) as equally acceptable.

Materials (truly homogenous materials, see 3.1.26) which achieve Class 0 are likely to be capable of achieving Class B under BS EN 13501-1 (first introduced in 2002).

Products which achieve Class 0 can only be assumed as being capable of achieving Class B if:

- a) every material component forming the product can independently achieve Class 0; or
- b) any non-Class 0 material component is fully encapsulated in material components which are Class 0, and this would likely continue to be the case under real fire and test conditions (i.e. the product will not delaminate and the encapsulating material components will not melt at temperatures below 800 °C).

Assemblies (of the type which might be tested to BS EN 13823) can also reasonably be assumed as achieving Class B if they:

- 1) are formed only of materials or products which are Class B (save for minor components; see “Sundry items” in Annex L); or
- 2) are formed only of materials or products which can be assumed as achieving Class B in accordance with a) and b) above.

A.2.2 BS EN 13501-1 – Classification using data from reaction to fire tests

This standard sets out the manner in which data are used from the previously described European reaction to fire tests to classify products and materials. Different criteria are set for different types of construction product.

The criteria for the various classes that apply to products and materials used in external wall construction are summarized in Table A.2.

In addition to the above classes, there are subclasses that are added to Class A2 to Class D for smoke production and flaming droplets or particles with criteria as shown in Table A.3 and Table A.4.

For products classified as Class E, no indication for flaming droplets (d) is given if the filter paper is not ignited in the BS EN ISO 11925-2 test. However, where flaming droplets/particles do ignite the filter paper, it is classified as d2.

Table A.2 – Requirements for classes of materials and products (excluding floorings and pipe insulation) under BS EN 13501-1

Class	Tests required	Criteria ^{A)}	
A1	BS EN ISO 1182	$\Delta T \leq 30 \text{ }^\circ\text{C}$ $\Delta m \leq 50\%$ $t_f = 0 \text{ s}$	
	BS EN ISO 1716	$PCS \leq 2.0 \text{ MJ/kg}$	
A2	BS EN ISO 1182 or BS EN ISO 1716	$\Delta T \leq 50 \text{ }^\circ\text{C}$ $\Delta m \leq 50\%$ $t_f \leq 20 \text{ s}$	$PCS \leq 3.0 \text{ MJ/kg}$
	BS EN 13823	No lateral flame spread to edge of specimen $FIGRA (= FIGRA_{0,2MJ}) \leq 120 \text{ W/s}$ $THR_{600s} \leq 7.5 \text{ MJ}$	
B	BS EN 13823	No lateral flame spread to edge of specimen $FIGRA (= FIGRA_{0,2MJ}) \leq 120 \text{ W/s}$ $THR_{600s} \leq 7.5 \text{ MJ}$	
	BS EN ISO 11925-2	30 s flame exposure No flame spread in excess of 150 mm within 60 s	
C	BS EN 13823	No lateral flame spread to edge of specimen $FIGRA (= FIGRA_{0,4MJ}) \leq 250 \text{ W/s}$ $THR_{600s} \leq 15 \text{ MJ}$	
	BS EN ISO 11925-2	30 s flame exposure No flame spread in excess of 150 mm within 60 s	
D	BS EN 13823	$FIGRA (= FIGRA_{0,4MJ}) \leq 750 \text{ W/s}$	
	BS EN ISO 11925-2	30 s flame exposure No flame spread in excess of 150 mm within 60 s	
E	BS EN ISO 11925-2	15 s flame exposure No flame spread in excess of 150 mm within 20 s	
F	BS EN ISO 11925-2	15 s flame exposure Flame spread in excess of 150 mm within 20 s	
<p>^{A)} The criteria are expressed as follows: ΔT is the change in temperature; Δm is the change in mass or mass loss; t_f is the final temperature recorded; PCS is the gross heat of combustion; and FIGRA is an index determined from the maximum quotient of heat release rate from the specimen at the time of its occurrence using a total heat release (THR) of either 0.2 MJ or 0.4 MJ.</p>			

Table A.3 – Smoke production classification – For products classified A2 to D

Class	Tests required	Criteria ^{A)}
s1	BS EN 13823	SMOGRA $\leq 30 \text{ m}^2/\text{s}^2$ TSP _{600s} $\leq 50 \text{ m}^2$
s2		SMOGRA $\leq 180 \text{ m}^2/\text{s}^2$ TSP _{600s} $\leq 200 \text{ m}^2$
s3	Products for which no performance is declared or which do not meet criteria for s1 or s2	—
^{A)} The criteria are expressed as follows: SMOGRA is the maximum quotient of smoke production rate from a specimen at the time of its occurrence; and TSP _{600s} is the total smoke production from the specimen in the first 600 s of exposure.		

Table A.4 – Flaming droplets/particles classification – For products classified A2 to D

Class	Tests required	Criteria
d0	BS EN 13823	No flaming droplets/particles occur within 600 s
d1		No flaming droplets/particles, persisting for longer than 10 s, occur within 600 s
d2	BS EN 13823	Does not meet criteria for d0 or d1
	BS EN ISO 11925-2	Flaming droplets/particles ignite filter paper
	No performance declared	—

A.3 Large-scale cladding test and classification – BS 8414-1, BS 8414-2 and BR 135

There are two parts to BS 8414.

- The BS 8414-1 test is for testing the fire performance of non-loadbearing external cladding systems fixed to, and supported by, a masonry substrate.
- The BS 8414-2 test is for testing the fire performance of non-loadbearing external cladding systems fixed to, and supported by, a structural steel frame.

The test requires construction of a test specimen onto a rig at least 8 m tall (at least 9.5 m as of the 2020 edition). It has a main face at least 2.6 m wide with a hearth at its base, with an opening 2 m by 2 m in area and a depth of 1 m. To the side of the main face is a wing wall perpendicular (90° angle) to the main face and at least 1.5 m wide.

The cladding system (or test specimen) to be tested is installed onto the test rig by the test sponsor, who is usually the manufacturer or designer (most tested systems incorporate a number of products produced by different manufacturers). Normally the test is carried

out prior to the installation of a system onto a building, and the specimen is therefore designed to fit onto the BS 8414 rig, with details that are representative of those that will be used when the system is fitted onto buildings (i.e. fixings, brackets, insulation, cavity sizes, rainscreen, gaps between components, etc.).

Thermocouples are installed into the cladding system at set intervals on levels 1 and 2 of the test rig as shown in Figure A.7, both external to the system and within the system, embedded at the mid-depth of each combustible layer of the system and any cavity. (A set of additional thermocouples at a new level 3 has been incorporated as part of the test rig in the 2020 versions of BS 8414-1 and BS 8414-2.) Figure A.8 illustrates the locations of thermocouples in the various layers of a simple rainscreen system applied to a masonry substrate.

The heat source, typically a large timber crib, is placed into the hearth at the base of the wall (see Figure A.9 and Figure A.10). This fire scenario simulates a fully developed fire in a room venting through a broken window and impinging on the external wall. The crib is designed to give a peak heat release rate of between 2.5 MW and 3.5 MW with a nominal heat output of 4 500 MJ over a 30 min period.

Figure A.7 – Location of thermocouples for a cladding test

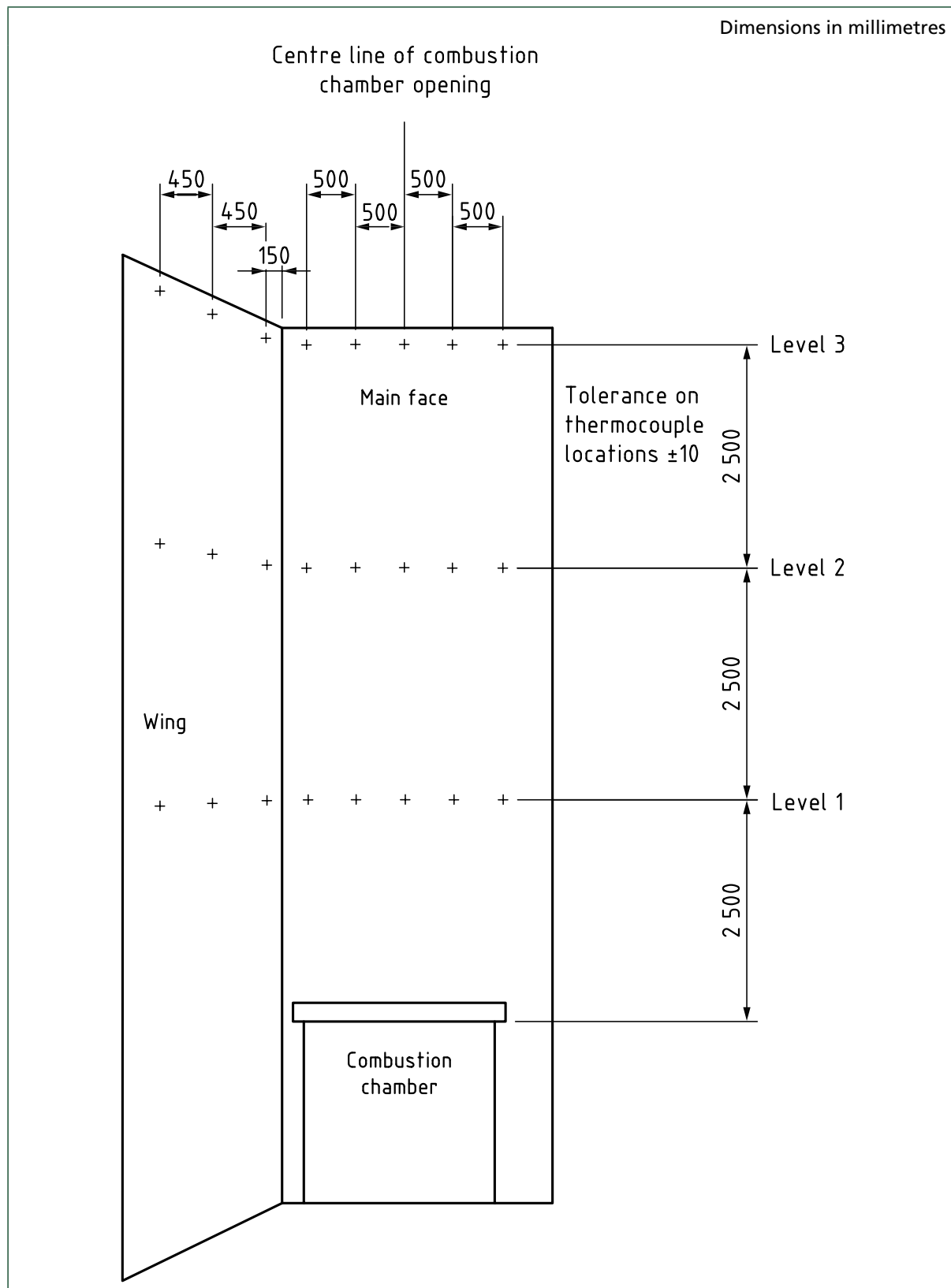


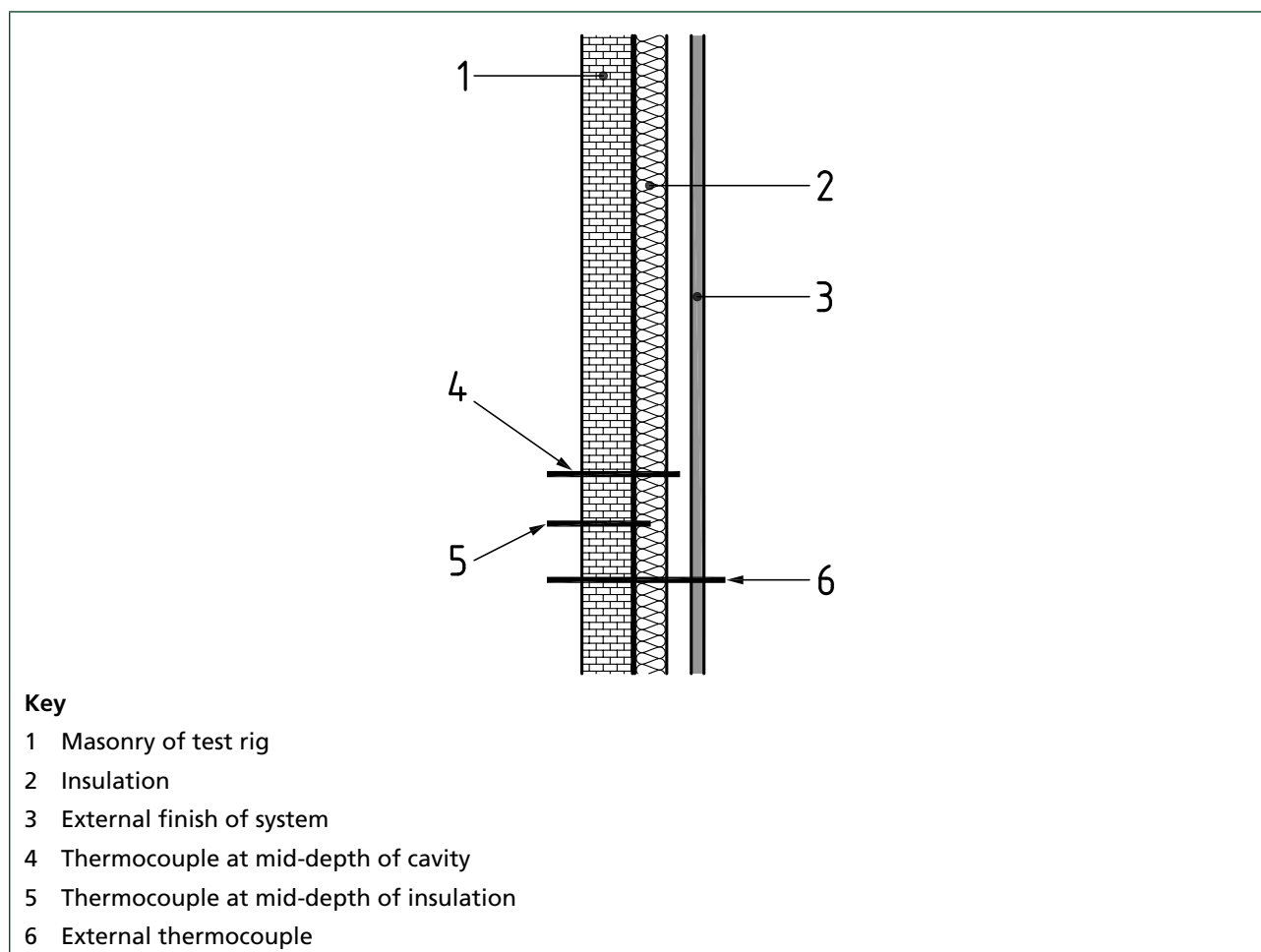
Figure A.8 – Illustration of thermocouple locations in the layers of the test system

Figure A.9 – BS 8414-1 rig with a timber crib installed in the combustion chamber but no test specimen installed onto the rig



Image courtesy of BRE Global

Figure A.10 – BS 8414-1 rig with a timber crib fully alight but no specimen installed, indicating severity of test when there is no contribution from a test specimen



Image courtesy of BRE Global

Temperature data and visual observations are gathered during the test. The timber crib is extinguished 30 min after ignition, and data recording and observations continue for a further 30 min (totalling 60 min from ignition).

Early termination criteria for the test are as follows:

- flame spread extends above the test apparatus at any time during the test duration; or
- there is a risk to the safety of personnel or impending damage to the equipment.

BR 135 [15] provides both guidance and the classification criteria for a cladding system that has been tested to BS 8414. The performance criteria and classification method are as follows.

- The system has to have been tested to the full test duration requirements without any early termination of the full fire load exposure period.
- A temperature rise above the starting temperature of any external thermocouples at level 2 exceeding 600 °C for a period of at least 30 s within 15 min of the start time is a failure due to external fire spread.
- A temperature rise above the starting temperature of any internal thermocouples at level 2 exceeding 600 °C for a period of at least 30 s within 15 min of the start time is a failure due to internal fire spread.

In relation to the classification of systems tested to BS 8414-2, where system burn-through occurs so that fire reaches the internal surface, failure is deemed to have occurred if continuous flaming, defined as a flame with a duration in excess of 60 s, is observed on the internal surface of the test specimen at or above a height of 0.5 m above the combustion chamber opening within 15 min of the start time, t_s .

Observations of any mechanical performance are to be reported under BS 8414, and it is recommended in BR 135 [15] that significant forms of mechanical performance, such as system collapse, spalling, flaming debris, etc., which are recorded in the classification report, be considered as part of the overall risk assessment when specifying the system. Any FRAEW which relies upon a BS 8414 test will need to establish whether any such collapse, spalling or flaming debris did occur, and to consider this as part of the assessment.

BS 8414 provides direct application rules for a system which has been subjected to a single BS 8414-1 or BS 8414-2 test and interpolation for systems which have been subjected to multiple tests. It can be used where there are variations and changes to products and systems that have been tested in accordance with BS 8414.

A.4 Fire resistance tests

Fire resistance is a measure of one or more of the following:

- resistance to collapse (loadbearing capacity), which applies to loadbearing elements only, denoted R in the European classification of the resistance to fire performance.
- resistance to fire penetration (integrity), denoted E in the European classification of the resistance to fire performance.
- resistance to the transfer of excessive heat (insulation), denoted I in the European classification of the resistance to fire performance.

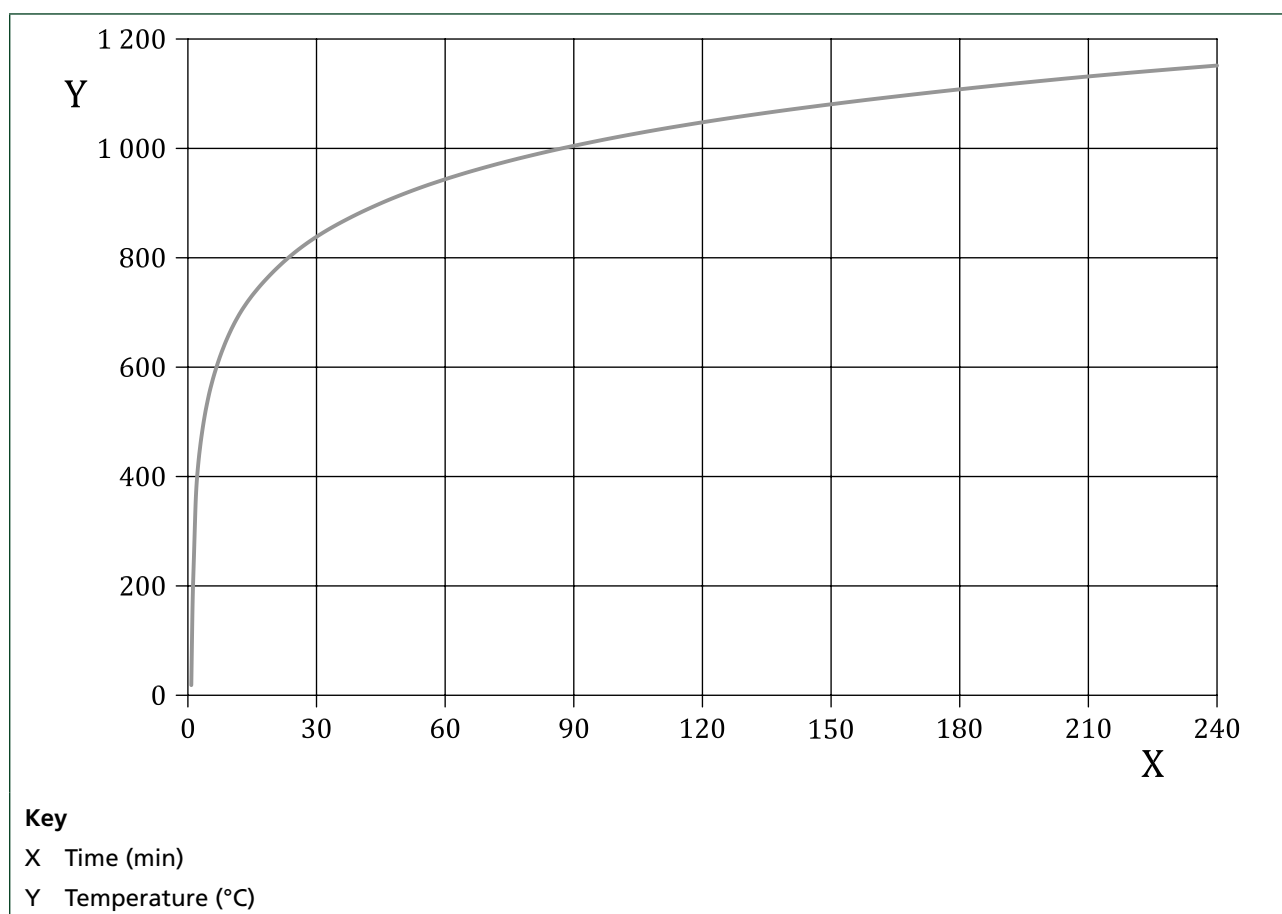
There are various fire resistance tests that can be employed, depending upon the particular component or system being tested, and the particular aspect of fire resistance that is of interest. In relation to external walls, the following tests are most likely to be relevant:

- BS 476-20 to BS 476-23;
- BS EN 1363-1 and BS EN 1363-2;
- BS EN 1364-1 to BS EN 1364-5; and
- BS EN 1365-1 to BS EN 1365-4.

In all these tests, the period of fire resistance is measured by mounting the test specimen into a furnace, running the furnace and noting the time at which one or a number of criteria are met. The test begins with the furnace at ambient temperature and gas burners are typically used to achieve temperatures set by the international standard, ISO 834. The temperature profile over a 4 h period is shown in Figure A.11.

With respect to the differences between equivalent national and European tests, the tests differ primarily in the way in which temperature measurements are taken.

- Furnace temperatures: In the national tests, thermocouples are of the bare wire type between 0.75 mm and 1.5 mm diameter. In the European tests, plate thermometers are used wherein the thermocouple itself is mineral insulated and sheathed and fixed in the centre of a nickel alloy plate which is folded around a layer of mineral insulation. The plate thermometers of the European tests are more durable (50 h service) than the national tests (6 h service) but are less sensitive. This means that, in practice, the furnace temperature is likely to be somewhat higher in the European tests than in the national tests.
- Specimen temperatures: The thermocouples used for measuring surface temperatures on the unexposed face of the specimen are broadly identical, although there are some minor differences in the specification as to where these are to be located.

Figure A.11 – Time temperature curve defined in ISO 834

Annex B (informative)

Mechanisms of fire spread and the implications for the risk posed by external wall fires

Fires, started either internally or externally, can spread to a building's exterior envelope. Internal fires usually spread by breaking out through a window or another opening which is not fire-resisting. Although an open window would allow this to take place at an earlier stage, the propensity for this to occur is most pronounced at the point of flashover within the room of fire origin (at which point, window breakage is assumed). Once flames from, for example, a broken window have attacked the external envelope of the building, there is the potential, especially if the façades incorporate external wall construction and cladding that is combustible, for the fire to develop rapidly and fire to spread extensively.

Ultimately, and as a matter of time, the outcome of any fire that spreads via the external envelope of a building is likely to be secondary fires on at least the immediate floor above the floor of fire origin. This is the case even with external wall construction that is considered to resist adequately the spread of fire. Figure B.1 depicts fire spread that is restricted in its extent and development in line with this scenario. By contrast, Figure B.2 depicts a situation in which the external wall construction and cladding gives rise to rapid fire spread and development. In the latter case, the extent of secondary fires can be far greater, affecting many floor levels simultaneously. This is indicative of external wall construction that is not considered to resist adequately the spread of fire. It is, of course, possible in both cases for fires to be started on lower levels by burning droplets and debris falling from the fire above.

A notable feature of external walls, and especially modern cladding systems such as a rainscreen cladding system, is the presence of cavities. These present the particular danger of concealed and extensive fire spread. As well as contributing to the speed of fire development, this mechanism for fire spread can, if not properly mitigated by cavity barriers, circumvent key features in the building's fire safety design. Most notably, in the case of a block of flats, this can allow the compartmentation between floors and between flats to be bypassed. As this compartmentation supports the fundamental principles underpinning the design of the means of escape and the evacuation strategy, with the latter usually limited to evacuation of only the flat of fire origin, while occupants of other flats stay put, the consequences of such fire spread can be very serious.

That cavities can contribute so significantly is evident from many fires and is discussed further below. It is due, largely, to the elongation of the flames as they seek out oxygen, and the dynamics of heat transfer from, and to, flames within a confined space. This is further exacerbated when the cavity contains combustible material that is readily ignitable and that is able to release a significant quantity of heat when it burns. Such a situation can give rise to extremely rapid fire spread.

However, Figure B.1 clearly shows that in order for external fire spread to pose a danger to the occupants of the building, it has to re-enter the building and cause secondary fires. Windows are an obvious route for fire to re-enter. This either directly threatens occupants remote from the original fire, if people are present in the space in which a secondary fire occurs, or indirectly poses a threat if such a fire renders their escape routes impassable.

Restricting the combustibility of the materials within the build-up of an external wall, as well as ensuring that any cavities present are limited in extent, are two of the most significant controls within the standards applied to fire safety of external walls; these controls have, for many years, underpinned the guidance in the various versions of ADB, as applied to new buildings.

Fires can equally start externally and spread to involve the exterior of the building. Such fires could involve, for example, a burning vehicle parked on a road adjacent to the building, or a waste skip on fire if positioned underneath an overhanging part of the external façade. Ignition of combustible cladding or other parts of the external walls could then occur, either by direct flame impingement on the combustible cladding, or through radiant heat transfer to the cladding. Indeed, it is also possible for a fire in a neighbouring building, if close enough, to cause radiant heat transfer, with sufficient intensity for exposed combustible material to be at risk of ignition.

Figure B.1 – Typical scenario in which external fire spread is restricted, with some, but limited, scope for secondary fires on floors above

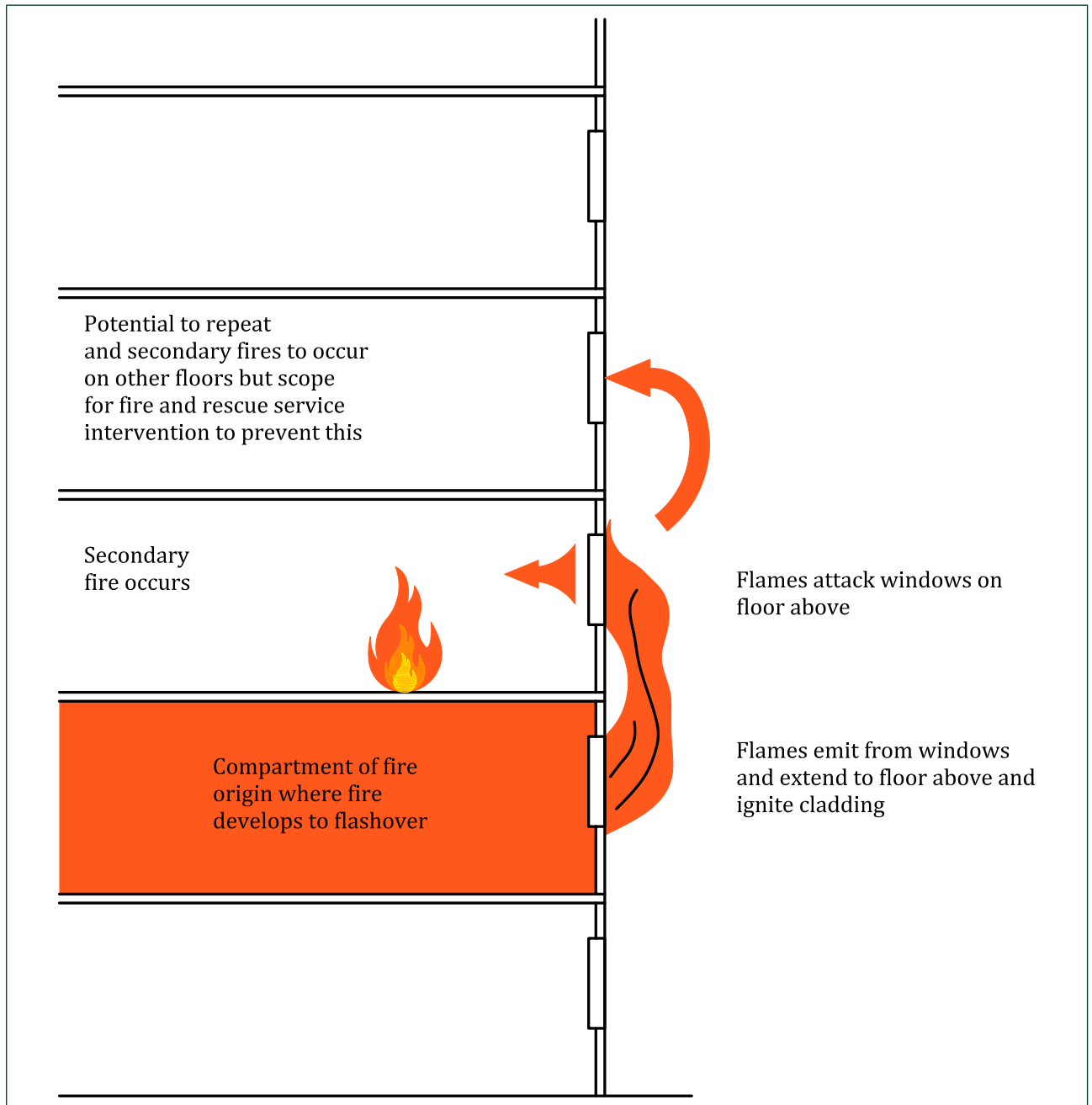
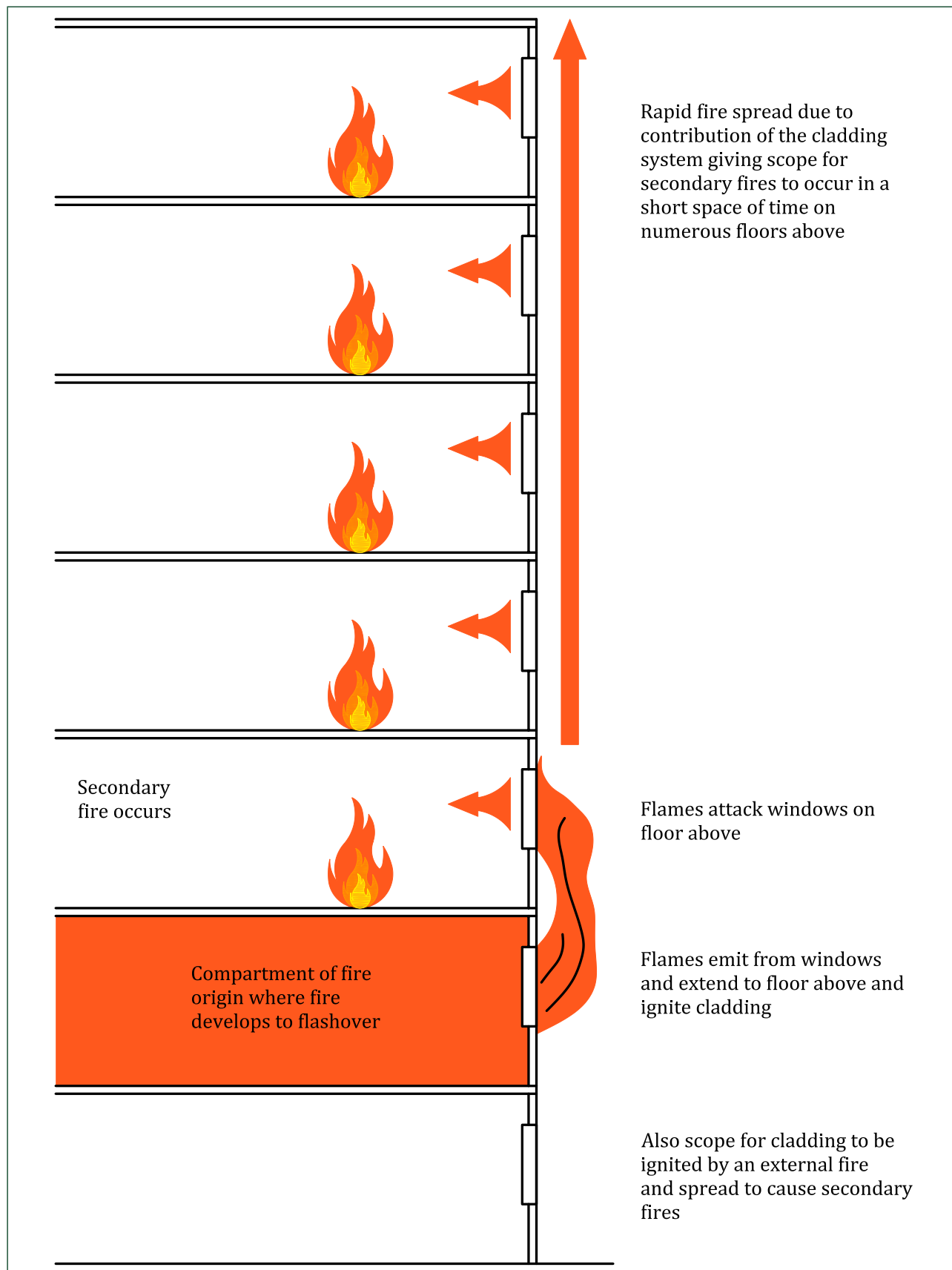


Figure B.2 – Potential scenario resulting in rapid external fire spread and significant risk of multiple secondary fires



Restricting the reaction to fire classification of surfaces, and, therefore, the propensity for materials and products to sustain a flame and propagate flame spread, as well as control of the amount of energy released by a material or product once exposed to fire, is the basis of controls within the guidance applied to fire safety of external walls. This has also underpinned, for many years, the guidance in the current and previous versions of ADB as applied to new buildings.

For context, details of the current functional requirement in relation to external fire spread, Requirement B4(1) in the Building Regulations 2010 [7], and the guidance in ADB ([8], [9]), can be found in Annex D of this PAS, along with details of routes to compliance in ADB ([8], [9]) that would have applied to existing blocks of flats prior to this.

The key points to note in Figure B.1 and B.2 with regard to the mechanisms of fire spread that apply to external walls are as follows.

- a) The type of cladding system, the materials used and the configuration of an external wall can, potentially, lead to rapid fire spread vertically up the outside of a building, and, as a result, cause secondary fires on several other floor levels, where fire breaks back into the building.
- b) Even where the external walls do not contribute to rapid fire spread, it is still possible and indeed likely that fire will eventually spread to the floors above, by means of, for example, windows, unless the fire is extinguished before this occurs.
- c) Even if rapid fire spread via the external wall construction is not likely, it is still necessary for effective intervention by the fire and rescue service to extinguish the fire, if, ultimately, floor-to-floor fire spread is to be avoided.

This highlights a fundamental point that the benchmarks inherent in current standards and guidance for the fire safety design of buildings do not preclude the possibility of floor-to-floor fire spread. It also highlights that time is an important factor.

The main focus of recent attention has been on the type of rainscreen cladding system on Grenfell Tower, and, in particular, the use of ACM with a polyethylene core. However, also notable was the presence, within the rainscreen system, of extensive cavities, in which there was polymeric insulation. One of the earliest fires to highlight the potential dangers of cavities was the fire at Knowsley Heights in Liverpool in 1991, which is cited in BR 135 [15].

BR 135 [15] also refers to the fire at Garnock Court, Irvine, Ayrshire in 1999, which involved external fire spread. In this case, the fire spread started on the fifth floor and spread externally to the 13th floor of this 14-storey block of flats. The extent of fire spread was largely limited to a single strip of the external wall, comprising what are known as spandrel, or infill, panels between the windows on each floor (see Figure B.3). (Although the fire resulted in a fatality, the casualty in question was located in the flat of fire origin; his death did not result from external fire spread.)

Figure B.3 – Fire at Garnock Court, Irvine

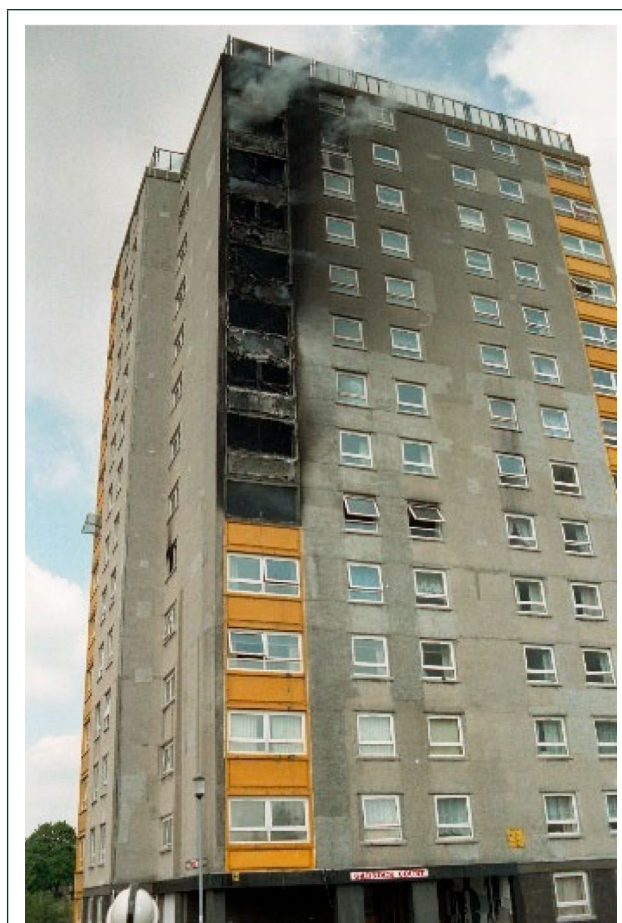
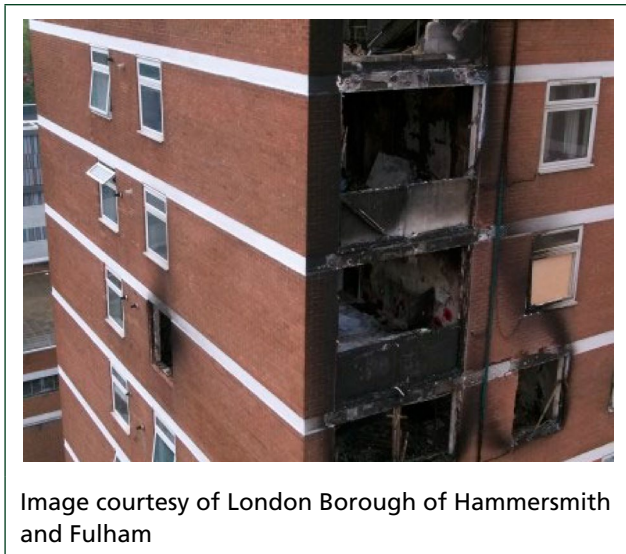


Image courtesy of Scottish Fire and Rescue Service

Spandrel/infill panels were also highlighted as significant in a fire in a high-rise block of flats at Shepherd's Court, London, in 2016. In this case, fire spread from a flat on the seventh floor to affect other flats up to the 12th floor. This, again, illustrated the scope for fire to spread extensively over the external walls, even when there is not continuous cladding; the mechanism in this fire, and in other fires involving combustible spandrel/infill panels, is one of flames leaping from one panel to the next, so giving rise to the fire cascading up the building (see Figure B.4).

Figure B.4 – Fire at Shepherd's Court, London



Other recent fires of particular significance in relation to external fire spread include those at the Lighthouse, Manchester (December 2017) and Samuel Garside House, Barking (June 2019). Both involved timber balconies. In many respects, these fires represented extremes in the scale of timber balconies. Timber was used as flooring for small balconies at the Lighthouse residential block in Manchester, but some timber was also present on the walls behind the balconies. At Samuel Garside House, there was even more extensive use of timber, in the balcony construction forming projections to the façade. Both fires resulted in secondary fires on upper levels, but in a far greater number at Samuel Garside House. While it has long been recognized that fires involving timber balconies, such as the balconies on the Lighthouse, can give rise to notable external fire spread, the scale of the fire spread at Samuel Garside House (see Figure B.5) has highlighted that this can be highly significant in terms of the fire risk posed by external wall construction and cladding.

A further fire that caused public concern and served to highlight, yet again, the dangers of combustible cladding, occurred in November 2019 at the Cube in Bolton (see Figure B.6). This student accommodation building had an HPL cladding system, which was implicated in the extensive fire spread that occurred.

The above are examples of notable fires involving significant external fire spread in the UK; others have occurred elsewhere. Table B.1 gives a list of notable fires involving external wall construction and cladding that have occurred since 1990, both in the UK and abroad. This list is not exhaustive in terms of either content or detail; further information on fires of this nature can be found in BRE Report P111324-1019 [27].

Figure B.5 – Fire at Samuel Garside House, Barking



Figure B.6 – Fire at the Cube, Bolton



Table B.1 – Notable fires involving external wall construction and cladding

Building name (where known), town/city, country	Year	Cladding type
Manitoba, Canada	1990	ETICS
Knowsley Heights, UK	1991	GRP rainscreen
Munich, Germany	1996	ETICS
Eldorado Hotel, Reno, Nevada, USA	1997	Curtain wall
Palace Station, Las Vegas, USA	1998	ETICS
Irvine, UK	1999	Mixture (fire involved GRP spandrel/infills)
Magdeburg, Germany	2000	ETICS
Lakeside Plaza, Virginia, USA	2005	ETICS
Berlin, Germany	2005	ETICS
Rin Grand Hotel, Bucharest, Romania	2007	Rainscreen
Water Club Tower, Atlantic City, USA	2007	Metal composite rainscreen
MGM Hotel, Las Vegas, USA	2008	ETICS
Miskolc, Hungary	2009	ETICS
Millenium Business Centre, Bucharest, Romania	2009	ACM rainscreen
Centre International Plaza, Nanjing, China	2009	Unknown
Lakanal House, London, UK	2009	Curtain wall
CCTV Tower, Beijing, China	2009	Mixture including ETICS (system involved)
Dijon, France	2010	ETICS
Wooshin Golden Suites, Busan South Korea	2010	ACM rainscreen
Shanghai, China	2010	Unknown
Bucharest, Romania	2011	Rainscreen
Mermoz Tower, Roubaix, France	2012	ACM rainscreen and decorative panels
Al Tayer Tower, Sharjah, UAE	2012	ACM rainscreen
Tamweel Tower, Dubai, UAE	2012	ACM rainscreen
Saif Belhasa Building, Tecom, Dubai, UAE	2012	ACM rainscreen
Targu Mures, Romania	2012	ETICS
Polat Tower, Istanbul, Turkey	2012	Rainscreen
Grozny City Tower, Chechenia, Russia	2013	Metal composite rainscreen
Karlstad, Sweden	2013	Unknown
Krasnoyarsk, Russia	2014	Rainscreen
Lacrosse Tower, Melbourne, Australia	2014	ACM rainscreen
Seoul, South Korea	2015	ETICS
Baku, Azerbaijan	2015	Unknown
Ream Island, Abu Dhabi, UAE	2015	Rainscreen
Address Downtown Hotel, Dubai, UAE	2015	ACM rainscreen
Torch Tower, Marina, Dubai, UAE	2015	ACM rainscreen
Shepherds Court, London, UK	2016	Mixture (fire involved composite spandrel/infills)
Grenfell Tower, London, UK	2017	ACM rainscreen
Torch Tower, Marina, Dubai, UAE	2017	ACM rainscreen
Taksim Training and Research Hospital, Istanbul, Turkey	2018	Rainscreen
NEO 200, Melbourne, Australia	2019	Rainscreen
Shenyang, China	2019	Unknown
The Cube, Bolton, UK	2019	HPL
Abbco tower, Sharjah, UAE	2020	Unknown
Ulsan, South Korea	2020	Unknown
Shijiazhuang, China	2021	Unknown

With the horrific scenes of the cladding on fire at Grenfell Tower, followed by these other recent dramatic fires involving external fire spread, many have concluded that insufficient attention has been paid to this matter in modern building construction. The threshold of tolerance of the public, regulators and enforcing authorities to the perceived risk from external fire spread has reduced dramatically at the same time. It is against this background that existing buildings are being scrutinized to determine whether or not they are “safe”.

However, it is important, in considering the external walls of a specific block of flats, to contextualize the risk posed to life in the case of that specific building.

Even in the examples of external fire spread cited above, although there have been minor injuries, in only one case, Grenfell Tower, has there been loss of life beyond the compartment of fire origin. This is not to suggest complacency. Indeed, the findings of surveys conducted after the Grenfell Tower fire, highlighting that Category 3 ACM (see 3.1.1) cladding panels had been installed on hundreds of other high-rise blocks of flats, served as a stark reminder that the potential scale of the problem is considerable.

Nevertheless, a more typical fire in a block of flats in which the external walls are involved is illustrated by the fire that occurred in a flat on the 11th floor of the 22-storey block pictured in Figure B.7 (cited in BRE report *External fire spread – Part 1: Background research* [28]). The fully developed fire that broke out of the windows caused only localized damage to the façade in the immediate vicinity of the windows, beyond which there was only surface charring and sooting of the rendered mineral wool ETICS, applied as a new cladding system to a 1960s building.

Most fires in blocks of flats are contained within the flat of fire origin. They rarely spread to involve the external envelope and give rise to external fire spread.

This can be seen from the very small number of incidences in which it has been necessary for the fire and rescue service to intervene to evacuate or rescue people beyond the flat of fire origin. Typically, in purpose-built blocks of flats, compartmentation and means of escape provisions have been effective, and neither internal nor external mechanisms of fire spread have led to fires requiring large numbers of people beyond the flat of fire origin to be evacuated or rescued. For example, in a specific analysis of data from 2019–2020, of over 7 500 fires in purpose-built blocks of flats in England, only 16 fires (0.2%) necessitated evacuation of more than five people with the assistance of the fire and rescue service⁹⁾.

⁹⁾ Home Office data.

In reality, the only way external fire spread can be prevented in its entirety is to build a building out of entirely non-combustible materials and not have any windows or other openings in the external envelope. As stated earlier, in any multistorey building which does have openings, external fire spread can occur if a fire is allowed to reach flashover; at this stage, flames are able to emit and extend from the openings until they reach an opening above.

Figure B.7 – Fire in high-rise block resulting in limited external spread



Image courtesy of BRE Global

Annex C (informative)

Legislative context

Prior to the Fire Safety Act 2021 [20], the scope of the Fire Safety Order [19] did not expressly include external walls. Different professionals have taken differing views over whether the risk of spread of fire across the external walls was captured by Article 4(1)(a) of the Order under the need to reduce the risk of spread of fire on the premises as part of the general fire precautions, or indeed whether external walls were part of the premises when they were not associated with any common parts of buildings (i.e. solely formed the external envelope of dwellings). The Fire Safety Act 2021 [20] has specifically placed external walls within the scope of the Fire Safety Order [19] where a building contains two or more sets of domestic premises.

By contrast, the scope for external fire spread over the external walls of blocks of flats has always been addressed by building regulations. The Building Regulations in England [7] are applicable to the construction of new buildings and alterations to existing buildings. ADB ([8], [9]) has, traditionally, been seen as the definitive guidance on fire safety of external wall construction in new buildings. In the absence of any alternative guidance, ADB has sometimes been used as a benchmark by which to judge the external walls of existing blocks of flats. This was the position within the MHCLG's Consolidated Advice Note, save that it applied the guidance in ADB for buildings taller than 18 m across all heights of buildings [17].

Reference is made extensively in this PAS to the Building Regulations [7] and various versions of ADB. ADB is highly relevant in that, from the functional Requirement B4(1) in the current Building Regulations [7], and the relevant clauses of the current version of ADB ([8], [9]) setting out recommendations for meeting B4(1), it is possible to gain an understanding of the underlying issues in relation to fire spread over the external walls of a building and the measures considered to be necessary to mitigate this. Less explicit, but inherent in this, and of particular importance in the consideration of buildings built prior to the latest Building Regulations [7] and guidance, is that there are limits to what is necessary, in order to consider the risk acceptable. Restrictions on the surface fire propagation of the exposed face of the cladding, or the combustibility of the components within the external wall build-up, only apply in certain circumstances, with building height being a major determinant of whether such restrictions apply.

Accordingly, when considering the fire risk posed by external wall construction, it is important to have cognizance of the requirements of building regulations and the recommendations of supporting guidance, and the differences between what is applicable now to new buildings and what would have been applicable at the time of construction of the building under consideration. Annex D refers to the Building Regulations 2010 [7] and the applicable version of ADB ([8], [9]) as they apply to new buildings or alterations to existing buildings at the time of publication of this PAS. However, this is for context only; it has been, and still is, possible, under certain conditions such as the height of the building, for the presence of combustible materials within external walls to be acceptable, provided the functional requirements of the regulations were met, typically by meeting the criteria within the supporting guidance in the relevant version of ADB. Annex P provides some of the history of changes in the relevant standards, codes of practice and guidance relating to conformity of external wall construction to building regulations (predominantly in England) over the years. Equally, it is acknowledged that the original design of the building might have been in accordance with other guidance, such as BS 9991.

An understanding of the philosophy behind the regulations and guidance, and how this has changed over time, is of vital importance when making judgements regarding the acceptability of the fire risk posed by external wall construction on existing buildings.

Reference to the guidance in the relevant version of ADB, applicable both now and at the time of construction, can also provide a useful indicator as to whether what might be seen as apparent deficiencies in the external wall construction, such as missing cavity barriers, are indicative of poor workmanship or deterioration, or, in fact, are examples of differences in the recommendations of guidance in place at the time the building was constructed and current recommendations on these matters.

However, for avoidance of doubt, the purpose of an FRAEW is not to determine whether the external walls of a building meet the current Building Regulations [7] or those that applied at the time of construction. Nor is it implied that, in including guidance on changes in regulations and guidance over the years, a form of gap analysis is needed.

It is vital to understand that, in the case of existing buildings, the context in which the fire risk posed by external wall construction is to be considered is the ongoing legislative control applicable to occupied buildings, which, in England, is the Fire Safety Order [19] and the Fire Safety (England) Regulations [29]. Accordingly, an FRAEW is intended to inform the FRA for the building, completed in accordance with Article 9 of the Fire Safety Order [19].

Of particular significance is the manner in which the legislative obligations under the Fire Safety Order [19] are satisfied and how this differs from that of the Building Regulations [7]. In the case of Building Regulations [7], a compliance-based approach is adopted, usually by reference to the guidance in ADB ([8], [9]), which is then commonly followed as if it were a prescriptive benchmark. In other words, following the recommendations of ADB tends towards evidence of compliance with the functional requirements; this is not to suggest that the guidance in ADB cannot be varied, and ADB itself makes it clear that alternative approaches are possible using fire engineering or other means to demonstrate compliance.

Nevertheless, a fundamental risk-based approach to compliance with the Building Regulations [7] is not commonly taken, and even more rarely is it ever adopted in terms of meeting Requirement B4(1). Even the performance-based option, of classification to BR 135 [15] based on data from a BS 8414 test, equates to a simple case of whether or not the construction of the external walls meets the criteria in BR 135, and therefore does, or does not, satisfy ADB ([8], [9]). It is not used to measure performance of the external walls in the context of performance of the fire safety design of the building as a whole.

It is also notable that, while, in general, guidance in ADB ([8], [9]) is framed around factors such as the use of the building, by virtue of relating recommendations to purpose groups, this is limited in the case of recommendations relating to compliance with Requirement B4(1); while there is some, albeit limited, difference regarding recommendations relating to surface propagation, depending upon the use of the building, the combustibility of the external walls is the same, irrespective of purpose group. Recommendations relating to both of these fire performance requirements are principally varied only on the basis of building height and the distance from the relevant boundary.

MHCLG's 2020 Consolidated Advice Note [17], similarly, took a relatively prescriptive approach to some of the fire risks posed by external wall construction, when determining whether the external walls and cladding are acceptable in terms of fire performance and whether the building is safe, recommending that professional advice be sought where compliance could not be confirmed.

In the light of the Grenfell Tower fire, there was an immediate need to assess external walls of existing buildings, and the approach taken within the MHCLG's Advice Notes, originally and in the 2020 version of the Consolidated Advice Note [17], was to default to the benchmark guidance used for new buildings. However, in doing so, the guidance referred to the benchmark guidance prior to the 2018 amendments to Regulation 7 of the Building Regulations [7], namely that the presence of combustible materials can be acceptable, subject to the walls meeting the performance route of classification to BR 135 [15], based on the data from a BS 8414 test. At its heart, this was the Consolidated Advice Note's benchmark of whether external walls are safe.

The Consolidated Advice Note [17] always recognized that there would be circumstances where conformity to BR 135 [15] could not be established. Indeed, the intent of the Consolidated Advice Note, in its earliest version [16] and in the 2020 version [17], was that, in circumstances in which the benchmark of BR 135 compliance could not be demonstrated, professional advice could be sought from suitably experienced fire engineers and other building professionals as to what to do about this situation and what measures could be taken "to ensure that the external walls meet an appropriate standard of fire safety".

In practice, fire engineers and others had no guidance on how to determine:

- what is an appropriate standard of fire safety, given that underlying rationale and success criteria underpinning the recommendations in ADB ([8], [9]) are not explicitly stated and, therefore, it is difficult to determine how this standard can be shown to have been successfully met;
- suitable measures to meet such a standard;
- in the absence of the certainty that a compliance-based approach establishes, how a risk-based alternative approach could be applied; and
- what to take into account in formulating an opinion on risk.

There has been a growing recognition over time and amongst, in particular, Government, enforcing authorities, building owners/occupiers, and fire risk assessors, that a prescriptive approach in the application of the Consolidated Advice Note [17] is no longer the appropriate way in which to determine whether existing buildings are safe. Amongst the drawbacks of a prescriptive approach are the following.

- This approach has proved to be very conservative, giving rise to excessive caution on the part of many applying the Consolidated Advice Note [17].
- It promotes a degree of certainty that cannot be provided for external wall construction on many buildings.
- It takes no account of changes in the regulations and guidance on new buildings over the years, and the fact that a building meeting the regulations that were in place at the time of construction many years ago would probably not conform to current standards and the recommendations in the current version of ADB.
- Where combustible material is present, the benchmark recommended in ADB ([8], [9]) cannot be readily demonstrated without arranging for large-scale fire tests to be carried out to prove that a building is safe, something which is not practicable, given the time and cost of the exercise, as a tool for making assessments for existing buildings. Moreover, the approach cannot be used for cladding systems that are not within the scope of BS 8414.
- It has resulted in expensive investigations and remediation works which, by comparison to blocks of flats with unsafe ACM cladding systems, are of demonstrably lower concern and which have diverted resources and effort away from buildings that are more important in terms of ensuring the safety of the occupants.

Accordingly, there has been an increasing recognition that a more flexible and pragmatic approach is needed, which is inherently risk-based. While this will inevitably be more subjective compared with one that is compliance-based and will offer less certainty, it is seen as a necessary means to progress the assessment of risk on existing blocks of flats and focus effort on those buildings that present the most concern to life safety from external wall fires.

By contrast to the compliance-based approach adopted in satisfying building regulations for new buildings, the Fire Safety Order [19] is inherently risk-based in its application to existing buildings. Given that this is the appropriate legislation to apply when considering external walls on existing buildings, a risk-based approach has been adopted in the preparation of this PAS. Risk assessment is seen as the means of determining whether a building is safe and what preventive and protective measures are needed.

Benchmarks in guidance supporting the Fire Safety Order [19] are, intentionally, less prescriptive than in guidance supporting building regulations. It is also an established principle that guidance that supports legislation applicable to existing buildings is less stringent, in respect of many measures, than guidance applicable to new buildings, or new building work, such as ADB ([8], [9]). A greater degree of latitude can usually be applied, by taking into account a broader range of factors relating to the particular circumstances and features of the building, than would normally be applied when following guidance for new buildings in ADB.

In principle, this applies equally when considering the external walls, thus allowing a degree of latitude to be applied, rather than compliance with the benchmark set in ADB ([8], [9]).

It is also an established principle that, to apply, retrospectively, the current guidance relating to the design and construction of new buildings when assessing existing buildings, is likely to be unduly onerous and is therefore likely to be inappropriate. An exception would be where the original design principles are far removed from those that are acceptable today. Use of Category 3 ACM (see 3.1.1) on the external walls of buildings is one such case. It is regarded today as being far removed from the standards acceptable in relation to the combustibility and surface propagation of external wall construction and cladding on buildings of any height.

Annex D (informative)

Requirement B4(1) (of Part B of Schedule 1 to the Building Regulations 2010) and associated recommendations of Approved Document B

D.1 General

This annex provides context and describes routes to compliance in general terms.

The functional requirement of the Building Regulations 2010 [7] which addresses external fire spread via walls is Requirement B4(1).

In addition to this functional requirement, Regulation 7 makes provision in relation to the construction of external walls on certain types of new buildings.

This PAS is concerned with matters relevant to Requirement B4(1) where a building has not been constructed in accordance with Regulations 7(2), 7(3) and 7(4). Where a building is known to have been constructed in accordance with those Regulations, a simpler assessment of the external walls can be carried out as part of the FRA (e.g. as recommended in PAS 79-2).

The relevant guidance is currently contained within Section 10 of Volume 1 of ADB [8], and Section 12 of Volume 2 of ADB [9]. The guidance in both volumes is, essentially, identical.

The current guidance clarifies that fire spread across external walls is not primarily an issue of fire resistance.

The guidance in ADB ([8], [9]) is divided into five parts, reflecting the five parts of Schedule 1, Part B of the Building Regulations 2010 [7]. These parts can be broken down into two overriding objectives of the Regulations with respect to fire safety:

- keeping fire and smoke spread contained (Requirements B2, B3 and B4); and
- providing warning of fire, and providing routes for people to escape from fire and for emergency responders to access, effect rescue and fight fire (Requirements B1 and B5).

Both Part B (of the Building Regulations 2010 [7]) and ADB ([8], [9]) result in the need for a package of measures in relation to fire safety. The wording of Part B is functional, stating objectives that are required to be achieved in terms of fire safety. This allows some flexibility in approach so that fire safety can be achieved in the way best suited to the design and use of any building. If a building offers less protection to spread of fire and smoke than that which might be expected under ADB, then provisions for means of escape might need to be increased in order to compensate for this. Conversely, limitations in means of escape might be addressed by improving the performance of the building with respect to limiting fire and smoke spread, or by increasing the provision of means of fire detection and alarm, so that evacuation commences more quickly.

Similarly, the recommendations in relation to external fire spread do not occur within a vacuum. The need to control external fire spread in buildings above 18 m in height arose most directly from the ability of fire and rescue services to effect firefighting and rescues from outside a building. It is obviously also the case that the taller the building, the more people it contains on the same footprint, and the greater vertical distance that these people need to travel to evacuate the building. Sleeping accommodation creates particular challenges in relation to external fire spread, as it cannot be assumed that escape will occur with maximum efficiency, given the likelihood that occupants could be asleep when a fire occurs. There are also issues with false alarms in blocks of flats which have, historically, led to common alarm systems not being favoured (people rapidly become resistant to being evacuated from their own homes on a regular basis).

However, as with buildings as a whole, the functional requirements relating to external wall construction are intended to provide flexibility in terms of how the need for a safe building can be satisfied. The functional requirement that "*the external walls of the building shall adequately resist the spread of fire over the walls...*" does not impose any absolute requirements on the materials used within the construction of an external wall. As set out later, the manner in which materials are brought together means that it is viable for combustible materials to be successfully incorporated into an external wall construction and for fire spread across that construction to be inhibited/resisted nonetheless.

D.2 Routes to compliance

Volume 1 of ADB [8] is now the applicable volume for guidance on how to design and construct new blocks of flats. With the 2018 amendment to the Building Regulations [7] and the Regulation 7 provisions referred to in D.1, it is no longer legal to construct a block of flats over 18 m in height with external walls containing combustible material (other than for specified exemptions). However, this would not have applied to existing buildings prior to the amendment.

It has not always been permissible to incorporate combustible materials in external wall construction, but, as Annex P illustrates, changes that have taken place over the years resulted in some of the previous versions of ADB containing guidance on two explicit routes to meet the functional Requirement B4(1), one of which applied specifically in the case of external walls of buildings with a storey height over 18 m in which combustible materials are present. This route was one of meeting the BR 135 [15] performance criteria using data from a BS 8414 test. This benchmark within ADB was adopted as the benchmark within guidance from MHCLG (contained in MHCLG's 2020 Consolidated Advice Note [17]) for determining whether external walls of existing blocks of flats are acceptably safe in fire. This route to meet the functional requirement is performance-based.

The other explicit route to meet the functional requirement in relation to buildings over 18 m in height involved, among other things, restricting combustibility of any insulation products, filler material (not including gaskets, sealants and similar), etc., by ensuring that they were materials of limited combustibility (currently stated as at least Class A2-s3,d2 in accordance with BS EN 13501-1:2018). This has been referred to as the "linear route" to compliance. This was intended to ensure the absence of any significant amounts of combustible material in the build-up of an external wall.

NOTE *This restriction did not apply to insulation, etc. within masonry cavity wall construction in which each of the leaves of brick or concrete is at least 75 mm thick.*

However, other routes to satisfying the regulations, although not explicit in ADB ([8], [9]), are, nevertheless, possible within the framework of the intentionally flexible approach inherent in meeting the functional Requirement B4(1).

The Building Control Alliance (BCA) Technical Guidance Note 18 [30] recognized a further two routes, giving four options for demonstrating compliance of external wall construction with the Building Regulations [7]. In doing so, the BCA has made clear that this guidance only reiterates the guidance stated in Volume 2 of ADB [9] and does not suggest any avoidance of any requirements. Indeed, in its current form, this guidance only relates to meeting the restrictions on the combustibility of the materials and products used in external walls of buildings addressed by the current Volume 2 of ADB [9]. It would not apply to new blocks of flats over 18 m in height.

Nevertheless, these are stated here, again for context, as such options might possibly have been used when an existing building within the scope of this PAS was originally constructed.

For buildings with a storey over 18 m in height, the routes to compliance can be summarized as follows.

- a) Option 1: The use of essentially non-combustible materials (at least Class A2-s3,d2) for all elements of the cladding system both above and below 18 m. The BCA advises that this includes the insulation, internal lining board and the external facing material. This was often the understanding previously of the extent of an external wall, although the definition within the 2019 version of ADB ([8], [9]) of an external wall now includes everything from the wall lining on the inside of the accommodation to the outer facing on the external façade. This is the linear route referred to above.
- b) Option 2: Assessment in accordance with the BR 135 [15] performance criteria using data from a BS 8414 test. This is the performance-based route referred to above.
- c) Option 3: A desktop study, more correctly termed an "assessment-in-lieu-of-test" (AILOT) report by a suitably qualified fire specialist, stating whether, in their opinion, BR 135 [15] criteria would be met with the proposed cladding system if tested in accordance with BS 8414.

The BCA advises that the report be supported by test data from a suitable, independent UKAS-accredited testing body with reference to tests which have been carried out. The BCA observes that this option might not be of benefit if the products have not already been tested in multiple situations/arrangements.

With the publication of BS 9414, a specific set of criteria are now available for carrying out AILOTs with respect to external wall construction of new buildings and/or newly applied external wall/cladding systems.

- d) Option 4: An holistic fire-engineered approach, taking into account the building geometry, ignition risk, factors restricting fire spread, etc. It would be expected to utilize established fire engineering principles and methods within their scope of application and be supported by quantitative analyses, where appropriate.

D.3 Buildings with a top storey below 18 m in height

For existing buildings within the scope of this PAS, the guidance in the various versions of ADB did not include any explicit restrictions in the combustibility of the external wall construction, and by comparison to those buildings with a top storey over 18 m, only very limited controls on the reaction to fire classification of surfaces.

Annex E (informative)

Fire and rescue service intervention

E.1 General

Whilst fire and rescue service attendance at any incident is to be expected, there are many factors that inform its effectiveness. These include the time it takes for the fire and rescue service to arrive after they have been alerted, the resources that can be allocated to the incident, and the time taken for firefighting operations to commence on arrival at the scene. An assessor carrying out an FRAEW needs to be mindful of these multiple factors when considering fire and rescue service attendance as part of the appraisal, as over-reliance on the fire and rescue service can lead to an ill-informed and incorrect assessment of the overall risk.

The key factors affecting fire and rescue service effectiveness are discussed in E.2 to E.4.

E.2 Fire and rescue service attendance

There are no longer national minimum standards for the attendance of the fire and rescue service based on risk. Attendance is now assessed individually by each fire and rescue service through their respective integrated risk management plan (IRMP). With varying models of governance across the UK fire and rescue services, coupled with differences in the way they source equipment and implement policies and procedures, as well as differences in the geographic areas they serve, assessors need to recognize that a blanket approach to fire and rescue service attendance cannot be taken.

When considering fire and rescue service attendance times, expectations need to be realistic. The time of attendance is generally defined as the period between the time of call to the fire and rescue service and the arrival of the first appliance. This does not represent the time for adequate resources to be in place to deal with an incident safely and effectively; that time will be influenced by multiple factors.

Although not an exhaustive list, the factors that need to be taken into account include:

- the nature of the premises;
- the access, both internally and externally;
- availability of local fire and rescue service resources, taking into account the time of day;
- availability of water supplies;

- the nature and location of the fire;
- the priorities of the fire and rescue service on arrival;
- occupant characteristics;
- the environmental conditions;
- other factors affected by the time of day; and
- the physiological effects of the circumstances on firefighters.

Fire and rescue service attendance is determined locally, so there are differences in securing resources to deal with some incidents effectively, and this varies geographically across fire and rescue services.

After arrival of the fire and rescue service at an incident, the time for effective intervention depends on the circumstances found by the officer in charge. It can take some time to resource and implement a safe system of work, and where rapid external fire spread is anticipated or experienced, the immediate priority of the fire and rescue service might be to perform activities such as instigating evacuation, undertaking rescues, etc., before attempting to fight the fire.

The delay between ignition and the time of call also needs to be taken into account, as there might be a latent delay before the fire and rescue service is summoned. For example, if the call to the fire and rescue service results from someone hearing a smoke alarm, seeing visible signs of fire, etc., the time between ignition and the call to the fire and rescue service, during which the fire develops, is indeterminate. On the other hand, where the call to the fire and rescue service is from someone within the flat of fire origin, or there is automatic transmission of fire alarm signals to an alarm receiving centre, the delay before the time of call could be significantly shorter.

Considering all of the above, and other factors that might be identified during the FRAEW (see Annex F), it is important that the assessor does not place an over-reliance on fire and rescue service intervention when assessing the risk.

Further guidance on fire and rescue service intervention can be found in PD 7974-5.

E.3 Fire and rescue service intervention in buildings not exceeding 18 m in height

The information given in statutory guidance in support of the building regulations has historically tended to assume that external fire and rescue service intervention, particularly to effect rescue, is generally effective up to a height of 18 m. This figure is now considered unrealistic, and is not a suitable metric for effective external firefighting; it is based on fire and rescue service equipment and practices that are no longer applicable.

Experience of the fire and rescue service, based upon modern equipment and practices, suggests that the maximum height at which external fire and rescue intervention can be assumed to be effective is 11 m, based on the height that can typically be reached by a firefighting jet at ground level and the height that can be accessed by the largest ladder carried on modern fire and rescue service appliances.

This height is regarded as a maximum but, in practice, the maximum height for effective fire and rescue intervention is influenced by several factors, which include, but are not necessarily limited, to the following.

- Fighting a fire involving an external wall from outside the building would not be by means of a ladder pitched to the wall that is on fire.
- A maximum height of 11 m still requires effective fire and rescue service access, which can be challenging, given issues such as poor access from courtyards, limited boundary access, parked cars, narrow roads and congested approach roads.
- The inherent design of the external walls will be intended to repel water, thereby directly diminishing the effectiveness of the firefighting water applied onto a fire involving external wall construction (although this is equally true in relation to buildings of any height).
- Fire and rescue services equipment and practices are continually evolving.

When considering the effectiveness of external firefighting, the assessor needs to be mindful of the above and any other relevant factors, and not to rely on height alone as the sole factor on which effective external fire and rescue service intervention depends.

E.4 High-reach appliances

Historically, compliance with the guidance in support of building regulations has not necessitated access for high-reach appliances to blocks of flats. In those higher buildings, where external rescue was considered to be impossible (generally above 18 m, as discussed in E.3), it has been assumed that fire and rescue service intervention will take place internally, supported by the provision of additional measures, such as firefighting shafts. Experience has shown that this assumption can be undermined if there is rapid fire spread within the external wall construction.

The provision, disposition and crewing of high-reach appliances varies significantly between different fire and rescue services and geographical locations, with some fire and rescue services having limited numbers of high-reach appliances, the capabilities of which also vary. This is taken into consideration in the IRMP of each fire and rescue service.

Experience has also shown that, even where high-reach appliances are available, there can be issues in the appliances accessing an incident, such as poor access from courtyards, limited boundary access, parked cars, narrow roads and congested approach roads. Other factors that impact on the effectiveness of their use include the following.

- It is unlikely that access is possible to all faces of the building.
- Where access to all faces of the building is possible, there are limitations to the height at which a high-reach appliance can effectively work.
- External walls are designed to prevent water penetration. Therefore, effective application of water might not be possible unless access can be gained to dismantle elements of the façade.
- Effective application of firefighting water onto external walls is unlikely to be easily achieved from inside the building.
- Dismantling of external wall elements to access cavities, extinguish fire, or form fire breaks, is unlikely to be easily achieved from inside the building.
- There is a need to consider the mechanical performance of external wall systems when exposed to fire, and the resultant hazards posed to firefighters, e.g. whether firefighters might be unable to work in close proximity to the external wall as a result of system collapse, falling materials, burning debris, etc.

Taking all these factors into account, the extent to which there can be any reliance on high-reach appliances is clearly limited when conducting an FRAEW.

Annex F (informative)

Risk factors arising from fire strategy/fire hazards (including fire and rescue service intervention)

Table F.1 gives a non-exhaustive list of examples of common factors influencing the ability of occupants to escape once fire occurs and spreads via the external wall construction to other parts of the building and the ability of the fire and rescue service to intervene effectively.

No single row in Table F.1 gives a definitive answer on risk. Whether an entry is considered positive, negative or neutral is purely indicative of the potential influence it might have. Careful judgement is needed when using the table to determine the actual relevance of each factor and its significance in the context of the particular building under consideration. Where numeric values are given, these are only intended to be indicative as to the possible influence the particular factor might have in a risk-based assessment.

Where a risk factor is marked with an asterisk (*), this indicates that it is notably more of a positive influence.

Table F.1 – Risk factors arising from fire strategy/fire hazards (including limitations of fire and rescue service intervention)

Positive	Neutral	Negative
Where a risk factor is marked with an asterisk (*), this indicates that it is notably more of a positive influence.		
F.1 Occupancy		
<p>Accommodation in which there will be short evacuation times</p> <p>NOTE 1 <i>Principally, this is likely to apply to student accommodation, which is managed on-site and has a fire detection and fire alarm system that can support escalation from a stay put evacuation strategy to a simultaneous evacuation strategy, in given circumstances. The building's FRA would be expected to confirm that this is the case.</i></p> <p>NOTE 2 <i>There might well be occupants with varying degrees of physical disability. Unless the accommodation is predominantly occupied by people requiring assistance to escape in a fire, it would remain a positive risk factor.</i></p>	<p>General needs housing</p> <p>NOTE <i>In general needs housing, there might well be occupants with varying degrees of physical disability in line with the general population. Unless the accommodation is predominantly occupied by people requiring assistance to escape in a fire, it would remain a neutral risk factor.</i></p>	<p>Specialized housing:</p> <ul style="list-style-type: none"> • sheltered/retirement; • extra care; and • supported <p>NOTE 1 <i>These housing types are indicative; terminology applying to specialized housing varies. See also BS 9991 and NFCC publication Fire safety in specialised housing [31].</i></p> <p>Other accommodation in which there will be long evacuation times</p> <p>NOTE 2 <i>This refers to accommodation that is predominantly occupied by people who are likely to require assistance to escape in a fire. It does not apply to general needs housing or student accommodation, in which there most likely will be at least a proportion of such people but not a predominance.</i></p>
NOTE <i>This relates to the predominant occupant type within the building, recognizing that the occupancy might be mixed.</i>		
F.2 Evacuation strategy		
<p>Immediate, total evacuation (or with simultaneous evacuation and a suitable investigation time)</p> <p>Phased evacuation (see Note)</p> <p>NOTE <i>Phased evacuation could be a positive or neutral depending on the extent of the phased evacuation protocol and how it is managed (e.g. in student accommodation).</i></p>	<p>Stay put</p> <p>Phased evacuation (see Note)</p> <p>NOTE <i>Phased evacuation could be a positive or neutral depending on the extent of the phased evacuation protocol and how it is managed (e.g. in student accommodation).</i></p>	—

Table F.1 – Risk factors arising from fire strategy/fire hazards (including limitations of fire and rescue service intervention) *continued*

Positive	Neutral	Negative
F.3 Escape route design		
<p>Access to more than one staircase for escape, where it is not possible for the same fire to affect all escape routes*</p> <p>Access to more than one staircase for escape</p> <p>NOTE Where it is foreseeable that the same fire could spread to affect all of the escape staircases, the likelihood of this happening in relation to the speed of fire spread, and the timescale needed to evacuate the building, need to be taken into account.</p>	<p>Single staircase, with lobby approach</p> <p>Extended travel distances ≤ 15 m (with supporting smoke control)</p> <p>NOTE Although generally this is considered as neutral, as with all risk factors, whether this is appropriate needs to be considered in the context of the actual building under consideration.</p>	<p>Single staircase for escape, with staircase rather than lobby approach</p> <p>Extended travel distances ≤ 15 m (without supporting smoke control)</p> <p>Extended travel distances > 15 m (with or without supporting smoke control)</p> <p>NOTE 1 A single staircase is permitted for blocks of flats under building regulations and it is not implied that such an arrangement is unsatisfactory.</p> <p>Open balcony approach to flats</p> <p>NOTE 2 An open balcony approach is permitted for blocks of flats under building regulations and it is not implied that such an arrangement is unsatisfactory.</p> <p>Open balcony approach to flats, with aggravating features such as combustible decking.</p> <p>Final exits from escape routes in close proximity to external wall construction that could result in danger to escaping occupants in the event of burning material or debris falling from a fire involving the external walls above</p> <p>NOTE 3 In this situation, burning material and debris from the fire above can also pose a danger to firefighters entering or leaving the building.</p>
<p>NOTE For the purposes of an FRAEW, deficiencies identified in an FRA or fire door condition survey in respect of the doors to flats or escape routes are expected to be rectified and are not taken into account.</p>		

Table F.1 – Risk factors arising from fire strategy/fire hazards (including limitations of fire and rescue service intervention) *continued*

Positive	Neutral	Negative
F.4 Compartmentation		
—	Adequate compartmentation in line with the expectations for a block of flats	Inadequacies in the compartmentation, e.g. between flats, that have been addressed by other compensatory measures NOTE <i>This only considers a permanent situation in which there is a shortfall in the standard of compartmentation compared to normal expectations for a block of flats. For the purposes of an FRAEW, deficiencies identified in an FRA or compartmentation survey are expected to be rectified and are not taken into account.</i>
F.5 Smoke control		
—	—	Arrangements in which openable windows, AOVs or inlets and outlets of mechanical systems are in close proximity to combustible cladding or otherwise exposed to fire and smoke spread from the external envelope that could compromise the effectiveness of the smoke control system or allow a route for fire spread back into the building
NOTE <i>Whether smoke control arrangements are positive or negative very much depends upon the context in which vents, for example, are located in relation to a potential fire involving combustible elements of a building's external walls. Where due to the remoteness of the vents, spread of fire and smoke is unlikely to compromise the effectiveness of the smoke control system, this is potentially positive as an efficient smoke control system will prolong the tenability of staircases both in relation to means of escape and also intervention by the fire and rescue service. Inlets and outlets for mechanical systems, where located on the roof of a building, might possibly be considerably less prone to being affected by an external wall fire than, for example, AOVs or other vents on the elevations.</i>		

Table F.1 – Risk factors arising from fire strategy/fire hazards (including limitations of fire and rescue service intervention) *continued*

Positive	Neutral	Negative
F.6 Fire detection and fire alarm system		
<p>System with automatic detection throughout the building, including within flats, capable of immediate full evacuation, configured as:</p> <ul style="list-style-type: none"> • common area coverage, also with detectors at least inside flat entrance halls (local warning within flat from domestic smoke/heat alarms); or • common areas and throughout flats*; or • monitored by staff on a 24 h basis or by an alarm receiving centre (ARC)* 	<p>Domestic smoke and heat alarms within flats, Category LD1*</p> <p>Domestic smoke and heat alarms within flats, Category LD2 or LD3</p> <p>NOTE 1 LD1, LD2 and LD3 are categories of fire detection and fire alarm systems in domestic premises defined in BS 5839-6. ADB ([8], [9]) guidance for new flats recommends at least Category LD3 for any flat, but a higher category in some circumstances, with LD2 being the minimum recommended for existing flats in BS 5839-6. LD1 has the benefit that fire is detected within any room (other than bathrooms and toilets) with openings onto the external façades of the building, thus giving the early warning of fire to occupants and, potentially, an early summoning of the fire and rescue service.</p> <p>Evacuation alert system for use by the fire and rescue service</p> <p>NOTE 2 These systems are provided to enable the fire and rescue service manually to evacuate a building operating a stay put strategy. At the time of publication of this PAS, such systems are in their infancy. Such systems include those conforming to BS 8629, or a fire detection and fire alarm system conforming to BS 5839-1 (or BS 5839-6, Grade A) configured to sound an evacuate alert in all flats on operation of a manual control. While such a system might be beneficial, caution is needed to avoid overreliance on the fire and rescue service. This would be a positive risk factor if present in conjunction with a fire detection and fire alarm system monitored at an ARC.</p>	<p>—</p>

Table F.1 – Risk factors arising from fire strategy/fire hazards (including limitations of fire and rescue service intervention) *continued*

Positive	Neutral	Negative
F.7 Fire suppression		
Sprinkler system throughout building, conforming to BS EN 12845* Domestic sprinkler/watermist system in each flat: <ul style="list-style-type: none"> • conforming to BS 9251 (sprinklers); • conforming to BS 8458 (watermist) 	Local protection within flats, e.g. cooker hood protection or other partial protection system	—
<p>NOTE The weight attached to the presence of any fire suppression system in the building needs to take into account whether the system extends into, for example, any car parking area below the flats such that the scope for a vehicle fire to ignite combustible material on the external walls of the flats is mitigated.</p>		
F.8 Firefighting facilities		
Good access for firefighting vehicles NOTE This is where access exceeds benchmark guidance on access for firefighting vehicles, taking into account the size of the building (floor area), height of the building and whether fire mains are present in the building. This might be the case where access is possible to all elevations of the building.	Adequate access for firefighting vehicles NOTE This is where access is possible in line with benchmark guidance on access for firefighting vehicles, taking into account the size of the building (floor area), height of the building and whether fire mains are present in the building.	Poor access for firefighting vehicles NOTE This could include where access is severely restricted or there is no access directly adjacent to the building, or where there is no access for high-reach appliances.
<p>NOTE 1 Access for firefighting vehicles is only one aspect relevant to effective fire and rescue service intervention. Annex E gives broader consideration to fire and rescue service intervention and the limitations that can apply to achieving this.</p> <p>NOTE 2 A source of benchmark guidance that could be used is ADB ([8], [9]), but advice might need to be taken from the fire and rescue service.</p> <p>NOTE 3 Suitable access to facilitate effective fire and rescue service intervention is fundamental to mitigating the fire risk posed by external walls on buildings below 18 m down to a tolerable level. However, even in low rise buildings, the difficulties of tackling a fire involving external wall construction when operating at ground level using typically available equipment need to be recognized (see Annex E).</p>		

Table F.1 – Risk factors arising from fire strategy/fire hazards (including limitations of fire and rescue service intervention) *continued*

Positive	Neutral	Negative
F.9 Rising mains		
—	<p>Suitable rising main present</p> <p>NOTE 1 <i>While rising mains have been a requirement for new buildings above 18 m in height for many years, their role in terms of the effectiveness in intervention by the fire and rescue service is a significant factor.</i></p> <p>NOTE 2 <i>“Suitable” refers to a main meeting current standards. It is recognized that there will be a variety of standards of rising main present depending upon the age of the building, including dry rising mains in very tall buildings that would currently be required to be fitted with wet rising mains. Dry rising mains in these situations could be considered as potentially negative unless pressure tests can demonstrate that their performance is satisfactory.</i></p>	Absence of rising mains in buildings above 18 m
<p>NOTE 1 <i>Rising mains are only one aspect relevant to effective fire and rescue service intervention. Annex E gives broader consideration to fire and rescue service intervention and the limitations that can apply to achieving this.</i></p> <p>NOTE 2 <i>There is no requirement for rising mains to be fitted in new buildings below 18 m in height, unless the distance between the fire appliance to all points within each flat exceeds 45 m on a route suitable for laying hose.</i></p>		
F.10 Lifts for use by firefighters		
—	<p>Suitable firefighting lift present</p> <p>NOTE <i>While firefighting lifts have been a requirement for new buildings above 18 m in height for many years, their role in terms of the effectiveness in intervention by the fire and rescue service is a significant factor.</i></p>	Absence of firefighting lift in buildings above 18 m
<p>NOTE 1 <i>Firefighting lifts are only one aspect relevant to effective fire and rescue service intervention. Annex E gives broader consideration to fire and rescue service intervention and the limitations that can apply to achieving this.</i></p> <p>NOTE 2 <i>There is no requirement for firefighting lifts to be fitted in new buildings below 18 m in height.</i></p> <p>NOTE 3 <i>There can be significant differences in the design and engineering of lifts for use by the fire and rescue service, depending upon when they were installed and the standard applicable at the time. A lift meeting current standards would be seen as a positive factor, whereas it might not be appropriate to attach the same weight to lifts that meet an older standard. BS 8899 gives recommendations for the improvement and maintenance of firefighting provisions in existing lifts. Advice might need to be sought from the fire and rescue service, particularly for very tall buildings, to establish whether what is present is suitable. Where it is not, this is likely to be a notable negative risk factor.</i></p>		

Table F.1 – Risk factors arising from fire strategy/fire hazards (including limitations of fire and rescue service intervention) *continued*

Positive	Neutral	Negative
F.11 Specific fire hazards		
—	Vehicle parking on roadways adjacent to building	Vehicle parking under overhangs Open-sided car parking directly underneath
—	—	Balconies that have combustible elements, and which are of such a size that it is foreseeable they will be used for significant items of furniture, for holding storage or waste, or for inherently hazardous activities such as holding barbecues Outbuildings of combustible construction, such as sheds, motorized buggy charging rooms or storage buildings, in close proximity (e.g. <2 m) of the external walls Permanent refuse storage in close proximity to the external walls.
<p>NOTE 1 Consideration would be expected to be given to the mechanisms by which fire can start and spread to involve the external wall construction and cladding (see Clause 5), and any particular ignition sources (e.g. façade lighting) and specific fire hazards present over and above those generally anticipated. See also Annex N.</p> <p>NOTE 2 Hazards that can arise in day-to-day activities (e.g. the placing of a waste skip close to the building) are matters for ongoing control by the building's management and would be expected to be addressed in the building's FRA. Only permanent features of the building that give rise to specific fire hazards are considered here and, even then, a proportionate response might be to remove the hazard, e.g. prevent parking under overhangs, rather than remediate the external walls.</p>		

Annex G (informative)

Considerations in an in-depth technical assessment using fire engineering analysis

G.1 General

This annex provides guidance on a methodology for in-depth technical assessments using fire engineering principles when assessing the fire risk posed by external walls. Basic level assessments are addressed in Clause 13.

G.2 Methodology

G.2.1 Differentiation of wall constructions

The first stage in the methodology is to divide the wall constructions into appropriate sections/types as a function of:

- a) systems: likelihood, rate and extent of fire spread specific to each system;
- b) location and coverage: location on a building and extent of coverage of a system, including:
 - continuity with other systems (i.e. whether fire spread via one system can lead to fire spread over another);
 - likelihood of ignition: whether there are credible ignition sources adjacent to the construction;
 - likelihood of fire spread: how far and over what parts of the building fire could spread via the construction in question; and
 - consequence of fire spread: the people and fire protection features/systems that might be compromised by fire spread over the construction.

G.2.2 Strategy identification

The second stage in the methodology is to identify, for each wall construction system, potential fire and smoke spread hazards and the strategy for resisting fire and smoke spread.

Hazards typically comprise:

- a) unprotected routes for fire spread between flats and other compartments via external walls (e.g. poorly installed structural framing systems); and/or
- b) cavities through which extensive fire and smoke spread can occur; and/or
- c) extent and continuity of combustible materials.

Hazard mitigation strategies might include one or more of the following.

- 1) Isolation (i.e. limiting coverage): The location and extent of coverage of a wall construction system is such that:
 - it is not a medium for fire spread (e.g. is limited to a small area of coverage such as spandrel and infill panels); and/or
 - fire spread over the construction is not possible (e.g. there are no external ignition sources and no openings through which fire could spread from inside the building to the wall construction) or is not likely to be a risk to health or safety (e.g. the wall construction system is only located on an elevation with no window or vent openings through which fire could spread from outside to inside).
- 2) Encapsulation (see **G.3.1**): Combustible materials and cavities are encapsulated by construction that is not combustible and is adequately fire-resisting (i.e. prevents fire penetration to the combustible material/cavity).
- 3) Restricting fire spread in the absence of a cavity (cavity absence) (see **G.3.2**): There are no cavities and the hazard of fire spread via materials and surfaces is adequately low.
- 4) Compartmentation continuation (see **G.3.3**): The internal fire-resisting construction continues through to the outside of the building such that any cavities and combustible materials do not span between compartments.
- 5) Limiting combustibility (see **G.3.4**): The combustibility of materials is such that they would not be a medium for fire spread.
- 6) Subdivision (see **G.3.5**): Combustible materials and/or cavities are subdivided by construction that adequately resists fire spread.

G.2.3 Assessment

The third stage in the methodology is to identify the critical success criteria for each wall construction system (as a function of the hazard mitigation strategy) and assess the wall construction system using the following steps.

- a) Identify the skills, knowledge and experience, including any specialist input by others, necessary to assess adequacy.
- b) Assess the adequacy of the system against the critical success criteria.

- c) Identify additional requirements for hazard mitigation (if any) for the system.
- d) Propose hazard mitigation options.

G.2.4 Documentation

The final stage in the methodology is to document the findings of the first three stages (G.2.1 to G.2.3).

G.3 Assessment considerations

G.3.1 Encapsulation

G.3.1.1 General

The intent of encapsulation is to prevent combustible materials from being ignited, and to resist fire spread via cavities, by encapsulating such materials in materials that are not combustible and are adequately fire-resisting. There are typically three encapsulating components:

- a) inner leaf: SFS, masonry, etc.;
- b) outer leaf: masonry, non-combustible cladding panels, inorganic render, etc.; and
- c) cavity edges protection: protection of cavity edges (i.e. top, bottom and sides) and cavity openings (e.g. windows, doors, vents).

G.3.1.2 Total encapsulation

Total encapsulation is where combustible materials and cavities are protected to a sufficient standard that flames will not penetrate the encapsulation to ignite combustible materials or enter any cavities.

Precast, insulated concrete panels are an example of total encapsulation.

G.3.1.3 Partial encapsulation

Partial encapsulation is where combustible materials and cavities are protected to a standard such that flame penetration to combustible materials and cavities is inhibited and fire break-out from combustible materials and cavities is also inhibited (the combined resistance results in adequacy).

Diagram 8.2 in ADB Volume 1:2019 [8] provides one example of partial encapsulation for brick cavity walls. Others include render systems where cavities and any combustible insulation are encapsulated by inorganic render that is sufficiently thick, or architectural wall panels where combustible materials are encapsulated in steel.

G.3.1.4 Assessing adequacy

The focus of the assessment is whether cavities and combustible materials are adequately encapsulated for total encapsulation, or whether the rate and extent of fire spread between flats and over the walls are adequately resisted by partial encapsulation (see Table G.1).

Table G.1 – Typical indicators of level of encapsulation

Level of encapsulation	Equivalence	Direct risk assessment
Total encapsulation	Fire resistance of encapsulation is equal to fire resistance of internal compartmentation	Risk of flame penetration to combustible materials or the cavity is expected to be very low
Partial encapsulation	Fire resistance of encapsulation is equivalent to Diagram 8.2 in ADB Volume 1:2019 [8], or demonstrated by reference to BS 8414 test data	Risk of fire spread via combustible materials and via cavities is expected to be sufficiently low

The primary means of assessing adequacy is likely to be by reference to fire resistance tests and/or tests to BS 8414 for constructions similar to the encapsulating components.

G.3.1.5 Competence

The skills, knowledge and experience required to assess adequacy of encapsulation are:

- a) fire performance: understanding the difference between fire resistance and reaction to fire (ignition and combustibility);
- b) fire resistance: knowledge of material behaviour under fire exposure to be able to assess whether encapsulating components achieve an adequate fire resistance standard given the manner in which they have been used/installed; and
- c) surveying: being able to assess whether encapsulating components have been installed and maintained correctly.

G.3.1.6 Uncertainty

Areas of uncertainty for existing constructions are likely to include:

- a) adequately determining the fire resistance of materials/components; and
- b) adequately identifying the protection of cavity edges around openings, including the edges of any cavities.

G.3.1.7 Deficiencies

Typical deficiencies that might need to be taken into account include:

- a) internal leaf edge, e.g. boards of the SFS construction not being continuous to the underside of floor slab above suspended ceilings;
- b) internal leaf holes, e.g. plug sockets in SFS plasterboard or vent pipe penetrations that are not adequately protected, or unsealed gaps between board joints; and
- c) cavity edge protection, e.g. cavity edges around windows not being protected by materials/products with a readily determinable fire resistance.

The consequences of such deficiencies need to be taken into account, but might vary as follows.

- 1) Size and prevalence of gaps and holes: Small holes (e.g. those formed by plug sockets) might have little or no consequence, whereas multiple unsealed service penetrations or systemic workmanship issues resulting in significant gaps in an SFS construction might allow extensive fire and smoke spread.
- 2) Combustible materials: Where a cavity contains combustible materials, fire spread within the cavity could be extensive due to deficiencies, resulting in fire or smoke spread into multiple flats.
- 3) No combustible materials: Where the cavity does not contain combustible materials, there could be fire and smoke spread within the cavity due to deficiencies, but the likelihood and rate of fire or smoke spread into secondary flats are likely to be low.

G.3.2 Restricting fire spread in the absence of a cavity

G.3.2.1 General

Where there are no cavities, or there is no possibility that cavities could be created by a fire, fire and smoke spread can be prevented or delayed by limiting the combustibility and/or controlling the reaction to fire properties of any materials that could be a medium for fire spread.

G.3.2.2 Assessing adequacy

Where there are no cavities, or there is no possibility that cavities could be created by a fire, the fire dynamics are largely driven by the fire characteristics of the products used in the external wall construction because there are no cavities to influence material transport, flows and heat feedback mechanisms.

Reaction to fire classifications can be used conservatively as summarized in Table G.2.

For products where the mass of product over the area of coverage is significant, heat of combustion by mass can be used as summarized in Table G.3.

For composite products, there is not necessarily a correlation between heat of combustion and rate or extent of fire spread. This is because in the test for non-combustibility and limited combustibility, composite products are ground to a powder (i.e. making them non-composite) when measuring heat of combustion such that the heat of combustion is an average of complete combustion of all the constituent materials. However, in practice, composite materials might remain composite and the effective heat of combustion can be less than the average of the components. An example is CP board where the wood particulate is bound in cement, and in its composite format the cement binder significantly inhibits the combustion of the timber component.

For products where the mass of product over the area of coverage is much less significant (e.g. membranes), heat of combustion by surface area can be used as summarized in Table G.4.

Table G.2 – Relevance of reaction to fire classes in the absence of a cavity

Reaction to fire class	Characteristic behaviour	Acceptability
a) Class A1 and Class A2 b) Class B where all constituent materials each achieve Class B without fire retardants c) Class C charring thermosetting insulations	Heat of combustion is sufficiently low that fire spread is likely to require an external heat source; as such, fire spread is likely to be limited to the vicinity of any heat source (e.g. external flaming)	Acceptable regardless of location and extent of coverage
Class B only when any composite components (e.g. CP board) retain the characteristics of the composite component under fire	Whether the composite product adequately resists fire spread depends on whether it remains composite under real building fire exposure	Acceptable regardless of location and extent of coverage provided the product remains composite under credible worst-case fire exposure
Class B due to use of fire retardants (e.g. fire-retardant treated high pressure laminate)	Whether the composite product adequately resists fire spread depends on whether the fire retardant is effective under real building fire exposure	Acceptable regardless of location and extent of coverage provided that fire retardant remains effective under credible worst-case fire exposure
Class C and Class D	Self-sustaining fire spread (i.e. no external heat source required for continued burning) is likely, but the rate of fire spread is likely to be slow enough to allow intervention (some Class C products exhibit self-extinguishing behaviour when the external heat source is removed)	Acceptable where fire and rescue service intervention is possible, recognizing its limitations, or where extent of fire spread is limited by extent of coverage ("isolation")
Class E, Other	Self-sustaining fire spread (i.e. no external heat source required for continued burning) is likely, and the rate of fire spread is likely to be fast	Only acceptable where location and extent of coverage is such that the likelihood of ignition and or consequences of fire spread are sufficiently low

Table G.3 – Relevance of heat of combustion by mass in the absence of a cavity

Heat of combustion ^{A)}	Characteristic behaviour	Acceptability
<5 MJ/kg	Heat of combustion is sufficiently low that fire spread is likely to require an external heat source; as such, fire spread is likely to be limited to the vicinity of any heat source (e.g. external flaming)	Acceptable regardless of location and extent of coverage
3 MJ/kg to 15 MJ/kg	Heat of combustion is likely to be sufficiently low that fire spread is likely to require an external heat source; as such, fire spread is likely to be limited to the vicinity of any heat source (e.g. external flaming)	Acceptable regardless of location and extent of coverage
15 MJ/kg to 35 MJ/kg	Self-sustaining fire spread (i.e. no external heat source required for continued burning) is likely, but the rate of fire spread is likely to be slow enough to allow intervention.	Acceptable where fire and rescue service intervention is possible, recognizing its limitations, or where extent of fire spread is limited by extent of coverage
>30 MJ/kg	Self-sustaining fire spread (i.e. no external heat source required for continued burning) is likely, and the rate of fire spread is likely to be fast	Only acceptable where location and extent of coverage is such that the likelihood of ignition and or consequences of fire spread are sufficiently low
^{A)} There is deliberate overlap in the heat of combustion values between categories to avoid a “binary” risk classification process.		

Table G.4 – Relevance of heat of combustion by area in the absence of a cavity

Heat of combustion ^{A)}	Characteristic behaviour	Acceptability
<4 MJ/m ²	Heat produced per unit area is sufficiently low that the consequences of fire spread are likely to be low	Acceptable regardless of location and extent of coverage
2 MJ/m ² to 10 MJ/m ²	Heat produced per unit area might be sufficiently low that fire spread is not likely to be a risk to health or safety	Acceptable unless located so as to create a risk beyond flats (e.g. adjacent to common escape routes)
>8 MJ/m ²	Heat produced per unit area is sufficiently likely to be a risk to health and safety to require detailed assessment	Only acceptable as part of detailed assessment
^{A)} There is deliberate overlap in the heat of combustion values between categories to avoid a “binary” risk classification process.		

G.3.2.3 Competence

The skills, knowledge and experience required to assess adequacy of restricting fire spread are:

- a) material fire characteristics: for composite and layered products and products with fire retardants, it might be necessary to assess whether tested performance is an accurate indicator of performance in real building fires; and
- b) surveying: being able to identify the products and materials used in the external wall construction.

G.3.2.4 Uncertainty

Areas of uncertainty for existing constructions are likely to include fire spread characteristics of materials and products.

G.3.3 Compartmentation continuation

G.3.3.1 General

Compartmentation continuation is where the fire resistance of internal compartmentation is continued to the outside of the building (e.g. by fire barriers that achieve the same fire resistance standard as the internal compartmentation) and the cladding does not provide a medium for fire spread around the compartmentation (e.g. non-combustible construction such as brickwork), internal compartmentation is maintained and any combustible materials do not constitute a medium for fire spread.

Compartmentation continuation does not rely on restrictions being placed on the combustibility of materials, since any combustible materials inside the outmost component of the external wall are contained within the compartment and in effect become part of the internal construction.

An example of compartmentation continuation would be construction of an external cavity wall with full-brick/masonry where the fire-resisting lines of internal compartment floors and walls are continued by fire barriers in the cavity to the inside face of the outer brick/masonry. In this example, insulation can be combustible and there is no constraint on the construction of the inner leaf of the cavity wall (i.e. it does not have to be brick or concrete and could be a different system, e.g. an SFS).

G.3.3.2 Assessing adequacy

Assessment of adequacy of compartmentation continuation requires assessment as summarized in Table G.5.

Table G.5 – Compartmentation continuation assessment

Element of construction	Equivalence	Direct risk assessment
Fire barriers	Fire resistance of fire barriers is equal to fire resistance of internal compartmentation	Fire resistance of fire barriers has to be sufficient to adequately resist fire spread
Outermost cladding component	Outermost cladding component cannot be readily combustible and needs to provide adequate resistance to fire spread around the fire barriers	Outermost cladding component has to provide a barrier against which the fire barriers can close and has to remain intact during fire for a sufficient time and not be a medium for fire spread around the fire barriers.

G.3.3.3 Competence

The skills, knowledge and experience required to assess adequacy of compartmentation continuation are:

- a) fire resistance: whether subdividing elements achieve an adequate fire resistance standard when installed in conjunction with the cladding in question;
- b) cladding: whether the cladding presents any significant risk for fire spread around subdividing components; and
- c) surveying: being able to assess whether the encapsulating components have been installed and maintained correctly.

G.3.3.4 Uncertainty

Areas of uncertainty for existing constructions are likely to include fire resistance of components such as fire barriers.

G.3.3.5 Deficiencies

Typical deficiencies that might need to be considered include fire barrier adequacy and workmanship of installation.

G.3.4 Limiting combustibility

G.3.4.1 General

Where materials are of limited combustibility or better, adequate resistance to fire spread can be achieved by provision of adequate cavity barriers. This is the essence of the guidance in ADB (Volume 2:2006 as amended [11]) often referred to as the "linear route" (see Annex D).

G.3.4.2 Assessing adequacy

Assessment of adequacy of limiting combustibility requires assessment of:

- a) cavity barriers at junctions with internal compartment floors and internal compartment walls;
- b) cavity edge protection (including around openings such as windows);
- c) the surface flame propagation/reaction to fire characteristics of cladding facing; and
- d) the combustibility of components that could be a medium for fire spread.

G.3.4.3 Competence

The skills, knowledge and experience required to assess adequacy of limiting combustibility are:

- a) material combustibility: whether materials and products are of limited combustibility or better;
- b) surveying: being able to assess whether cavity edges are adequately protected; and
- c) cladding: whether the cladding presents any significant risk for fire spread.

G.3.4.4 Uncertainty

Areas of uncertainty for existing constructions are likely to include being able to adequately identify protection of edges (which might include cavities) around openings.

G.3.4.5 Deficiencies

Typical deficiencies that might need to be considered include cavity barrier adequacy and workmanship of installation.

G.3.5 Subdivision

G.3.5.1 General

A strategy based on subdivision accepts that flames might ignite combustible materials and enter cavities but restricts the extent of fire and smoke spread by dividing the construction into sufficiently small sections by fire-resisting construction.

G.3.5.2 Assessing adequacy

The fire dynamics associated with subdivision can be complex. Assessment of adequacy is therefore likely to rely on a combination of:

- a) data from tests in accordance with BS 8414 or other representative tests at suitably large scale; and
- b) expert assessment by a person with the appropriate skills, knowledge and experience.

G.3.5.3 Competence

The skills, knowledge and experience required to assess adequacy of subdivision depend on the extent to which the as-built construction deviates from limited combustibility or BS 8414 tested systems. However, the following skills, knowledge and experience are likely to be required:

- a) ignition and combustion chemistry: whether combustible materials will ignite and, if so, the resulting rate and extent of burning;
- b) fire dynamics: impact of cavity fire dynamics on the rate and extent of burning of materials/products within the cavity or forming the cavity, including an understanding that traditional compartment fire dynamics principles are not validated for use in external wall construction;
- c) thermodynamic material/product response: changes in thermodynamic response of materials/products with respect to time and temperature; and
- d) thermomechanic material/product response: changes in mechanical response of materials/products with respect to time and temperature.

G.3.5.4 Uncertainty

Areas of uncertainty for existing constructions are likely to include:

- a) fire resistance of components;
- b) being able to adequately identify protection of edges (which might include cavities) around openings;
- c) adequacy of cladding and subdividing elements to resist fire spread around subdividing elements (e.g. via combustible cladding panels or gaps); and
- d) relative contribution to resisting fire and smoke spread of different components.

G.3.5.5 Deficiencies

Typical deficiencies that might need to be considered include:

- a) cavity barrier adequacy and workmanship of installation; and
- b) excessive combustibility of insulation and or cladding panels.

For subdivision, minor deficiencies might have a significant impact on overall performance.

G.4 Using BS 8414 test data

G.4.1 Principles

Fire test data, including BS 8414 data, can be useful for assessing adequacy of existing external wall systems. In this context, it is the data from the tests (as opposed to BR 135 [15] classification or BS 9414 assessment) that are most relevant when assessing risk, rather than regulatory or ADB compliance.

Like any fire test, the result of a fire test to BS 8414 is not a prediction of a real building in a real fire, but instead is a means of benchmarking performance for use as part of assessment of adequacy. The BS 8414 test configuration and fire specification subjects large-scale specimens of external wall constructions to a thermal load that is commensurate with that which might be experienced in a real building fire. As such, BS 8414 test data can be used to inform an assessment of whether an external wall system adequately resists fire spread.

There is little or no evidence of unacceptable risk to health and safety arising from systems that have met the BR 135 [15] performance criteria when tested in accordance with BS 8414. Therefore, it is reasonable to assume that systems built in accordance with a BR 135 classification can adequately resist fire spread.

Where the as-built system differs significantly from the BR 135 [15] classification, when using data from BS 8414 tests to assess adequacy, the assessment needs to take the following factors into account.

- **Reliance on the data:** The higher the potential risk of fire spread, the greater the reliance on accurate interpretation of test data within the assessment of risk.
- **Similarity between test specimen and as-built construction:** The greater the difference between the as-built construction and the tested assessment, the greater the degree of assessment required in using data from the test.
- **Margin of safety:** The greater the margin of safety, the lower the uncertainty in use of data.
- **Critical success factors:** The key components of a wall construction depend on the strategy for adequacy (see G.3). Depending on the strategy, adequacy is sensitive to some components more than others. For example, compartmentation continuation is sensitive to the performance of fire barriers, but not sensitive to combustibility of insulation. On the other hand, subdivision is sensitive to the relative contribution of subdividing elements, robustness of cladding panels and combustibility of insulation.

G.4.2 Interpreting BR 135 classifications

G.4.2.1 Performance criteria

Performance criteria, both explicit and implicit, are described in A.3.

G.4.2.2 Application of criteria

The intent of the BS 8414 test configuration is to investigate fire spread over the walls of the construction significantly beyond the source of fire when exposed to a standardized (albeit severe) fire, for the purposes of classification to BR 135 [15]. Whilst the BR 135 classification sets a benchmark of performance, the performance criteria are to some extent arbitrary, and the following factors need to be taken into account:

- a) whether a system passes or fails to meet the criteria does not necessarily dictate whether or not it is safe;
- b) the risk of fire spread via a system that just fails to meet the criteria might not be significantly greater than the risk associated with a system that just passes; and
- c) whilst small differences in system details can influence whether a system meets the performance criteria or not, they do not necessarily result in a significant change in risk of fire spread.

Therefore, when using BS 8414 test data to assess risk, it is important to:

- 1) identify the critical success factors for the system in question;
- 2) assess differences between critical success factors for the as-built system against those of the tested system(s); and
- 3) consider the margin by which the tested system met or failed to meet the BR 135 [15] performance criteria (data from systems which failed to meet BR 135 criteria can also be used to inform an assessment of risk).

G.4.2.3 Field of application

BR 135 [15] classification reports include a field of application. The main purpose of the field of application is in respect of system certification and compliance, and does not necessarily relate to system performance in a real fire. That is to say, whilst a system that falls outside the field of application cannot be assumed to be certified as compliant, it still might achieve an adequate performance.

The external wall assessor needs to use their skill and experience to determine whether a difference between the as-built construction and the field of application is likely to have a significant impact on risk.

It is reasonable to assume that deviations from a field of application that are still within allowable construction tolerances (e.g. a cavity thickness that varies of the height of a building within allowable construction tolerances) are unlikely to have a significant impact on the overall performance of a system.

G.4.3 BS 9414 – Extended application rules for BS 8414 tests

BS 9414 defines how to extend the field of application for tested systems. It is intended for manufacturers bringing cladding systems onto the market and for designers of buildings needing to comply with building regulations; it is not intended for the purpose of defining the limits of application of the results of a tested system for assessing the risk presented by an existing as-built cladding system. It therefore only allows the field of application to be extended by interpolation between tested systems or extrapolation where this is known to be conservative.

Therefore, it cannot be assumed that the performance of an as-built system is not adequate simply because BS 9414 does not permit any difference between the as-built system and BR 135 [15] field of application.

The external wall assessor needs to use their skill and experience to determine whether a difference between the as-built construction and the field of application is likely to have a significant impact on risk.

G.4.4 Performance approximation

BS 8414 test data can be used to approximate the likely performance of as-built systems using one or more of the following concepts:

- a) component comparison: using BS 8414 test data for a system that is similar to an as-built system except in respect of specific components, and demonstrating that the thermodynamic and thermomechanic performance of the as-built component are as good as or better than those of the tested component; for example, stone tiles might be equivalent to or better than terracotta tiles;
- b) interpolation/extrapolation: interpolating (or extrapolating) between BS 8414 test data for tested systems to assess whether the as-built construction would meet the BR 135 [15] performance criteria if it were to be tested in accordance with BS 8414; and
- c) direct assessment: demonstrating through scientific analysis that the as-built construction would meet the BR 135 [15] performance criteria if it were to be tested in accordance with BS 8414.

G.4.5 Critical success factors

BS 8414 testing is most typically useful for systems that rely on encapsulation, compartment continuation and subdivision to resist fire spread. For these systems, the following can be critical success factors:

- a) fire resistance of construction that inhibits fire spread into cavities and/or combustible materials;
- b) fire resistance of subdividing elements;
- c) combustibility of cladding panels;
- d) thermodynamic and thermomechanic properties of the cladding panels; and
- e) combustibility of materials behind the cladding panels including in any cavity.

Table G.6 shows some combinations of critical success factors that are likely to result in adequate resistance to fire spread.

Table G.6 – Typical examples of critical success factors

Factor	Compartmentation continuation	Subdivision (combustible insulation)	Subdivision (limited combustibility insulation)
Fire resistance of cavity barriers	Critical: Same as internal compartmentation	Critical: At least 30EI (see A.4) or demonstrated by BS 8414	Not critical
Fire resistance of substrate	Not important	Critical: At least 30EI (see A.4) or demonstrated by BS 8414	Low sensitivity
Combustibility of cladding panels	Critical: Limited combustibility or Class A2 or better	Critical: Class B or better or demonstrated by BS 8414	Critical: Class B or better or demonstrated by BS 8414
Thermodynamic and thermomechanic properties of cladding panels	Critical: Needs to retain functionality in respect of inhibiting fire spread	Critical: Enough to ensure adequacy of subdivision	Low sensitivity
Combustibility of cavity materials	Not important	Limited sensitivity	Critical: Limited combustibility or Class A2 or better

G.5 Mitigation of risk

G.5.1 Principles

The conventional means of mitigating risk would be to address the hazard by remediating the deficiencies, but this is often difficult, disruptive and expensive. Depending on the circumstances, it is possible that the risk associated by deficiencies can be mitigated without having to remediate the deficiencies themselves.

Rather than simply specifying remediation of all deficiencies, alternative options need to be explored, and an appropriate solution chosen such that the cost of remediation is proportionate to the risk and that the most cost-effective solution is implemented (particularly given that in many instances costs might have to be paid by leaseholders and/or taxpayers).

Societal tolerance of low probability/high consequence events is lower than that of high probability/low consequence events (e.g. 100 events causing a single fatality is more tolerable than a single event causing 100 fatalities).

Mitigation therefore needs to be such that the assessor is satisfied that both the consequences and the probability of fire spread are sufficiently low (e.g. where the consequences of fire spread over external wall construction are severe, it is likely that mitigation cannot be achieved by reduction of probability of fire spread alone).

In summary, the process for risk mitigation is to:

- a) reduce the consequences of fire spread to a tolerable level; or
- b) reduce risk to an acceptable level by reducing the probability of fire spread to the external wall construction.

In this context, consequences comprise the product of:

- 1) the number of people who could be exposed to a hazard;
- 2) the severity of the hazard; and
- 3) the speed of exposure.

For example, risk could be evaluated using Table G.7.

Table G.7 – Subdivision risk evaluation

Factor	High	Medium	Low
Number of people at risk from hazard	Many	—	Few
Severity of hazard	Combustible cladding panels and insulation	Combustible cladding panels or insulation	Limited combustibility
Speed of exposure	No fire barriers or significant deficiencies in fire barriers	Fire barriers at floors only and deficiencies are minor	Fire barriers at floors and walls and deficiencies are minor

G.5.2 Practical application of principles

G.5.2.1 Probability reduction

As an example, where sprinklers are installed, they reduce the probability of fire spread via external walls by reducing the likelihood that combustible materials/products in an external wall construction will be ignited by a fire in the building.

Most other measures to reduce probability relate to fire prevention, as opposed to fire protection, which also addresses the consequences.

G.5.2.2 Consequence reduction

G.5.2.2.1 General

Consequence mitigation measures are listed in Table G.8 and discussed further in G.5.2.2.2 to G.5.2.2.10.

G.5.2.2.2 Remediation of deficiencies

Repairing or fixing some or all deficiencies is the most obvious means of mitigating risk, but because deficiencies usually occur within the construction, repair can be difficult, disruptive and costly.

Table G.8 – Consequence mitigation measures

Option	Factor mitigated?		
	Number of people at risk from hazard	Severity of hazard	Speed of exposure
Remediate deficiencies	Yes	Yes	Yes
Remove combustible products	Yes	Yes	Yes
Encapsulate combustible products	Yes	Yes	Yes
Fill cavities	Yes	Yes	Yes
Reduce extent of coverage	Yes	No	Partial
Insert fire barriers	Yes	Partial	Partial
Evacuation	Partial	Partial	No
Fire and rescue service intervention	No	Partial	Partial
Upgrades to include firefighting shaft features	No	Partial	Partial
Sprinklers	No	Partial	No

G.5.2.2.3 Removal/encapsulation of combustible products

Removing or encapsulating combustible products reduces:

- a) the number of people at risk, by removing the medium for fire spread;
- b) the severity of hazard, by removing the volume of combustible material (i.e. energy); and
- c) the speed of exposure, by reducing the mechanisms for fire growth and spread.

Depending on the circumstances, adequate encapsulation might be achieved by overboarding, as opposed to a construction that achieves a tested fire performance standard.

This approach would involve modification to the design of the external walls, and the potential impact on other areas of performance (e.g. weathertightness, energy performance, resistance to condensation and damp) would need to be taken into account.

G.5.2.2.4 Filling cavities

Filling cavities (e.g. by pumping in non-combustible insulation) can reduce the likelihood and/or rate of fire spread via cavities). Filling cavities is likely to be appropriate where there are no combustible materials within the cavity or where combustible materials in the cavity are charring (as opposed to melting) solids (e.g. timber derivatives or charring thermoset insulation). Filling cavities might not be appropriate where the cavity contains non-charring thermoset insulation (e.g. PUR) or thermoplastic insulation (e.g. polystyrenes).

This approach would involve modification to the design of the external walls, and the potential impact on other areas of performance (e.g. weathertightness, energy performance, resistance to condensation and damp) would need to be taken into account.

G.5.2.2.5 Reduction in extent of coverage/insertion of fire barriers

Reducing the extent of coverage (i.e. increasing isolation) or inserting fire barriers reduces:

- a) the number of people at risk, by removing the medium for fire spread and reducing the speed of exposure by reducing the area over which fire can accelerate; and
- b) the severity of hazard, by reducing the area over which fire can develop and grow.

This approach would involve modification to the design of the external walls, and the potential impact on other areas of performance (e.g. weathertightness, energy performance, resistance to condensation and damp) would need to be taken into account.

G.5.2.2.6 Simultaneous evacuation

Simultaneous evacuation can be a viable means of mitigation provided that:

- a) the system can detect fires that would result in risk (i.e. fires that would be likely to spread via the external wall construction); and
- b) the frequency of unwanted alarms is sufficiently low; and
- c) the building's fire strategy can accommodate a simultaneous evacuation (e.g. it has suitable means of escape and smoke control systems); and
- d) occupants are supportive of the fire strategy and are thus prepared to evacuate when the alarm sounds. This is an often overlooked aspect of the practicability of simultaneous evacuation as a risk mitigation measure.

G.5.2.2.7 Local fire alarms

Where consequences of fire spread are sufficiently low, local detection and alarm might provide adequate mitigation, e.g. extending in-flat fire alarms to include smoke detection in all rooms with openings onto external walls.

G.5.2.2.8 Fire and rescue service intervention

Where the rate of fire spread is sufficiently slow (to allow fire and rescue service intervention), and adequate access is available to attending firefighters, the consequences of fire spread can be reduced by fire and rescue service intervention. However, it is important to recognize the limitations of such intervention, such as the effectiveness of external firefighting for buildings over 11 m in height and the resources that can be expected to arrive in given timeframes (see Annex E).

G.5.2.2.9 Firefighting shaft measures

Firefighting shafts have historically only been recommended by ADB for provision in residential buildings with a top storey above 18 m, although BS 9999 has mentioned the possibility of their inclusion in buildings with a top storey above 11 m since 2008.

Where a building's layout makes it practicable to include some of the features of a firefighting shaft, whether via the upgrading of walls, doors and/or a dry rising main, it can provide benefits in terms of a place of relative safety within a building that facilitates both evacuation and firefighting in the event of fire affecting the external wall construction.

The extent of the particular design and facilities constituting the "firefighting shaft upgrade" needs to be decided on a case-by-case basis, although particular attention is needed where one or more of the walls enclosing the firefighting shaft is an external wall that presents the hazard being considered.

G.5.2.2.10 Sprinklers

Automatic sprinkler protection reduces the probability of ignition of external wall construction by suppressing or controlling fire within the building. However, sprinklers cannot control fires that might start externally, and they cannot be assumed to control fire spread via the external wall construction if it is ignited.

In consequence, although sprinklers can provide viable mitigation, consideration needs to be given to the likelihood of any fire scenarios that sprinklers would not control (e.g. fires involving combustible balconies, balcony storage or external fuel loads), and the potential consequences of fire spread in the event that the external wall construction is ignited.

Annex H (informative)

Expected skillsets of a competent external wall assessor

Table H.1 sets out the skillsets typically expected of external wall assessors carrying out different tasks or levels of assessment.

This includes indicative expected skillsets based on the National Qualifications Framework¹⁰⁾.

Table H.1 – Expected skillsets of an external wall assessor

Task or level of assessment	Typical professional recognition	Expected skillset
Information gathering and site survey and inspection (Clause 10)	Surveyor or other building professional such as an architect or façade engineer	<p>Able to undertake document study and conduct on-site verification in order to establish what is known about the likely performance of materials and components that have been installed on the building. Has knowledge of materials, components and systems used in external wall construction and cladding and of the construction techniques used.</p> <p>Able to conduct or direct others in site surveys and inspections, including opening up works. Capable of making judgements on where components of walls need to be removed and samples taken, while avoiding undue damage and enabling the appropriate repairs to be made.</p> <p>Able to present, evaluate and interpret qualitative and quantitative data, in order to make sound judgements in the context of the scope, extent and findings of the inspection of the relevant external wall construction in the context of performance in fire. Capable of making judgements as to whether walls have small quantities of combustible material present which are inconsequential, and thus concluding that such walls do not need to be considered further in an FRAEW.</p> <p>Able to communicate the results of their inspection accurately and reliably.</p> <p>Takes personal responsibility for their work.</p> <p>Knows the limitations of their skillset and can draw in additional skills as required.</p>

¹⁰⁾ Further details of this framework are available from <https://www.gov.uk/what-different-qualification-levels-mean/list-of-qualification-levels>.

Table H.1 – Expected skillsets of an external wall assessor *continued*

Task or level of assessment	Typical professional recognition	Expected skillset
Basic level assessment (Clause 13)	Fully qualified member of a relevant professional body	<p>Knowledge of the underlying concepts and principles associated with fire engineering and an ability to evaluate and interpret these within the context of the fire performance of the relevant external wall construction.</p> <p>Able to present, evaluate and interpret qualitative and quantitative data, in order to develop lines of argument and make sound judgements in accordance with basic theories and concepts in the context of the fire performance of the relevant external wall construction.</p> <p>Able to evaluate the appropriateness of different approaches to solving problems related to the fire performance of the relevant external wall construction.</p> <p>Able to communicate the results of their assessment accurately and reliably, and with structured and coherent arguments.</p> <p>Takes personal responsibility for their work.</p> <p>Knows the limitations of their skillset and can draw in additional skills as required.</p>
In-depth technical assessment using fire engineering analysis (Clause 14)	Chartered engineer	<p>Possesses a systematic understanding of key aspects of fire engineering, including acquisition of coherent and detailed knowledge, at least some of which is at, or informed by, the forefront of aspects of the fire engineering discipline as it relates to the fire performance of the relevant external wall construction.</p> <p>Able to deploy accurately established techniques of analysis and enquiry within the fire engineering discipline.</p> <p>Able to devise and sustain arguments, and/or to solve problems, using ideas and techniques that are at the forefront of the fire engineering discipline and relating to the fire performance of the relevant external wall construction.</p> <p>Able to describe and comment upon particular aspects of current research in the discipline of fire engineering as it relates to the fire performance of the relevant external wall construction.</p> <p>Appreciates the uncertainty, ambiguity and limits of knowledge relating to the fire performance of the relevant external wall construction.</p> <p>Able critically to evaluate arguments, assumptions, abstract concepts and data (that might be incomplete), to make judgements, and to frame appropriate questions to achieve a solution – or identify a range of solutions – to a problem.</p> <p>Able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.</p> <p>Able to exercise initiative and accept personal responsibility.</p> <p>Knows the limitations of their skillset and can draw in additional skills as required.</p>

Annex I (informative)

Aspects of information gathering

I.1 Document study

The availability of original project documentation is likely to vary considerably. For some more recent buildings, there might be a comprehensive set of records from the beginning of the project through to its completion. In these cases, in-depth study of documents will be possible. For others, there will be very little, or even none, of the information to hand and greater reliance will be placed on intrusive inspection as the starting point (see Clause 10).

Where possible, the starting point in establishing what components and materials have been used in any cladding system that is being considered ought to be a detailed examination of the design documents prepared by the architect and any other specialist consultants or subcontractors involved in the construction of the building. These are likely to consist of both drawings and specifications.

Drawings show the spatial relationship between the various components of the system, and between the system and the structure of the building to which it is being attached. They would be expected to include critical dimensions, such as the thickness of insulation, and the width of any ventilated and/or drained cavities.

Specifications set out the overall performance that the system is expected to provide, as well as the physical composition and characteristics of the materials to be used. They might also make reference to specific proprietary products where these have been selected.

The level of detail and information contained in the design documents typically increases as the design is developed through the various work stages. The typical sequence of work stages can be summarized as follows:

- a) **concept design:** outline information provided for consideration and approval by the employer and planning authorities;
- b) **detail design:** detailed information for use in selecting appropriate subcontractors. The role of a specialist subcontractor often includes developing the technical detail of the proposed design as well as the installation of the system;
- c) **tender information:** this includes the detailed design information related to the cladding system package, with information regarding those other

parts of the building with which the cladding system will connect and interface. Its purpose is to enable prospective subcontractors to submit accurate tenders for consideration by the contractor and employer;

- d) **construction information:** this incorporates the developed technical design and includes coordination with other aspects, systems and components of the building. This is the information which is used by the contractor and its subcontractors in the construction of the works;
- e) **as-built information:** this is intended to provide a record of what has been built, in order to inform maintenance, repair and alteration works during the working life of the building. It needs to include any variations made to the design during construction as a result of, for example, the availability of materials and components, changes to other aspects of the design, etc. In practice, as-built drawings are often no more than the last set of drawings to be produced, possibly marked up by hand to show some of the more significant changes.

***NOTE** Such as-built information would be expected to have been part of the fire safety information relating to the design and construction of a building, which Regulation 38 (formerly Regulation 16B) of the Building Regulations 2010 [7] requires to be given to the responsible person. In Scotland, the Fire safety design summary [32] records key information relating to the design and construction of buildings.*

I.2 On-site verification

No matter how comprehensive the design information might be, it can only ever show what was intended to be constructed. What has actually been built can be quite different. A notable finding from the many investigations carried out into the fire risk posed by external walls on existing buildings following the Grenfell Tower fire is how commonly there are differences between the as-built record information and the materials used in the actual wall build-ups on the building. Product substitution is not uncommon, and sometimes there are highly significant differences in fire performance between products selected for use in the construction of the buildings and those that have actually been used.

Therefore, what has actually been constructed needs to be verified, or determined if the design information is incomplete, by inspection of the building itself. The purpose of initial inspections is to focus on establishing whether or not the design documents accurately reflect what has been installed and can be relied upon when assessing any risks inherent in the cladding system installed. Site surveys and inspections are discussed further in Clause 10 and Annex J.

When identifying products, assessors need to be aware that families of products might appear very similar from visual inspection but have very different fire performances.

I.3 Establishing likely performance

Having established what materials and components have been installed on the building, the next step is to assess whether that installation met the standards that governed fire performance at the time of construction and that can be taken into account now in an FRAEW.

Data regarding fire performance classification of the materials and products used as cladding panels and insulation in cladding systems is, typically, provided in the technical literature published by their manufacturers. This is likely to be the first point of reference when seeking to establish the performance of a cladding system.

In addition, most construction products marketed in the UK have certification based on independently derived product performance data. This typically includes technical and test data about construction materials and products, and details of their suitability for use in defined situations, including their compliance with relevant sections of the building regulations.

Specifiers and designers typically rely upon the content of such certification and would usually be expected to accept statements within such certification of an appropriate national, or European, fire classification as confirmation of compliance with the guidance provided by ADB ([8], [9]).

However, it is important to note that such certification only provides a concise summary of information needed to demonstrate that a product conforms to the building regulations. It is usually based on documentary material supplied by manufacturers, who would have obligations to disclose details of any testing carried out and to notify the independent certification body of any changes to products. Certificates of this nature need to be read in their entirety, particularly to establish any limits in the application of the products.

It has become apparent that some manufacturers did not fulfil their obligation to disclose all testing and/or changed products without informing certifiers or testing bodies. This has led to certain testing reports, and extended application reports based on those reports, being withdrawn. It is therefore important to confirm the status of such reports if they are to be relied upon.

External wall assessors are expected to review technical literature to establish the relevant data on fire performance, based on test standards and classification schemes that are applicable to the materials, components and systems used in external wall construction and cladding. This is discussed further in Clause 11.

I.4 Test data

Test data relating to reaction to fire classification are taken from small-scale tests. However, intermediate and large-scale fire tests might also have been undertaken providing different, and possibly more directly relevant, indicators of how a complete cladding system will perform.

Some manufacturers have published data from large-scale tests carried out to BS 8414 where these demonstrate that the product meets the performance requirements set out in BR 135 [15]. These data apply only to systems installed in exactly the same configuration and manner as those tested. Nevertheless, the data can still provide a useful insight into fire performance and, if used carefully by competent and experienced professionals, a clear understanding of the limitations in respect of which they are provided.

Depending upon the circumstances, an external wall assessor normally needs to scrutinize more than just the manufacturer's declared technical data on the performance of their products in fire; they also need to seek to establish limits of applicability and other information that might only be found by reviewing the test laboratory's reports.

Establishing the greater level of detail that can be found in a test laboratory's report on how a product performed under test will often form part of an in-depth technical assessment using fire engineering principles, as described in Clause 14 and Annex G.

Annex J (informative)

Site survey and inspection considerations

J.1 Methods of construction and workmanship

J.1.1 General

First and foremost, site surveys and inspections are aimed at gaining a full understanding of the composition and geometry of the external wall construction and cladding, in order that the information this generates on the materials and products used can, in turn, be used to establish how the walls might behave in fire.

However, in addition to the performance of the individual components and materials that make up a cladding system, there are a number of other factors that can affect its response to fire. These include workmanship, tolerances, and junctions between different types of construction.

J.1.2 Workmanship

The ability of a cladding system to perform to the full extent of its design capability can be compromised by poor workmanship in the installation of one or more of its components. A full list of the potential issues is beyond the scope of this PAS, but two areas which can have a critical impact on the performance of a system are gaps between cladding panels and the installation of cavity barriers.

Gaps between external cladding panels are instrumental in determining the volume of external air that can enter and circulate through the ventilated cavity of a rainscreen system and, hence, support a fire. Where the fire performance is dependent upon the size of gaps, it is essential that the gaps, as installed, are compared with those with which the system was designed and, where applicable, tested.

The investigation of numerous buildings in the wake of the fire at Grenfell Tower has revealed that, even where cavity barriers have been correctly included in the design, they are often:

- installed with gaps that will impair their performance;
- obstructed from intumescenting by support framework;
- removed or distorted by following trades; or
- not installed at all.

Cavity barriers need to be suitably installed, whether in accordance with manufacturers' instructions or with industry best practice. Assessors need to be able to understand these instructions/best practice in order to assess the adequacy of the cavity barriers.

J.1.3 Tolerances

The basic structure of the building on which the cladding system is to be installed is often constructed to wider tolerances than the cladding system itself. This might result in the dimensions of cavities, or gaps between panels, falling outside the range required for effective performance of the system.

For insulated render systems, this can mean the introduction of cavities behind the insulation, where this is spaced out on dabs of adhesive to accommodate irregularities in the substructure. For rainscreen cladding systems, it can result in variations in the width of the ventilated cavity and the volume and flow of air within it.

J.1.4 Junctions

Many buildings are designed with several different external wall types in different locations. Whilst each individual wall type might, in itself, have been deemed satisfactory in relation to fire performance, junctions between different wall types, or changes of direction within a single wall type, sometimes introduce a lack of continuity of some components, including cavity barriers across the junction between types or directions.

The presence of these other factors, and the extent to which they differ from the installation described in the design, and recommended by product manufacturers, can only be discovered by intrusive inspection of the installation on site.

J.2 Invasive investigation and sampling

Site survey and inspection necessarily involves the removal of certain external components of the system, such as cladding panels, trims and decorative features, in order to expose the internal components. Some internal components might also need to be removed in order to examine the composition and condition of the substrate to which the system is attached.

This clearly requires a degree of intrusive inspection and destructive exposure. It is important that external wall assessors, or those who undertake this part of an FRAEW on their behalf, plan this carefully, both to maximize the benefit gained from such work and to minimize the amount of exposure and damage. As well as the cost of repairs, which could be considerable, there are other negative consequences of opening up work that need to be taken into account, including:

- damage to the function of the walls, especially in terms of watertightness and fire performance;
- weakening of the structural integrity of the cladding system;
- inconvenience to residents; and
- aesthetic considerations, such as differences in appearance from an inability to procure exact replacements for components that have been damaged, or to colour match repairs.

Careful selection of sample locations can often minimize negative consequences, but, clearly, selection of more sample points will impact on the extent of such consequences. Appropriate timing of investigations can be a means of reducing the inconvenience to residents, but this is not to be achieved by limiting the scope of the investigations.

This requires a balance, fundamental to which is the understanding that it is neither realistic nor appropriate, in the case of an existing building, to expect site surveys and inspections to be fully comprehensive, or able to identify all instances of deficiencies in external wall construction and cladding. An FRAEW is not a forensic investigation into the construction of a building, and 100% exposure to view the construction of the walls is neither proportionate, nor would it be adopted in other types of retrospective investigation of building-related issues.

This parallels the building's FRA process, which cannot involve 100% inspection of elements of the building's fire safety design, such as the structural fire performance of floors and walls. Sampling is inherent in the building's FRA process and is similarly the case in an FRAEW. Nevertheless, the degree of sampling is a key consideration in an FRAEW.

When planning an inspection, plans and elevation drawings can be used to identify the location of critical features such as compartment walls and floors, as well as the locations of any variations of cladding types or substrate types. Locations to be opened up can be selected to include as many features of interest as possible, in order to minimize the amount of work required. For example, a single area of opening up around a junction between a compartment wall and floor not only exposes cladding components, but also demonstrates whether cavity/fire barriers have been installed at both the compartment wall and the compartment floor.

Accessibility also needs to be taken into account when selecting areas to be inspected, together with the availability of suitable access equipment, such as mobile elevating work platforms, scaffolding towers, cleaning cradles or abseiling points. Sampling from low-level areas, for ease of accessibility, might appear preferable, but low-level cladding is frequently designed to be more robust (due to impact resistance and anti-vandalism considerations) and might not, therefore, be sufficiently representative.

A limited inspection of the exposed construction and components is usually sufficient to establish whether the materials and components described in the original specification, or on the as-built drawings, where available, including proprietary products where these have been specified, have been used, or whether alternatives have been substituted. It also enables verification that the dimensions of the components, cavities and other features are in accordance with those indicated on the drawings.

This type of inspection would also enable the quality of the workmanship of the various trades involved in the installation to be assessed.

On larger buildings, where the installation might have been carried out by more than one gang of operatives, opening up needs to be carried out in several locations, remote from one another, so that any variations in standards of workmanship can be seen and assessed. Similarly, where there are several types of cladding system, the degree of opening up needs to be sufficient to examine all of the different wall build-ups.

Annex K (informative)

Fire performance risk factors

Table K.1 gives a non-exhaustive list of examples of common factors influencing the likely speed and extent of fire spread, based on the properties of, and fire performance of, the materials, components, systems and configurations of external wall construction on buildings.

No single row in Table K.1 gives a definitive answer on risk. Whether an entry is considered positive, negative or neutral is purely indicative of the potential influence it might have. Careful judgement is needed when using the table to determine the actual relevance of each factor and its significance in the context of the particular building under consideration. Where numeric values are given, these are only intended to be indicative as to the possible influence the particular factor might have in a risk-based assessment.

In the event that any combination or system referred to in the Neutral or Negative columns has been subject to a BS 8414 test and classified to BR 135 [15] with the same build-up, but is not an exact match, these could be considered for the Positive column. However, for avoidance of doubt, this is not implying that it can be regarded as meeting the benchmark in ADB ([8], [9]); only if the system has been subject to an "assessment-in-lieu-of-test" in accordance with BS 9414 could such a conclusion be drawn.

The relevance of the factors in Table K.1 might vary on different elevations or different parts of the same elevation. Consideration will need to be given as to how significant such variations are when assessing the fire risk on the building as a whole.

Factors influencing the scope for an external wall fire to circumvent compartmentation are also given in Annex N.

Where a risk factor is marked with an asterisk (*), this indicates that it is notably more of a positive influence.

Table K.1 – Fire performance risk factors

Positive	Neutral	Negative
Where a risk factor is marked with an asterisk (*), this indicates that it is notably more of a positive influence.		
K.1 General		
Materials with a calorific value (gross heat of combustion) of ≤3 MJ/kg	Materials with a calorific value (gross heat of combustion) >3 MJ/kg and ≤35 MJ/kg	Materials with a calorific value (gross heat of combustion) of >35 MJ/kg
<p>NOTE 1 Calorific values are to be based on BS EN ISO 1716 test results.</p> <p>NOTE 2 This is a broad indicator only and needs to be seen in the context of the particular component to which it relates, how that component interacts with other materials, the quantity of the material, its location and the extent to which it covers the building. The boundaries between the different ranges need not be seen as rigid in this context. Depending upon this, judgement made by the external wall assessor may allow differences, e.g. up to 6 MJ/kg as still positive or over 20 MJ/kg as negative. It is likely that more in-depth technical assessment would be needed to fully utilize the values for individual components and their contribution to the wall build-up as a whole.</p>		

Table K.1 – Fire performance risk factors *continued*

Positive	Neutral	Negative
<p>External wall materials, components/systems and configurations that are combustible, but known to provide adequate fire performance in certain circumstances</p> <p>[Based on knowledge of fire behaviour from fire tests.</p> <p>For example:</p> <ul style="list-style-type: none"> any combination or system which has been classified to BR 135 [15] for same build-up, albeit not an exact match; or any combination or system which has passed an alternative large-scale test (e.g. LPS 1181, Part 1 [33]).] <p>NOTE 3 Care needs to be taken when considering the weight that can be attached to tested build-ups that differ from the actual wall build-up on the building. The performance of build-ups in a test only provides an indication of potential performance; it cannot be assumed that the same performance will be always achieved.</p> <p>NOTE 4 BS 9414 has, since its publication, been used in relation to this aspect of assessment; however, it is not intended as a means of reverse engineering an applicable BS 8414 test based upon site observations (see Clause 11).</p>	<p>External wall materials, components/systems and configurations that are combustible, but with the potential to provide adequate fire performance in certain circumstances</p> <p>[Knowledge of fire behaviour from only limited fire tests. For example:</p> <ul style="list-style-type: none"> subject to intermediate-scale tests (e.g. ISO 13785-1, NFPA 285) and/or ad-hoc fire tests, but not large-scale tests; or components classified to BS EN 13501-1 but not complete system/configuration.] 	<p>External wall materials, components/systems and configurations that are combustible, but with no knowledge of fire behaviour</p> <p>[No evidence available from fire testing. For example:</p> <ul style="list-style-type: none"> not tested in large-scale or intermediate-scale fire tests (e.g. BS 8414); not classified to BS EN 13501-1; or no ad-hoc testing.]
K.2 External surfaces: reaction to fire classes		
Class A1/A2* Class B	Class C	Class D, Class E, Class F
<p>NOTE This is a broad indicator only, and needs to be seen in the context of the particular component to which it relates and where it is within the wall build-up. It is likely that more in-depth technical assessment would be needed to fully utilize the values for individual components and their contribution to the wall build-up as a whole.</p>		

Table K.1 – Fire performance risk factors *continued*

Positive	Neutral	Negative
K.3 Facings/cladding panels		
Low HRR	—	High HRR
<p>NOTE Heat release rate (HRR) is an important indicator of performance, given that it indicates how rapidly heat energy is released in the process of combustion. It is not currently possible to state values here, but studies that compare the HRR of different materials, components and systems in similar conditions can be useful references to enable this factor to be considered.</p>		
Mechanically fixed	—	Adhesive fixed
Solid metal panels with high melting point (>800 °C) (Typically, steel) NOTE Some paint finishes can result in a Class B or lower rating.	Solid metal panels with low melting point (<800 °C) (Typically, aluminium, zinc and copper)	Metal faced panels with a combustible backing (Typically, aluminium on plywood)
Category 1 ACM or other MCM (At least Class A2)	Category 2 ACM or other MCM (Typically, a combustion modified polyethylene core, also referred to as FR type)	Category 3 ACM or other MCM (Typically, an unmodified polyethylene core)
Other rigid non-combustible facings (Typically: <ul style="list-style-type: none"> • brick; • ceramic; • stone; • clay tile; • concrete; • stone wool cladding boards; and • cement fibre boards) Masonry or concrete at least 75 mm thick*	Brick slip with organic mortar Brick slip with inorganic mortar*	Brick slip and other similar facing/cladding panels supported by thermoplastic materials
Glazing and glazed curtain walling (See K.11 for infill panels) NOTE 1 Glass type might not be Class A2 or better, but still considered positive. NOTE 2 Based on past experience of laminated glass in fires, replacement of laminated glass is not, at the present time, considered justified in relation to existing blocks of flats. NOTE 3 Further consideration of laminated glass is given in Annex L.	—	—

Table K.1 – Fire performance risk factors *continued*

Positive	Neutral	Negative
Glass rainscreen panels, where either: <ul style="list-style-type: none"> • at least Class A2; or • if incorporating organic resins, binders, etc., a similar combination has been subject to BR 135 classification 	Glass rainscreen panels, with organic resins, binders, etc.	—
HPL, combustion modified (no lower than Class B), when used in combination with non-combustible insulation NOTE Class B products are sometimes also referred to as an “FR” HPL.	HPL (Class C or lower), when used in combination with non-combustible insulation* NOTE 1 Class C or lower products are sometimes also referred to as a “standard” HPL. HPL, combustion modified (no lower than Class B), when used in combination with combustion modified polymeric foam insulation NOTE 2 Class B products are sometimes also referred to as an “FR” HPL.	HPL, combustion modified (no lower than Class B), when used in combination with polymeric insulation* NOTE 1 Class B products are sometimes also referred to as an “FR” HPL. HPL (Class C or lower), when used in combination with polymeric foam insulation NOTE 2 Class C or lower products are sometimes also referred to as a “standard” HPL.
—	Timber, direct on non-combustible substrate* Timber, in combination with non-combustible insulation	Timber, in combination with combustible insulation, etc.
—	Other combustible facing or panel with combustible content, but not readily ignitable (at least Class B)	Other combustible facing or panel with combustible content (Class C or lower)
K.4 Panel construction		
No gaps between panels	Limited size of gaps between panels (Typically <10 mm)	Gaps between panels of 10 mm to 20 mm* Gaps between panels of >20 mm
NOTE 1 Gap sizes can be highly influential in terms of performance of in large-scale tests and the values given above are only intended to be indicative of their possible influence as a factor in a risk-based assessment. Panels can take different forms: flat sheets and cassettes. Different methods of fixing are possible including hook on, rivet fixed and adhesive bonded. These variations can result in differences in fire performance in certain fire tests. Further commentary on this is given in Annex L.		
NOTE 2 Gaps might result from loss of integrity of sealant during fire exposure.		

Table K.1 – Fire performance risk factors *continued*

Positive	Neutral	Negative
K.5 Cavities		
Facings into the cavity at least Class A2	Facings into the cavity combustible, but at least Class B	Facings into the cavity combustible, but Class C or lower
Cavities closed by barriers/fire stopping located in line with all of the following: <ul style="list-style-type: none"> • compartment floors; • compartment walls; • around openings, e.g. windows, doors; and • ventilation ducts, grilles and other openings for services NOTE Suitable protection for ventilation ducts, grilles or other openings for services could take other forms, e.g. intumescent collars where passing through the walls, steel sleeves around the ducts and duct extensions to the cladding panels.	Cavity barriers present with no more than minor workmanship defects	Cavities closed at least at compartment floors and walls but not: <ul style="list-style-type: none"> • around windows and other openings*; or • at ventilation ducts, grilles or other openings for services* No cavity barriers present, or cavity barriers ineffective through poor installation/maintenance
NOTE The minimum fire resistance for a cavity barrier/stop is 30 min integrity/15 min insulation. Proprietary products are made for this purpose, but suitable protection will be provided if the following are present: <ul style="list-style-type: none"> • steel at least 0.5 mm thick; • timber at least 38 mm thick; • polythene-sleeved mineral wool, or mineral wool slab, installed under compression in the cavity; or • calcium silicate, cement-based or gypsum-based boards at least 12 mm thick. Fire stopping that is present to close gaps in compartmentation provides a higher standard of fire resistance than a cavity barrier/stop.		
K.6 Insulation		
No insulation	—	—
Class A1/A2, Class B	Class C	Class D, Class E, Class F
NOTE This is a broad indicator only. It is likely that more in-depth technical assessment would be needed to fully utilize the values within the context of the particular wall build-up.		
Mineral/glass insulation	Thermoset polymeric foams that form a stable char on fire exposure, e.g. phenolic foams and some PIR foams NOTE Consideration of the thickness of such insulation cannot be taken into account here, but is highly relevant in a more in-depth technical assessment when considering the contribution of the burning insulation to the heat generated in the fire and heat transfer to the rest of the wall build-up.	Thermoplastics (e.g. EPS/XPS) or thermoset polymeric foams that do not form a stable char on fire exposure (e.g. PUR) NOTE Consideration of the thickness of such insulation cannot be taken into account here, but is highly relevant in a more in-depth technical assessment when considering the contribution of the burning insulation to the heat generated in the fire and heat transfer to the rest of the wall build-up.

Table K.1 – Fire performance risk factors *continued*

Positive	Neutral	Negative
K.7 Substrate		
Masonry, >75 mm thick* Masonry, <75 mm thick SFS with cement, calcium silicate or magnesium oxide-based sheathing of Class B or better and non-combustible (Class A1/A2) insulation	SFS with sheathing of Class B or better and combustible insulation Timber frame, CLT, SIPs, etc., with sheathing of Class B or better and non-combustible insulation	Timber frame, CLT, SIPs, SFS, etc., with OSB or similar sheathing and combustible insulation
K.8 Sheathing boards		
Class A1/A2 Cement, calcium silicate or magnesium oxide-based Class B	Other Class B Class C	Class D, Class E, Class F OSB, hardboard or similar
K.9 Insulated core panels		
Combustible insulation, but panels either: <ul style="list-style-type: none"> classified to BR 135 [15]; or met success criteria in alternative large-scale fire testing (e.g. LPS 1181, Part 1 [33] and LPS 1208 [34]) Non-combustible insulation encapsulated in metal	Readily combustible insulation, but fully encapsulated in steel	Readily combustible insulation, but not fully encapsulated Readily combustible insulation, but only encapsulated in aluminium or other low melting point metal
K.10 ETICS		
Thin organic render or inorganic render on Class A1/A2 insulation	Inorganic render on thermoset polymeric foams that form a stable char on fire exposure, e.g. phenolic foams and some PIR foams Thick inorganic render on thermoplastic polymeric foams (e.g. EPS/XPS) Thermoset polymeric foams that do not form a stable char on fire exposure (e.g. PUR) with fire breaks through the full depth of the insulation at each floor level	Any other render system
<p>NOTE The fire performance of ETICS is a specialist area requiring external wall assessors to have relevant expertise. ETICS with specifically formulated renders can achieve classification to BR 135 [15] even with polymeric foam insulation. However, in-depth technical assessment might be necessary where there is reliance on information suggesting that the ETICS on the building is one classified to BR 135 [15] and intrusive inspection has revealed potential installation issues, for example, that could be critical to performance in the particular application.</p>		

Table K.1 – Fire performance risk factors *continued*

Positive	Neutral	Negative
K.11 Infill/spandrel panels		
<p>Glazed (excluding vision glazing), with Class A1/A2 core</p> <p>Metal faced, with Class A1/A2 core</p> <p>Thermoset polymeric foams that form a stable under fire exposure (e.g. phenolic and some PIRs) encapsulated with steel</p>	<p>Thermoset polymeric foams that form a stable char under fire exposure (e.g. phenolic and some PIRs) faced on front and rear with Class A1/A2 materials (this could include laminated glass on the front face)</p> <p>Other polymeric foams fully encapsulated with steel</p> <p><i>NOTE Consideration of the thickness and sizes of such panels cannot be taken into account here, but is highly relevant in a more in-depth technical assessment when considering the contribution of burning panels to the heat generated in the fire and heat transfer to the rest of the wall build-up.</i></p>	<p>Panels with either combustible facing materials and/or thermoplastic cores not fully encapsulated by steel</p> <p><i>NOTE Consideration of the thickness and sizes of such panels cannot be taken into account here, but is highly relevant in a more in-depth technical assessment when considering the contribution of burning panels to the heat generated in the fire and heat transfer to the rest of the wall build-up.</i></p>
K.12 Internal finishes		
—	—	—
<p><i>NOTE It is not anticipated that internal finishes of external walls would be a notable risk factor, especially if they comprise a paint or wallpaper finish. However, it is possible that there might be finishes that, in the context of the overall wall build up, might influence fire spread to the extent that they constitute a negative risk factor and would need to be considered.</i></p>		

Annex L (informative)

Generic fire properties of external wall materials, systems and configurations

L.1 General

The generic fire properties described in this annex are set out on the basis of performance typically obtained from various types of products. However, while these descriptions can be reasonably relied upon where no product specific information is available, where products can be identified then their product specific information will necessarily take precedence over the generic information in this annex.

There are also various instances in this annex which relate to expectations arising from construction in accordance with ADB ([8], [9]) (e.g. cavity barriers around openings and in line with every compartmenting element of structure).

Buildings can be subject to alternative solutions which justify how the functional requirement of building regulations has been achieved in an alternative manner to following the provisions in ADB ([8], [9]) (e.g. cavity barriers omitted from around windows on the basis of the proximity of windows to compartment line cavity barriers).

L.2 Common components across all system types

Table L.1 to Table L.6 describe the fire properties of common elements that can be found in or around external wall construction. Other factors, such as connections and interfaces between components, can affect fire performance in service.

Table L.1 – Fire properties of common elements – Structural elements

Element	Property
Masonry (brickwork, blockwork, reinforced concrete)	Loadbearing masonry, provided it is in good condition, can generally be regarded as providing a substrate which is both non-combustible and fire-resisting to a standard of at least 30 min (60 min if 100 mm thick or more). Non-loadbearing masonry might, or might not, have the same properties.
Steel (loadbearing hot rolled structural)	Loadbearing steel is non-combustible but, in buildings of more than two storeys, usually highly dependent upon applied fire protection (applied coatings or boards) in order to achieve a fire resistance standard of 30 min or more.
Steel framing system (SFS)	Cold-drawn light gauge SFS steel studs are generally used to form non-loadbearing external walls that infill between floor slabs. Provided they are imperforate and continuous, SFS studs can serve as adequate cavity barriers to subdivide cavity wall construction. Where SFS studs are needed to perform as cavity barriers, it needs to be confirmed by inspection whether they are imperforate, appropriately fitted, and at least 0.5 mm thick.
Solid mass timber	Mass timber generally has a cross-section not less than 100 mm in any direction. It is combustible but can possess a significant period of fire resistance due to the rate of charring and the amount of unaffected timber beneath the char which can continue to maintain the loadbearing function and usually without significant distortion.
Lightweight timber	Lightweight timber (e.g. that used in typical modern timber frame buildings) generally comprises large numbers of elements with a cross-section less than 50 mm in at least one direction. Lightweight timber is consumed rapidly under direct fire exposure and therefore, to achieve fire resistance, it is highly reliant on the fire protection it is afforded by being encased, usually using plasterboard.
Cross-laminated timber (CLT)	CLT, provided it is in good condition, can be treated as behaving in the same manner as mass timber. CLT needs to be inspected to determine whether there has been any degradation of the adhesive bonding the various laminate layers (which can occur if, for example, the CLT has been exposed to high humidity environments/excess moisture). Any degradation of adhesive will give rise to a risk of delamination which could give rise to collapse, whether in fire or generally.
Other engineered timber [including joists and structural insulated panels (SIPs)]	Other forms of engineered timber can incorporate OSB, laminated veneer lumber, particle board, plywood, metal nail plates, etc. These forms of timber are generally reliant on being encased by materials such as plasterboard to achieve fire resistance, and cannot be relied upon to provide any period of fire resistance unless relevant evidence is obtained.

Table L.2 – Fire properties of common elements – Plasterboard and sheathing boards

Element	Property
Plasterboard	<p>The core material of plasterboard is non-combustible, but the paper linings are not. Plasterboard is fire-resisting, with the specific period of fire resistance dependent upon the grade and thickness of plasterboard used, the frame to which it is fixed and the manner of its fixing. Where product markings are not visible, it is generally difficult to identify plasterboard without expert knowledge. In the absence of specific information, it is reasonable to assume plasterboard to be of standard grade.</p> <p>Notwithstanding the above, plasterboard can be regarded as providing an adequate cavity barrier within wall or floor construction provided it is at least 12 mm thick. Where partitions are formed of stud construction and plasterboard at least 12 mm thick on both faces, the partition is likely to be capable of providing 30 min fire resistance, provided it is well built.</p>
Cement-based boards	<p>Cement-based boards invariably involve the binding of an aggregate using cement. The most common aggregates are derived from timber (sawdust or pulp) but mineral aggregates can be used.</p> <p>CP boards with high timber/cellulose content are unlikely to be Class A2 (limited combustibility), but they generally perform well given the binding of particles in non-combustible cement.</p> <p>CP board can be regarded as providing an adequate cavity barrier within wall or floor construction provided it is at least 12 mm thick.</p>
Calcium silicate board	<p>Calcium silicate board is a fire protection board which is non-combustible and, if appropriately installed, can provide fire resistance dependent upon the board used, the frame to which it is fixed and the manner of its fixing.</p> <p>Calcium silicate board can be regarded as providing an adequate cavity barrier within wall or floor construction provided it is at least 12 mm thick.</p>
Magnesium oxide board	<p>Magnesium oxide board uses magnesium oxide as a cement replacement and aggregate.</p> <p>Magnesium oxide board is non-combustible and can offer fire resistance dependent upon the board used, the frame to which it is fixed and the manner of its fixing. Its fire performance is generally better than general CP board. It generally has a better moisture resistance to plasterboard and has been used in rainscreen cavities as a sheathing board.</p> <p>Magnesium oxide board can be regarded as providing an adequate cavity barrier within wall or floor construction provided it is at least 12 mm thick.</p>
Hybrid boards	<p>Hybrid boards have been developed to provide particular combinations of properties (e.g. non-combustibility and fire resistance with flexibility). Performance of hybrid boards cannot be assumed and manufacturers' data needs to be sought.</p>

Table L.3 – Fire properties of common elements – Insulation

Element	Property
<p>Insulation materials previously classified as non-combustible/limited combustibility (now Class A1 or Class A2)</p> <ul style="list-style-type: none"> • Stone wool • Ceramic fibre • Glass fibre • Foamed glass • Exfoliated vermiculite 	<p>Class A1 or Class A2 (non-combustible and limited combustibility) insulators pose negligible risk in external wall construction. Where such insulators fully fill wall construction then this might indicate that they are being relied upon as contributing to a period of fire resistance. However, if fire resistance is required or being relied upon as part of the assessment, it is important that these insulators fully fill the space they are in or are sufficiently rigid or otherwise mechanically retained/supported to provide a continuous barrier through the space (e.g. batts will retain their shape whereas quilt can slump in a cavity).</p>
<p>Rigid (thermoset) foam insulations</p> <ul style="list-style-type: none"> • Polyurethane (PUR) • Polyisocyanurate (PIR) • Phenolic 	<p>Thermoset foam insulations are combustible, but can offer a wide range of fire performance, depending upon the specific product in question.</p> <p>Both PUR and PIR can be formulated in a wide variety of ways, so where possible the assessor needs to identify the product in question. PUR and PIR foams are based upon similar underlying chemistry, but PIR foam generally performs better than PUR due to it having greater thermal stability (more likely to char and less likely to break down into flammable substances).</p> <p>Phenolic foams are generally similar to PIR foams in terms of their fire performance, though their underlying chemistry is different.</p> <p>Where a rigid foam has been engineered for improved fire performance, a foil facing is commonly employed to improve performance further by protecting the foam from direct flame attack. Where a foil faced foam is used, it is typically necessary to use foil tape to seal any joints so that the underlying foam is not left exposed. The extent to which tape failure can be accepted needs to be considered in the context of the overall wall construction.</p> <p>While cavity barriers need to be fixed to substrates offering the same period of fire resistance as the cavity barrier, rigid foams might, in practice, remain in place for long enough to afford a satisfactory delay to fire spread, provided the cavity barrier is not reliant upon the foam itself for support.</p>
<p>Thermoplastic insulation</p> <ul style="list-style-type: none"> • EPS foam • XPS foam • “Multifoil insulation” (e.g. layers of reflective foil and thermoplastic fibre wadding or bubble-wrap type material) • Importance of cavities being formed on heating 	<p>Thermoplastic insulation typically offers poor fire performance and so is reliant upon encapsulation to achieve safe external wall construction.</p> <p>Thermoplastic insulation will, by definition, melt on heating, so any space which is occupied by a thermoplastic insulation needs to be assumed as becoming a cavity lined with combustible residue once involved in fire. Encapsulation of thermoplastic insulation therefore needs to retain its integrity and likely needs to retain its shape when exposed to fire; it cannot be reliant upon the thermoplastic insulation to do this.</p> <p>It is generally accepted that thermoplastic insulation will be installed below damp-proof course (DPC) level in buildings, given the need to mitigate against damp. This is unlikely to have a significant impact on fire risk.</p>

Table L.4 – Fire properties of common elements – Cavities

Element	Property
Ventilated versus unventilated cavities	<p>Cavities form a necessary part of many modern forms of wall construction, generally as they contribute to energy performance and to keeping moisture out of buildings.</p> <p>Cavities can be entirely unventilated, drained but otherwise unventilated, slightly ventilated, or well ventilated. Cavities are often described by non-fire professionals by their position in relation to a building's insulation. "Warm" cavities are generally inboard of insulation whereas "cold" cavities are generally outboard of insulation. Cold cavities are more likely to be ventilated to some extent so as to mitigate against condensation, whereas warm cavities are more likely to be unventilated; however, the level of ventilation cannot be assumed.</p> <p>The extent to which a cavity is ventilated, in combination with the fuel load presented by any materials in or facing into the cavity, dictates the extent to which a fire can become well developed in a cavity and contribute to fire spread. Cavity fires are generally most severe when the cavity involved is ventilated at its top and its base, as this provides an opportunity for air entrainment at low level, smoke escape at high level, and efficient combustion within the cavity.</p>
Differentiating cavity barriers, fire stopping and fire barriers	<p>Cavity barriers are often confused with fire stopping and fire barriers.</p> <p>Cavity barriers subdivide cavities. In general, any structure within external wall construction that subdivides cavities could be a cavity barrier (subject to whether its construction is capable of providing the function of a cavity barrier). ADB ([8], [9]) recommends that cavity barriers provide 30 min fire-resisting integrity and 15 min insulation unless they are in a stud wall or partition, or around an opening, and constructed from one of the following "deemed to satisfy" materials:</p> <ul style="list-style-type: none"> • steel 0.5 mm thick; • timber 38 mm thick; • mineral wool provided it is in slab form or sleeved in polythene; and • calcium silicate, cement-based or gypsum-based (plaster) board at least 12 mm thick. <p>Cavity barriers need to be fixed in such a way which offers at least as much fire resistance as the cavity barrier itself, so as to avoid failure of the fixing causing premature failure of the cavity barrier. Construction formed of concrete, masonry or any of the "deemed to satisfy" cavity barrier constructions (i.e. stud wall construction lined with minimum 12.5 mm standard plasterboard) can be considered sufficient for this purpose.</p> <p>Fire barriers are generally used to subdivide sections of combustible construction (usually combustible insulation) that does not have a cavity. Their individual performance is not defined, although they generally need to have been incorporated into a system which has been successfully tested to the relevant part of BS 8414 and classified to BR 135 [15].</p> <p>Fire stopping is used to complete discontinuities in fire-resisting construction; it needs to provide the same period of fire resistance as the element it is completing. In the context of external wall construction, anything that connects compartment floors onto the inside face of the external walls is fire stopping. Once within the thickness of the external wall, only cavity barriers or fire barriers are required; however, any discontinuities in these might also require fire stopping.</p>

Table L.4 – Fire properties of common elements – Cavities *continued*

Element	Property
Cavity barriers	<p>Cavity barriers are generally needed where cavities pass across compartment lines (so as to avoid the cavity providing a route for fire to circumvent the compartment line), to the extent needed to limit extensive cavities, and around openings including doors, windows and penetrations through cavity construction. Cavities do not, in and of themselves, need their entire envelopes to be fire-resisting (e.g. the inner face of an external wall cavity can be formed of OSB, provided there are cavity barriers where the cavity passes across a compartment line and to the extent set out previously).</p> <p>Services passing through cavity external wall construction need either to be surrounded by cavity barriers or to be provided with fire stopping where they pass through the inner leaf of the external wall construction, as would be the case for services passing through 30 min fire-resisting construction.</p> <p>There are various types of cavity barrier that are commonly encountered in external wall construction.</p> <p>Full fill cavity barriers can be made of any of the “deemed to satisfy” materials. Mechanical fixing of such cavity barriers is the most reliable approach, but they can be compression fitted if formed of a compressible material such as stone wool.</p> <p>Open state cavity barriers are commonly used to solve the competing needs of fire separation and ventilation/drainage. There are various forms of open state cavity barrier, ranging from stone wool batt with intumescent edge strips through to multifoil cavity barriers. These cavity barriers are generally only proven to perform in particular arrangements between solid substrates forming the faces of the cavity. Where the cavity barrier only needs to be fixed to one of the two faces and expands onto the other, only the face onto which it is fixed needs to be representative; the other need not be, particularly if it is the inside face of the rainscreen and therefore likely to fall away prior to failure of the cavity barrier. Where the cavity barrier requires fixing into both faces of the cavity (e.g. certain multifoil cavity barriers are designed to be set into mortar in cavities formed of two leaves of brickwork) then both faces and the method of fixing need to be representative of the certification of the cavity barrier.</p> <p>Open state cavity barriers take time to close, so caution is necessary if they are combined with cavity linings that could spread particularly rapidly, such as EPS.</p> <p>Proprietary cavity barriers might only be suitable for installation in a particular orientation:</p> <ul style="list-style-type: none"> • vertical cavity barriers might not be suitable for use as horizontal cavity barriers; • horizontal cavity barriers (particularly those which are open state) are unlikely to be suitable for use as vertical cavity barriers, and also need to be installed both the right way up and the right way round.

Table L.5 – Fire properties of common elements – Glazing

Element	Property
Glass	<p>There is a wide variety of glazing systems that can be incorporated into external wall construction. Glass can be laminated with layers of polymeric material (e.g. polyvinyl butyl) to improve various aspects of performance. Whilst these polymeric interlayers are combustible, experience has indicated that these are unlikely to contribute significantly to external fire spread.</p> <p>If windows, or anything appearing to be made of glass, are found to be an alternative material (usually a solid plastic), then further information needs to be sought concerning the material's fire performance, as it might behave in a manner more akin to an infill panel or rainscreen panel.</p> <p>Fire-resisting glazing also comes in a variety of forms offering varying degrees of fire resistance. The two most common types are:</p> <ul style="list-style-type: none"> • integrity-only glass, which remains in situ when exposed to fire, acting as a barrier to flame spread, but transmits thermal radiation through it; and • insulating glass, which acts as a barrier both to heat and to thermal radiation, usually by turning opaque on heating. <p>If fire-resisting glazing is required to achieve satisfactory levels of safety as part of an assessment, then specialist advice needs to be sought (e.g. from the Glass and Glazing Federation).</p>
Frames (window and door)	<p>The frames of windows and doors can, subject to the materials used in their construction, provide the function of cavity barriers or cavity closers around these openings. Typically, timber and steel frame windows offer the cavity barrier function whereas aluminium and uPVC do not. However, it is advisable to check uPVC frames with a magnet, as steel can be incorporated within the frame, particularly where the doors are required to provide a level of security.</p>
Spandrel/infill panels	<p>The terms "spandrel panel" and "infill panel" are used interchangeably throughout the industry to refer to panels which are normally fitted in lieu of glazing in either window fenestration systems or curtain wall units. The edges of these panels usually expose the insulating core and are normally only protected by the frame into which they are installed. They are sometimes protected with aluminium foil tape but this cannot be assumed.</p> <p>Spandrel and infill panels are typically some form of composite, such as:</p> <ul style="list-style-type: none"> • metal skins with an insulating core; • metal skins with an insulating and timber (typically plywood) core; • metal external face with insulating core and timber (typically plywood) internal face; • HPL skins with an insulating core; and • solid HPL. <p>Their performance needs to be assessed in light of the materials involved in their construction (as described in this annex) and the manner in which they interact with compartmentation.</p> <ul style="list-style-type: none"> • Panels which are installed in such a way as to cross compartment lines (e.g. to conceal the edges of floor slabs) need to be considered in light of the potential route they provide for fire to spread from one compartment to another. • Panels which are installed entirely within the confines of a compartment (as it meets the external wall) are unlikely to have a significant impact on fire spread, unless their performance is such that they are likely to contribute to substantial flame extension.

Table L.6 – Fire properties of common elements – Other generic components

Element	Property
<ul style="list-style-type: none"> • Breather membrane • Vapour membrane • EPDM • DPC 	<p>Some membranes are available which achieve Class A2 (limited combustibility). Membranes used on existing buildings are more commonly comprised of combustible thermoplastic material. However, they do not tend to constitute a significant fuel source in their own right (as their mass per unit area is very small) but might be capable of propagating flame spread throughout when exposed within a cavity by igniting other combustible materials in close proximity. The risk of fire spread involving combustible membranes is typically mitigated by them being tightly fitted between other materials, either entirely sandwiched between other layers of wall construction, or tightly fitted between cavity barriers and their substrates. Where this has not been achieved, the potential for ignition of other materials needs to be taken into account.</p>
Paint/coatings	<p>Paints and coatings can have a significant impact on the extent to which a surface will support and spread flame. Thin, factory applied coatings (typically around 100 µm) such as polyester powder are unlikely to result in any significant spread of flame but this cannot be assumed for all coatings. Additionally, performance can vary depending upon pigmentation, so if the painted surface under consideration is covered by a test report, the colour needs to be covered by the test certificate for the product or an extended application assessment.</p> <p>External walls sometimes have paints or coatings applied to them which claim to improve fire performance (typically Class 0 or intumescent paints). There is no generic test evidence supporting the use of these, so specific test evidence is required that combines both the paint/coating and the substrate to which it is applied.</p>
Fixing methods	<p>Mechanical fixings are invariably the most reliable means of fixing together the various components of external wall construction.</p> <p>Metals, depending upon their softening/melting temperature, might remain in situ or might soften, melt, or even rapidly oxidize, exposing the underlying construction to fire.</p> <p>Adhesives can be simply relied upon where it is clear that they are cementitious in nature and provide a good bond onto their substrate. Where an adhesive is not clearly cementitious, it might need to be identified so that its fire performance can be ascertained, particularly where failure of the adhesive could have direct implications for fire performance (e.g. supporting insulation, rainscreen or cavity/fire barriers).</p>
Movement joints	<p>Movement joints are a common feature of cladding systems but are unlikely, in and of themselves, to present an opportunity for substantial fire spread. However, particular attention ought to be paid to movement joints which intersect cavity barriers or fire barriers, as these might need fire stopping (to match the performance of the cavity barrier or fire barrier) that is capable of accommodating the relevant movement. In addition, cladding systems that rely upon encapsulation of combustible insulants need to be properly detailed at movement joints.</p>
Thermal breaks	<p>Thermal breaks are provided to minimize heat loss via thermal bridging through external wall construction. Thermal breaks might need to be formed of combustible material, but they are generally provided at discrete locations, so do not provide an opportunity for significant fire spread.</p>
Acoustic breaks/ inserts	<p>Similar to thermal breaks, acoustic breaks are provided to limit sound transmission through external wall construction. These might be combustible but are generally provided at discrete locations, so do not provide an opportunity for significant fire spread.</p>

Table L.6 – Fire properties of common elements – Other generic components *continued*

Element	Property
Cavity trays	<p>Cavity trays, which can be of either metallic (non-combustible) or polymeric (combustible) material, are installed in cavities where water in the cavity needs to be sent back to the outside of the building. Combustible cavity trays are unlikely to present a substantial fire risk given the limited fire load they represent.</p> <p>Cavity trays are typically accompanied by weep holes to drain the water they collect, and generally need to be installed above cavity barriers unless the wall construction permits omission of cavity barriers.</p>
Cavity closer	Cavity closers are materials used to close a cavity that do not need to achieve a specific performance in relation to fire resistance.
Lightning conductors	Lightning conductors are common in tall buildings. Provided that lightning conductors are installed in accordance with BS EN 62305-1, it is expected that they will pose no risk to surrounding construction along their length (as the temperature rise along their length is negligible during a lightning strike). Combustible cladding ought to be no closer than 0.3 m to any air terminations on the lightning conductor.
Sundry items (seals, gaskets, spacers, backer rods, etc.)	Various sundry items can be included in external wall construction, depending upon the specific design. Sundry items can typically be excluded from any assessment of risk, provided they do not form a continuous network of combustible materials throughout the external wall construction.
Photovoltaic systems	<p>Photovoltaic systems pose both an ignition and fuel source; at the time of writing this PAS there are no photovoltaic systems that are Class A2 or composed entirely of materials of limited combustibility or better. The risk associated with the specific type of photovoltaic panels installed needs to be carefully assessed in light of their relationship to:</p> <ul style="list-style-type: none"> • the general external wall construction (are the panels integrated with or stood off from the system?); • whether the external wall construction is likely to be fire-resisting; • windows onto accommodation; • windows onto means of escape; and • any other routes that might allow fire and smoke spread into the building.
Green walls	The fire performance of green walls is highly reliant upon the survival and irrigation of the vegetation incorporated into it. If vegetation dies or becomes dried out then there is a heightened risk of fire spread; conversely, a healthy green wall is unlikely to pose a substantial risk of fire, although it is important to note that many systems incorporate plastic components which are also not of limited combustibility.

Table L.6 – Fire properties of common elements – Other generic components *continued*

Element	Property
Balconies	<p>Balconies are defined in BS 8579. However, for the purpose of this PAS and the manner in which balconies impact external fire behaviour, balconies fall into one of three categories:</p> <ul style="list-style-type: none"> a) those which fall entirely within the curtilage of the building structure (i.e. they are built on the slab and appear inset into the building when observed from outside). They might be enclosed to an extent and might effectively be made fully enclosed (sometimes referred to as a “winter garden”). The extent of enclosure needs to be considered in light of whether, from a fire perspective, the space can be treated as part of the outside or whether it is in effect a compartment (i.e. subject to compartment fire behaviour); b) those which project beyond the main building structure but do so on an extension of the floor slab. They provide an advantage in that their construction matches that of the compartment floor within the building, and can deflect fire/smoke plumes away from the building; and c) those which project beyond the main building structure and are fixed to the outside face of the building. They can only be of lightweight construction; their construction needs to be assessed based upon the combustibility and fire resistance of any materials used. <p>Regardless of balcony type, the materials used to line the balconies (including soffits) need to be assessed in light of their likely contribution to external fire spread.</p> <p>Storage of materials and other uses by residents also need to be taken into account. Any bulk storage can pose a significant hazard, as can the use of combustion appliances such as barbecues and heaters.</p> <p>Aside from the above, means of escape external walkways (a form of balcony) are not within the scope of this PAS, as any risk associated with these would need to be considered as part of the overarching FRA.</p>
Solar shading systems	<p>Like balconies, solar shading systems (e.g. external blinds or louvres) need to be considered insofar that they constitute a projection out from a building which might be combustible and aid propagation of flame, or might be non-combustible and deflect fire/smoke plumes away from the structure.</p>
Terraces	<p>Terraces that communicate with external walls ought to be considered in a similar context to the balconies described in item a) of the “Balconies” row above. In particular relation to terraces, pergolas can provide a fuel load which can support a significant fire.</p> <p>Where a terrace is on a roof or communicates with an external wall that is only single storey (e.g. terrace to a penthouse) then it can be considered as a roof.</p> <p>As with balconies, the materials used to line terraces, and storage by residents, both need to be taken into account.</p>

L.3 Common system types

Table L.7 to Table L.9 describe the fire properties of common types of external wall system. Further considerations relating to specific system types are given in Table L.10.

Table L.7 – Fire properties of common system types – Masonry/concrete systems

Element	Property
Masonry/concrete outer skin	<p>When assessing a building which appears to have masonry or concrete external wall construction, the following issues need to be taken into account.</p> <ol style="list-style-type: none"> a) Is the masonry/concrete loadbearing or simply providing a façade? b) Is the masonry/concrete traditional (i.e. full bricks laid in courses using sand/cement mortar or concrete exceeding 75 mm thick); or <ol style="list-style-type: none"> 1) brick slip (tiles) fixed to a substrate; or 2) factory produced (typically panellized) brickwork? <p>If either item 1) or item 2) above, then treat as other form of cladding depending upon underlying construction (most likely rainscreen).</p> c) What is the underlying construction? For example: <ol style="list-style-type: none"> 1) second leaf of masonry/concrete forming a cavity; 2) timber frame; 3) steel structure and frame; 4) concrete structure and SFS; 5) concrete structure and concrete panels; or 6) insulated build-up (this is typically used where historic façades are retained over more modern construction, and can come in a variety of forms).
Double masonry/ concrete skin with cavity	<p>As set out previously in this PAS, a building whose external walls are composed exclusively of this form of construction is not ordinarily expected to require an FRAEW. However, it is recognized that this form of wall construction might be mixed with other forms of wall construction.</p> <p>This form of construction constitutes the lowest risk form of construction that might be used for external walls, for the following reasons.</p> <ul style="list-style-type: none"> • Each leaf of the wall, provided it is formed of masonry/concrete at least 75 mm thick and is generally well constructed, is likely to provide at least 30 min fire resistance. • The masonry/concrete is likely to be of limited combustibility or better. <p>Given the above, this form of construction is invariably accepted as:</p> <ul style="list-style-type: none"> • not requiring cavity barriers generally, except that cavity closers are needed so that there is no free flow of air through the cavity; and • being able to accommodate combustible materials within the cavity irrespective of building height. <p>This is illustrated in Diagram 8.2 in ADB Volume 1:2019 [8]. The equivalent diagram in Volume 2:2019 [9] is Diagram 9.2.</p>

Table L.8 – Fire properties of common system types – Rainscreen systems

Element	Property
Types of rainscreen system	<p>Rainscreen systems come in various forms, generally defined by the cold cavity arrangement they incorporate (see Table L.4):</p> <ul style="list-style-type: none"> • ventilated and drained; or • pressure equalized. <p>Rainscreen systems are invariably supported on some form of framing or bracketing system. In the majority of cases, framing and bracketry transmit the load of the rainscreen to the back wall, and in turn to the building structure at each floor level. However, consideration needs to be given to the possibility that the rainscreen load is transmitted down to the base of the system and only provides lateral restraint at floor levels. In this instance, the extent to which the frame might be exposed to fire needs to be taken into account, particularly if a material is used which offers no fire resistance, such as aluminium.</p> <p>Framing and bracketry are likely to interact with cavity barriers; where these cross over the cavity barriers then the detailing of the cavity barrier needs to be appropriate (including additional fire stopping as necessary) to achieve fire separation of cavities.</p> <p>Table L.3 gives information on the various insulation materials that might be incorporated into a rainscreen system. It is unlikely that thermoplastic insulation will be acceptable in a rainscreen system, particularly if it is exposed in a cavity.</p>

Table L.9 – Fire properties of common system types – Rainscreen facing materials^{A)}

Element	Property
Non-combustible and limited combustibility materials	<p>These materials can be subdivided into two categories; those which retain their shape when exposed to fire and those which do not.</p> <ul style="list-style-type: none"> • Natural stone, terracotta and non-combustible boards all generally remain in situ for a significant period of time when exposed to a fire plume emitting from a building (though they might eventually shatter), thus affording some protection to the underlying construction. • Metals, depending upon their softening/melting temperature, might remain in situ or might soften, melt, or even rapidly oxidize, exposing the underlying construction to fire.
Combustible materials	
Engineered/reconstituted stone	<p>Engineered/reconstituted stone cannot be assumed to be non-combustible (as is the case with natural stone) because it contains combustible polymeric resin binder. Unless combustibility can be confirmed by small-scale testing, the likely fire performance of these materials needs to be considered by reference to appropriate large-scale fire tests.</p>

Table L.9 – Fire properties of common system types – Rainscreen facing materials^{A)} *continued*

Element	Property
Metal composite panels	<p>The fire performance of thin sandwich panels with a solid filler or core (such as ACM) is highly dependent upon both the metal and core material. Thin metal facings with a low melting point rapidly expose the core material to any fire.</p> <p>Core materials might contribute to fire or might enhance the performance of the metal, as follows.</p> <ul style="list-style-type: none"> • Untreated polyethylene cored metal composite panels are unlikely to be acceptable in most circumstances but, if there is a specific justification based on risk assessment, it might be possible to retain them. • Fire retarded/fire rated core material (generally provided with an “FR” product reference prefix by manufacturers) is typically formed from approximately 70% non-combustible mineral material and 30% combustible polyethylene. This material typically has a much better fire performance with the production of significant amounts of burning droplets of molten polyethylene being prevented. The acceptability or otherwise of this type of cladding panel needs to be determined on a case-by-case basis, in conjunction with the other materials and the manner in which they are brought together in the particular form of external wall construction being assessed. The fire performance of combinations of such panels with combustible insulation in large-scale tests have been shown to be sensitive to relatively minor differences between wall build-ups, such as in the size of gaps between panels. • Class A2 rated ACM panels (i.e. with core material achieving at least limited combustibility) are likely to provide performance similar to non-combustible boards and might be better than panels that are solid metal, particularly where the metal has a low melting point. This is because the core material provides a supporting structure to the metal after the softening/melting point of the metal has been exceeded, offering greater protection to underlying materials. <p>Where metal composite panels are used, it is important to establish whether the edges are simply cut, leaving the underlying layers exposed, or whether there is some form of edge treatment to protect these.</p>
High pressure laminate (HPL)	<p>HPLs are most commonly formed of a mixture of cellulose (wood pulp, recycled paper or similar) and combustible polymeric resin, though external wall assessors need to be aware that any combination of materials formed in a press can be termed a “high pressure laminate” and might be difficult to differentiate visually.</p> <p>HPLs formed of cellulose and resin typically behave in a charring manner analogous to timber, with similar flame spread, energy release and mechanical behaviour (charring until breaking apart). With treatment for enhanced fire performance (usually by additive of chemical fire retardant), these behaviours can potentially be improved, but need to be known on a product-specific basis before they can be relied upon as providing better performance.</p>
Timber	<p>Timber is a well understood material. Provided that it is of a substantial thickness, it is difficult to ignite with a small flame, but unless it is treated, it is likely to become involved in any substantial fire to which it is exposed, and ultimately to spread flame across all surfaces extending up and across from the point of ignition.</p> <p>Timber can be treated to improve its reaction to fire characteristics up to national Class 0 (European Class B) surface performance. However, it is important that the nature of the treatment is understood, as some treatments (e.g. those based on impregnation by mineral salt fire retardants) are hygroscopic and gradually leach out of the treated timber.</p>

Table L.9 – Fire properties of common system types – Rainscreen facing materials^{A)} *continued*

Element	Property
Plastics	Plastics are infrequently used as the outer surface of cladding due to their poor long-term durability; they tend to degrade under prolonged exposure to UV light and heating/cooling cycles. Where plastics are encountered and there is a desire to retain them, external wall assessors need to establish their fire performance in some way, noting in particular that fire performance can degrade as the plastic degrades over time.
Geometry of rainscreen (cassettes vs flat panels)	
Cassettes	<p>Cassettes are generally used for both their aesthetic performance (reducing angles at which it is possible to see into cavity) and weather performance (minimizing water ingress to cavity), particularly where the material being used is relatively thin (e.g. metal sheets and composites).</p> <p>Where a composite is used to form cassettes, the surface of the composite is likely to be broken on the insides of folds, so as to facilitate the formation of a clean fold. This exposes the underlying components of the composite so that it can be directly attacked by fire. If the underlying materials are readily combustible or have a low melting point, it can also lead to delamination of any portions of the cassette which are separated from fixing points by these folds, exposing more of the underlying material.</p> <p>Some cassettes can also be formed by fixing elements together, rather than simply folding a sheet into the desired shape. Where this occurs the manner of fixing needs to be assessed to determine whether it is likely to fail prematurely in the event of fire.</p> <p>The returns on cassettes need to be checked to determine whether there is sufficient cavity barrier detailing (or fire stopping) to mitigate the risk of fire circumventing the cavity barrier. The channel between cassettes can be open, but any spaces in the cavity need to be addressed, whether by fully filling or with an appropriate intumescent solution.</p> <p>Where cassettes have a particularly complex shape, particularly where that shape does not run parallel to the line to which cavity barriers are fixed, external wall assessors need to check that the cavity barrier fits or is able to close properly onto the inside face of the cassette along its entire length.</p> <p>Where test evidence is available for a cassette, assessors need to check that it is relevant to the cassette, and not just to the material in flat panel form.</p>
Panels (other than ACM)	Panels are cut from sheet material to the relevant size and fixed as rainscreen. The materials used to form panels, and the method of fixing them, both need to be assessed (see "Fixing methods" in Table L.6).
<p>^{A)} The rainscreen itself can be formed of any number of materials in a variety of geometries. Both the material and the geometry can have a significant bearing on fire performance.</p>	

Table L.10 – Further considerations for specific system types

System type	Notes
External thermal insulation composite systems (ETICS)	<p>These systems are sometimes referred to as rendered systems, as they feature an externally applied render coat as their weatherproof surface.</p> <p>The level of risk that might potentially be posed by these systems is generally dictated by the type of insulation they incorporate.</p> <ul style="list-style-type: none"> • Mineral wool-based systems are likely to be low-risk. • Rigid thermoset foam-based systems can be low-risk if fire barriers and cavity barriers (if a cavity exists behind the insulation) are properly provided. If there are gaps or other deficiencies then the level of risk might increase to medium or, in extreme cases, high. • Thermoplastic foam-based systems might be low-risk if fire barriers and cavity barriers (if a cavity exists behind the insulation) are properly provided and where there is a significant thickness of cement-based render applied to the insulation. If there are gaps or other deficiencies, a non-cement-based (i.e. polymeric organic) render has been used or an insufficient thickness of cement-based render has been applied, then the level of risk is high. <p>In particular regard to thermoplastic systems, there are historic systems which are known to have had approximately 20 mm thick slivers of EPS insulation passing across the front of fire barriers, providing a route for fire to rapidly circumvent the barriers. It needs to be confirmed by inspection whether or not this situation exists; if it does exist, such a system is high risk irrespective of the type of render provided.</p>
Sandwich panel systems	<p>Sandwich panels are formed of insulation between two sheets of metal. The particular materials used in sandwich panel construction determine the potential hazard that could be presented if the sandwich panel becomes involved in fire (see Table L.2 and Table L.3). Whether or not the insulating core of sandwich panels will become exposed to fire depends upon the manner in which joints and edges are addressed.</p> <p>Sandwich panels might be incorporated within an external wall construction (potentially as loadbearing elements) and overclad by a rainscreen, or might be exposed to the exterior, effectively as a rainscreen in their own right.</p>

Table L.10 – Further considerations for specific system types *continued*

System type	Notes
Curtain wall systems	<p>There are two principal forms of curtain wall system.</p> <ul style="list-style-type: none"> • Stand-off systems are built beyond the edges of floor slabs and run continuously across the height and width of a building. Unless a strategy has been devised to negate this need, fire stopping needs to be provided between slab edges and the inside face of the curtain wall system. • Infill systems (now more commonly referred to as window assemblies) are built inboard of slab and/or wall edges, although they might pass across particular floor and/or wall lines to achieve a particular architectural objective. Where the system is broken up by lines of fire compartmentation, this limits the extent/speed at which fire can spread across the system. <p>The structures of these systems can differ substantially; whereas infill systems are invariably supported at regular intervals by the building's primary structure, low-rise stand-off systems can transmit their load down to ground level, with only lateral support back to the primary structure.</p> <p>Regardless of whether a curtain wall system is built as a stick system (assembled on site) or a unitized system (prefabricated panels), it is the materials used to form the framework that influence the fire performance.</p> <ul style="list-style-type: none"> • Steel framed systems can provide good edge protection to the panels in the curtain wall (provided the geometry actually covers and protects edges) as well as good resistance to collapse in the event of fire. • uPVC framed systems are combustible; they might offer some edge protection and resistance to collapse if steelwork is embedded within them, but this would need to be confirmed. • Aluminium framed systems are non-combustible but melt when exposed to fire, offering little edge protection and potentially risking collapse (which can be extensive if the aluminium transmits the load of the curtain wall down to ground level). <p>The other components of curtain wall systems are covered in Table L.5.</p>

Annex M (informative)

Fire performance considerations of different external wall materials, systems and configurations

External cladding systems involve the combination of several different components, including cladding panels, ventilated cavities, thermal insulation, breather membranes, cavity/fire barriers and support systems. These systems can be applied to a variety of substrates, ranging from existing precast concrete panels to lightweight steel or timber framing sheathed in ply, OSB or CP board.

Each of the components, of both the cladding and the substrate systems, might incorporate different types of material, all with differing characteristics in relation to their reaction to fire. Also, different combinations of these materials can interact in different ways, resulting in differing levels of risk.

In addition to the characteristics of the various individual materials, the way in which the design combines them, the standard of workmanship achieved in the construction and the architectural detailing of the junctions between different elements of the building all have an impact on the behaviour in fire of the external envelope as a whole. Particular care is needed in respect of unusual forms of construction, such as modular building systems, where the fire performance might differ from that of traditional construction types.

The result of this variety and complexity is that there can be no universally applicable means of definitively determining the likely behaviour in fire and rate of fire spread for any particular external cladding system, other than to test it in a representative large-scale fire test. Hence, the approach in ADB of BR 135 [15] classification using the data from a BS 8414 test was the benchmark referred to in MHCLG's 2020 Consolidated Advice Note [17] as the principal basis of determining whether a building is safe in terms of external fire spread.

As stated elsewhere in this PAS, a benchmark using BR 135 [15] classification cannot be readily applied as an approach to determining whether an existing building is safe. This would effectively require a substantial number of responsible persons and other persons having control of buildings to carry out large-scale fire tests to match the exact wall build-up on a building. Potentially, there could be many different variations to the wall build-up on the same building or, indeed, many different forms of cladding on the same building. It is not, therefore, seen as a practical approach.

Equally, assessment-in-lieu-of-test in accordance with BS 9414 is not considered a practical means of assessing the fire risk posed by external walls on existing buildings; given the many types of cladding and variations that have been used on buildings, there is simply insufficient BS 8414 test data to apply the rules set out in BS 9414 to determining whether the differences between an untested cladding system and one that has been tested are significant. In addition, BS 9414 is intended and structured to enable cladding system manufacturers to reliably establish the manner in which tested systems might reasonably deviate from the specific system (or number of similar systems) that has been tested to BS 8414; it is not intended as a means of reverse engineering an applicable BS 8414 test based upon site observations.

There is a wide variety of cladding types, and different façade linings and insulation materials, in use within the external walls of existing multistorey, multi-occupied residential buildings. This PAS focuses on those that are combustible or contain combustible components.

There are many varieties of facings and insulation materials, which, individually and in combination, all perform very differently in fire. The initial focus following the Grenfell Tower fire was on ACM, given the combustible polyethylene core that was present to provide rigidity while reducing use of expensive aluminium. Other composite panels, such as insulated core sandwich panels, can also have a combustible core.

However, insulated core metal panels of this type differ markedly from ACM; the fire performance of sandwich panels was a significant issue in the 1990s, following a series of large loss fires, in particular, in food processing factories (see Research report no. 76 [35]). While much of the concern related to the internal use of sandwich panels, it led to the development of fire test standards (see LPS 1181, Part 1 [33]) that include external use of such panels.

In relation to fire spread, the performance of an external wall is dependent not only upon the fire behaviour of the facing material, but also, where present, on that of the thermal insulation behind it. Equally, as discussed in Clause 5 and Annex B, the presence or otherwise of cavities, and barriers to restrict fire spread within those cavities, is highly significant.

There are various types of thermal insulation in use, and, because of their combustibility, those that are polymeric, such as PIR, phenolic, PUR and EPS foam insulation, have the potential, in their own right or in combination with combustible facings, to give rise to more rapid fire spread than would necessarily be considered acceptable in all circumstances.

This is, fundamentally, why, even prior to the amendment of Regulation 7 of the Building Regulations 2010 [7], effectively banning combustible material in the external walls of blocks of flats above 18 m in height, ADB included a warning that combustible materials in cladding systems ought not to give rise to an undue rate of fire spread that presents a risk to the safety of occupants. It led to the adoption of classification to BR 135 [15], using the data from a BS 8414 large-scale fire test, as a benchmark for determining whether a particular wall build-up presented such a risk. While being performance-based, this ultimately applies pass/fail criteria to determine whether a cladding system needs to be classified.

Not all such polymeric materials exhibit the same burning behaviour and there are notable differences between thermosetting and thermoplastic materials. Furthermore, the performance of these materials in fire can be altered by formulation. Equally, encapsulation, such as in rendered façades or behind high melting point metals, can also serve to influence dramatically the likely contribution that such insulation materials make to the overall performance of a cladding system in fire.

In practice, the degree to which fire spread occurs and the means by which external fire spread can be controlled involves two separate aspects of fire safety.

- **Fire resistance:** this is the ability of an element of structure to withstand fire attack and maintain its function, whether of loadbearing capacity, or acting as a barrier to fire spread itself (integrity) or to heat from a fire (insulation). Fire resistance is measured as a period of time, the time within which an element of construction is able to withstand the fire attack from a standardized furnace applying a standard fire. There are both national and European tests for determining fire resistance, but both use very similar test methods.
- **Reaction to fire:** this concerns the way in which a material responds to fire attack in terms of flaming, release of energy, generation of smoke and toxic gases. The classification of reaction to fire properties is more complex than for fire resistance, and there are both national and European classification systems. Production of toxic gases is not addressed by the classification standards referred to in statutory guidance for the design of buildings.

Both the national and European classification systems deal with the propensity for materials and products to sustain a flame and propagate flame spread, as well as the amount of energy released by a material or product once exposed to fire. The European classification system also deals with the production of smoke and of burning droplets. The classification schemes are covered in more detail in Annex A.

The difference between fire resistance and reaction to fire can be demonstrated by the following examples.

- A timber fire door might be able to provide good fire resistance by preventing fire in one room reaching the room on the other side of the door, but have poor reaction to fire properties as its surface burns, spreading flame and releasing heat and smoke back into the room that is on fire.
- A sheet of aluminium might be able to provide good reaction to fire properties as it does not readily burn, but poor fire resistance as it softens and melts, therefore failing to provide a barrier to fire spread from one space to another, or any loadbearing capacity.

A number of relevant testing and research programmes have been conducted since the Grenfell Tower fire and have sought to provide an indication of the relative performance of different cladding systems. Unlike BS 8414 tests, which are aimed at testing a wall build-up representative of the external walls of a particular building, these testing and research programmes are inevitably more generic, but, nevertheless, are a valuable source of comparative data.

Among these is the series of large-scale fire tests using BS 8414 that were commissioned by Government under the Building Safety Programme and completed soon after the Grenfell Tower fire. These sought to compare the performance of the three different categories of ACM in combination with both stone wool and PIR foam; a seventh test, involving phenolic foam, was added to the original programme.

Details of the programme of tests and findings were summarized in the MHCLG 2020 Consolidated Advice Note [17], including a later test of a Class B rated HPL in conjunction with stone wool.

These tests provided useful indicators of performance, using the temperature readings taken from the tests and how these compared to the success criteria in BR 135 [15]. Early termination of the tests was also used as an indicator that the rate of fire spread was unduly high.

Strictly speaking, for the outcome of any of the seven tests to indicate directly whether walls on an existing building could be classified to BR 135 [15], the build-up would need to be an exact match, including identical materials from the same manufacturer, and, amongst other things, the same cavity depth, panel gap sizes and insulation thickness. Nevertheless, the comparative performance of the different materials and combinations is a useful indicator of the relative performance of similar wall construction.

Work since then [36] has used similar combinations of the three categories of ACM, again in combination with the same three forms of insulation, but looking instead at indicators of performance based around parameters such as temperature, heat release (peak heat release rate and total heat released), gas emissions and smoke production. The programme of tests used the protocol for intermediate-scale fire tests within ISO 13785-1.

This gave useful insight as to the different contributions to fire spread from the three categories of ACM, and also from the insulation material used, and how these compare.

In April 2020, BRE published research [27] based on an experimental programme investigating the comparative performance of different products used as facings in a cladding system, including:

- brick slip;
- reconstituted stone panels;
- aluminium honeycomb;
- zinc composite material (ZCM);
- copper composite material (CCM);
- various forms of HPL; and
- timber.

Category 1, Category 2 and Category 3 ACMs (see 3.1.1) were also used as reference sources for comparison of the results.

Heat release rates were measured and used to provide a comparative indication of contribution to fire growth. Heat flux was also measured and used as part of assessing cavity fire performance.

Annex N (informative)

Façade configuration risk factors

Table N.1 gives a non-exhaustive list of examples of common factors influencing the likely speed and extent of fire spread based on:

- the extent to which the building is covered by combustible cladding;
- the presence or otherwise of continuous cavities;
- the extent of openings in the external building envelope; and
- the location of the cladding.

No single row in Table N.1 gives a definitive answer on risk. Whether an entry is considered positive, negative or neutral is purely indicative of the potential influence it might have. Careful judgement is needed when using the table to determine the actual relevance of each factor and its significance in the context of the particular building under consideration. Where numeric values are given, these are only intended to be indicative as to the possible influence the particular factor might have in a risk-based assessment.

The relevance of the factors in Table N.1 can vary on different elevations or different parts of the same elevation. Consideration will need to be given as to how significant such variations are when assessing the fire risk on the building as a whole.

Where a risk factor is marked with an asterisk (*), this indicates that it is notably more of a positive influence.

Table N.1 – Façade configuration risk factors

Positive	Neutral	Negative
Where a risk factor is marked with an asterisk (*), this indicates that it is notably more of a positive influence.		
N.1 Building height		
<11 m	<18 m	18 m to 30 m* >30 m
<p>NOTE These are commonly used trigger heights, but it is important that these are considered, along with all other pertinent factors in the round. Indeed, in risk terms, there is a reducing gradation in risk for heights below 18 m.</p> <p>On buildings below 18 m in height, the extent of cladding is inherently limited by virtue of the number of storeys. For such buildings, traditionally, there have been no explicit restrictions on the combustibility of the external wall construction and, only in limited circumstances, any requirements relating to the reaction to fire classification of surfaces; it has still been necessary to provide cavity barrier protection, where applicable. It is therefore possible, and indeed likely, that rapid external fire spread would occur in buildings where elements of the external walls are combustible.</p> <p>It is reasonable to expect that an assessment of the fire risk posed by external walls of low-rise blocks of flats (buildings below 18 m in height) ought normally to place the building in the low-risk category. However, with current knowledge of the burning behaviour of certain materials and how the configuration of these on the building can promote rapid fire spread at a rate much greater than previously anticipated for low-rise buildings, it is possible that an external wall assessor might place the risk in the medium risk category, albeit still considering the risk tolerable. Where extremely rapid fire spread is likely (e.g. where Category 3 ACM is present or there is excessive use of timber or other combustible materials configured in such a way as to promote unusually rapid and extensive fire spread), this would suggest that fire spread would be at a rate far greater than previously considered acceptable for a low-rise building, with the conclusion that the risk is unacceptably high. Issues around deficiencies in the construction of the walls might also lead an external wall assessor to conclude that further and more in-depth technical assessment might be necessary to refine the risk. Concerns regarding effective intervention by the fire and rescue service might also lead to this conclusion; even in low rise buildings the difficulties of tackling a fire involving external wall construction when operating at ground level using typically available equipment need to be recognized (see Annex E).</p>		
N.2 Height of base of cladding above ground		
>5 m NOTE At this height, the likelihood of a fire originating externally (e.g. involving a parked vehicle or waste skip and started either accidentally or deliberately) igniting the cladding is highly unlikely.	2 m to 5 m NOTE At this height, the scope for a fire originating externally (e.g. involving a parked vehicle or waste skip started either accidentally or deliberately) igniting the cladding is considered possible, but not likely at an early stage in the development of the fire.	<2 m NOTE At this height, the likelihood of a fire originating externally (e.g. involving a parked vehicle or waste skip started either accidentally or deliberately) igniting the cladding is highly likely.

Table N.1 – Façade configuration risk factors *continued*

Positive	Neutral	Negative
N.3 Extent of cladding		
Limited in extent and not vertically aligned, such as to delay significantly fire spread to windows and other openings on upper levels	Limited in extent such as to delay fire spread over the external walls	Entire façade covered
<p>NOTE In the case of a high-rise building with only partial cladding, the limited extent of combustible cladding might not be materially different, in terms of external fire spread, from the same extent of cladding on a low-rise building. However, its location could lead to a situation that is very different in terms of overall risk because of the difficulty of fighting a fire involving the cladding at that height. This exemplifies the need for consideration of the potential for firefighting by the fire and rescue service. Also, in this situation, even when a high-rise building only has combustible cladding on a limited number of lower floors, a fire involving that cladding could impact on fire protection measures, such as smoke control systems, required to protect the upper floors (see also Annex F).</p>		
No scope for a cladding fire to breach compartment wall and floor boundaries	—	Scope for a cladding fire to breach compartment wall and floor boundaries significantly worsened by the nature and the extent of combustible material in the external wall construction
N.4 Cavities		
No cavity	—	—
Cavity not continuous, due to façade being only partially clad or broken by building features (Examples include: <ul style="list-style-type: none"> projecting floor slabs that divide part of the wall and isolate sections of cavity from each other; and walls that project out or are set back, such as to limit the vertical extent of cavities) Continuous vertically running cavity with cavity barriers or fire stops as appropriate	Cavity limited in vertical extent, e.g. ventilated rainscreen that spans more than one floor level but not all floor levels Cavity limited in extent and running horizontally only	Continuous vertically running cavity without cavity barriers or fire stops
Limited or no windows or openings in façade	Openings in façade limited to ventilation outlets	Windows and other openings in line with vertical cavity

Table N.1 – Façade configuration risk factors *continued*

Positive	Neutral	Negative
N.5 Infill/spandrel panels		
<p>Sufficiently remote from windows and not forming a continuous vertical section, such that fire and smoke spread into the building to give rise to secondary fires is unlikely and fire will only spread by cascading up panels*</p> <p>Continuous vertical sections but sufficiently remote from windows such that fire and smoke spread into the building, causing secondary fires, is unlikely</p> <p>Isolated areas of panels that do not cross compartment boundaries or cause a fire to cross a compartment boundary</p>	<p>Adjacent to, but not in a vertical continuous line with, windows</p>	<p>In a vertical continuous line with windows such as to increase the likelihood of secondary fires</p> <p>Where spanning a compartment boundary and in particular a compartment floor</p>
<p>NOTE 1 The above relates to panels that could, due to their combustible facing or content, contribute to fire spread. Non-combustible panels might serve to divide a façade and positively reduce the scope for fire spread where other parts of the walls are combustible. Spandrel and infill panels are terms often used interchangeably for panels within a window or curtain wall framing system. However, spandrel can denote a panel that, by virtue of being between the sill of a window and the head of a window below it, spans a floor of the building. Thus, where floors are compartment floors, the significance of such panels lies in the potential for fire spread to bypass the compartment floor.</p> <p>NOTE 2 The above is only indicative of some of the considerations relating to infill/spandrel panels. It does not address all potential situations where panels are present, such as in curtain wall systems also incorporating glazing.</p>		

Table N.1 – Façade configuration risk factors *continued*

Positive	Neutral	Negative
N.6 Setbacks		
<p>Combustible cladding is set back from the wall edge, such that direct flame impingement on the cladding from a fire on a lower level is highly unlikely (An example would be a penthouse flat constructed on the roof of an existing building)</p> <p><i>NOTE 1 This depends upon the distance from the wall edge, the nature of the construction of the external wall below the set back and the proximity of the openings in the wall from which fire can spread. Consideration might need to be given to the use of the terrace and nature of the construction of the terrace itself if it is considered that there is a high likelihood that fire could spread due to the combustibility of the terrace, e.g. where there is timber decking in conjunction with exposed polymeric roof insulation below. Management controls are outside the scope of this PAS and are considerations for the building's FRA.</i></p> <p><i>NOTE 2 Fire engineering analysis and calculation might be able to assist by estimating the length of flame projecting from a window below and the level of radiant heat on the cladding from these flames.</i></p>	<p>—</p>	<p>—</p>

Table N.1 – Façade configuration risk factors *continued*

Positive	Neutral	Negative
N.7 Overhangs and projections		
Projecting floor slabs that divide combustible cladding such as to divert flames away from the walls and protect the cladding above or slow the rate of fire spread	—	Where fire spread under an overhang can give rise to extended flame lengths over the soffit and up the external wall beyond NOTE This depends upon the size of the overhang and the distance for flames to spread before reaching the wall edge. It can occur whatever the construction of the overhang, but is exacerbated where this construction is combustible.
<p>NOTE 1 Overhangs, where a section of the façade projects forward from the section below, have the potential to divert flames horizontally under the soffit of the overhang and then for the flames to adhere to the vertical façade of the section above.</p> <p>NOTE 2 This does not refer to balconies as projections (see N.11).</p> <p>NOTE 3 The potential beneficial contribution of projections in terms of dividing cavities is referred to earlier in this table.</p>		
N.8 Proximity to windows and other openings to the accommodation		
Remote from windows and openings, such that fire and smoke spread into the building, causing secondary fires, is not possible (Typically, this occurs when a façade has no openings for windows and other unprotected openings; see N.9.)	Horizontally adjacent to windows and openings, but not vertically in line with such openings, such that fire and smoke spread into the buildings, causing secondary fires, as a result of direct flame impingement, is possible, but only under adverse wind conditions	Horizontally adjacent to windows and openings, and vertically in line with such openings, such that fire and smoke spread into the buildings, causing secondary fires, as a result of direct flame impingement, is highly likely
N.9 Presence of vents or other openings for services in the façade		
Where vents pass through a cavity, either: <ul style="list-style-type: none"> • they are either protected by cavity barriers (including ADB “deemed to satisfy” alternatives); or • the cavity is not a medium for fire spread between compartments (e.g. because it has adequate cavity barriers on compartment lines or does connect multiple compartments) 	Where vents pass through a cavity, either: <ul style="list-style-type: none"> • the cavity does not include combustible materials; or • the cavity is faced on either side by brick or concrete at least 75 mm thick and any combustible insulation in the cavity is not thermoplastic 	Any other circumstances where vents pass through a cavity

Table N.1 – Façade configuration risk factors *continued*

Positive	Neutral	Negative
N.10 Proximity of combustible elements of a façade to escape route windows and other openings		
<p>Remote from windows and openings, such that fire and smoke spread into the escape routes to give rise to untenable conditions is not possible*</p> <p>(Typically, when a façade has no openings onto escape routes)</p> <p>Remote from windows and openings, such that fire spread into the escape routes to give rise to untenable conditions is remote</p> <p>(Typically, when a façade has openings onto escape routes, but these are sufficiently separated by construction that would not support combustion)</p>	<p>Adjacent to windows and openings onto escape routes, but the same fire could not spread to affect more than one escape route</p> <p>(Typically, where there are two or more escape routes which can be used by occupants who all have access to multiple routes)</p>	<p>Adjacent to windows and openings, such that fire and smoke spread into the escape routes to give rise to untenable conditions is likely and there is only one escape for some or all occupants</p> <p>(This includes vents that are part of a smoke control system, where there is the potential from an external fire to prejudice the effectiveness of the smoke control system)</p> <p>Above doorways forming final exits from escape routes, such that burning material or debris from a fire involving the external walls above will pose a danger to escaping occupants</p> <p>NOTE <i>In this situation, burning material and debris from the fire above can also pose a danger to firefighters entering or leaving the building.</i></p>

Table N.1 – Façade configuration risk factors *continued*

Positive	Neutral	Negative
N.11 Attachments		
<p>[Covers:</p> <ul style="list-style-type: none"> • a balcony attached to an external wall; • a device for reducing heat gain within a building deflecting sunlight, which is attached to an external wall (brise soleil); • a solar panel attached to an external wall; • any other attachment which could present a fire risk] <p>NOTE A balcony approach to flats could potentially be considered an attachment if combustible, but other constraints regarding its construction and combustibility apply in the case of new buildings because of its use as an escape route. A combustible balcony used as a communal means of escape has the potential not only to impact on the fire behaviour of the external walls but also to lead to the means of escape being compromised in the event of fire.</p>		
<p>Non-combustible open balconies (Where these extend along a façade, they have the potential both to:</p> <ul style="list-style-type: none"> • interrupt a cavity; and • deflect flames away from the building and away from the façade) 	<p>Timber (or other combustible) balconies of limited extent Timber decking with steel plate or concrete below</p>	<p>Timber balconies of large extent Timber (or other combustible) balconies, with aggravating features (For example:</p> <ul style="list-style-type: none"> • without protection from the underside; and • adjacent to timber or other combustible wall panelling) <p>Combustible features such as brise soleil incorporating combustible material Photovoltaic (PV) installations, especially if incorporating combustible elements</p> <p>NOTE PV installations present an ignition hazard as well as a potential fire load.</p>
<p>NOTE 1 There is no current guidance relating to the risk posed by balconies with combustible elements and, in particular, timber decking. While it has always been possible for fire to spread vertically over the façade of a building by a fire igniting a balcony and spreading to the balcony above and then cascading up the building, the consequences of this have usually been limited. Some high-profile fires which resulted in fire spreading into a large number of flats above by this mechanism have led some to take a very conservative approach. In practice, the scale and extent of such fires varies, and depends upon various factors, including:</p> <ul style="list-style-type: none"> • the size of the balcony; • the extent to which more than the decking is combustible; • whether the balcony is in line with similar balconies above/below, giving the potential for a fire to cascade upwards from balcony to balcony or cause ignition to balconies below; • whether the balcony is staggered from others, reducing the potential for fire to cascade upwards or spread downwards; • whether combustible material in the balcony is exposed from below, or is simply a lining on top of a metal or concrete deck, or underdrawn with an essentially non-combustible material; and • whether the likelihood of ignition is minimized by virtue of the limitations on what the balcony can be used for, by virtue of its size, or by management controls that can be placed on residents by the owner of the building, e.g. a prohibition on using barbecues. Management controls are primarily considerations for the building's FRA, although recommendations relating to management controls could appear in the FRAEW report. <p>NOTE 2 Based on past experience of laminated glass in fires when used as part of balcony construction, replacement of laminated glass on balconies is not, at the present time, considered justified in relation to existing blocks of flats. Further consideration to balconies and laminated glass is given in Annex L.</p>		

Table N.1 – Façade configuration risk factors *continued*

Positive	Neutral	Negative
N.12 Proximity of combustible elements of a façade to a neighbouring building		
—	—	<p>Windows or other openings in adjacent or abutting neighbouring buildings that are sufficiently close that direct flame impingement from a fire in the neighbouring building is foreseeable</p> <p><i>NOTE The potential for sufficiently high levels of radiant heat flux from unprotected openings in a neighbouring building could also be a negative risk factor, although it is recognized that there will be difficulties in determining this, given the need for information relating to the neighbouring building.</i></p>

Annex O (informative)

Case studies with working examples illustrating the use of the methodology

O.1 General

The following case studies are fictitious and are solely intended to illustrate the application of the framework and rationale in Clause 13. They do not purport to provide, and are not to be relied upon as, generic solutions to the particular forms of external wall construction, which, by virtue of the principles within this PAS, can only be considered in the particular circumstances of the building under appraisal and by taking into account all relevant risk factors.

O.2 Case study 1: Six-storey building with Category 2 ACM cladding panels and polymeric foam insulation on penthouse flats

O.2.1 Background

An FRAEW of a mixed-use building with residential on the top floor consisting of two, single storey flats was requested in response to testing of the metal panels on the façades of the flats. This revealed that the panels comprised ACM, but with a combustion modified core. It was classified as a Category 2 ACM, based on the results of a BS EN ISO 1716 test of samples taken from the building, which revealed that the calorific potential of the ACM was 12.67 MJ/kg.

The flats were on the top level of the building with offices below, but were independent and separated from the offices by substantial fire-resisting construction. Both flats were set back from the walls of the offices, giving both a roof terrace and gardens. Although the flats had a dedicated and independent staircase for access and escape in the event of a fire, there was also a secondary means of escape available to the residents, through shared use of one of two staircases that served the offices and that could be accessed from a roof terrace on the top level.

A Type 1 FRA had been carried out for the part of the building in which the flats had been subject to an FRA, but, while this recognized the presence of metal cladding, it concluded that, irrespective of the type of panel, there was not undue risk to the residents of the flats, who were relevant persons under the Fire Safety Order [19].

Nevertheless, given a general concern regarding ACM, the owner commissioned an FRAEW to supplement the building's FRA.

O.2.2 External wall construction

Details of the manufacturer and the ACM product were stamped on the back of the panels removed for testing and it was a product referred to as an "FR" version within its range. The cladding formed side and head panels to large expanses of window glazing, which meant the panels were rarely wider than 1 m.

Some timber panelling was also present on the upright sections between windows, and timber decking was used on the roof terraces.

The external walls of the offices below comprised brick and, from the age of the building (1950s), it was expected that the walls would be of traditional construction.

There was no knowledge of how the ACM and timber were fixed (e.g. if on metal supports) and what the wall build-up comprised. However, the presence of Category 2 ACM was sufficient for it to be appropriate for the external walls of this building to be subject to an FRAEW in accordance with this PAS.

O.2.3 Findings from investigations

Given the lack of information on the wall-build and method of fixing, intrusive inspection was aimed at determining this and also establishing the nature of the horizontal separation between the two flats. However, only limited sampling was deemed necessary, especially as the points at which the flats adjoined each other were so limited.

The intrusive inspection and sampling confirmed that there was a cavity behind the ACM and timber, which contained polymeric foam insulation. The latter was determined, from markings and follow-up research, to be a form of PUR foam. There were gaps ranging from 15 mm to 20 mm where the flat panels abutted and where they were adjacent to the timber cladding. Further details of the wall build-up were established and, of note, full fill vertically aligned stone wool cavity barriers were present at the junction between the flats.

The external wall assessor was aware that the calorific potential and the thickness and, therefore, quantity of PUR insulation present, were significant negative risk factors. They were also aware that, while Category 2 ACMs, in certain wall build-ups and within specific constraints on cavity depth, cavity barrier location, etc., are known to perform satisfactorily when tested in large-scale fire tests, this was only in combination with a combustion modified polymeric foam insulation. Also, gap sizes have proved critical in these tests and here the relatively large gaps were another negative factor.

Overall, it was considered that the risk rating, based on consideration of the fire performance risk factors alone, remained at the high end of the “high” risk band.

O.2.4 Façade configuration risk factors

Despite consideration of the fire performance of the external walls and cladding placing the risk at the high end of the “high” risk band, the FRAEW noted significant positive risk factors relating to the façade configuration, including:

- the flats were only barely above 18 m and, in any case, were limited in extent to the height of one storey of the façades;
- as the flats were side by side, there was no scope for vertical fire spread from one flat to another;
- as the flats were located on the roof, there was little scope for fires starting externally to involve the ACM and timber on the façades – a roof terrace fire involving the timber decking ignited from, say, a barbecue, could not be totally discounted but was considered to be a remote possibility;
- fire spread from a window on the level immediately below the flats, with direct flame impingement onto the ACM, was not considered a realistic possibility, given that the flats were set back from the façades of the offices, with a parapet wall that would further serve to project flames vertically away from the flats; analysis of flame height and radiant heat transfer to the ACM and timber on the façades of the flats was evidently unnecessary, given the circumstances; and
- with the walls of the offices being of brick, there was also clearly no connecting cavity in the wall construction to allow fire spread to the flats.

These positive risk factors were deemed so significant that the risk rating could be moved into the “low” risk band.

O.2.5 Risk factors arising from fire strategy/fire hazards (and limitations of fire and rescue service intervention)

The change in the risk rating was further reinforced by the number and type of positive risk factors arising from consideration of the fire strategy/fire hazards. Of particular note were the following:

- both flats had access to two remote and independent staircases for escape, one the dedicated access stair to the flats and the other an office staircase with permitted entry, for emergency use, from the roof terrace; and
- it was inconceivable that a fire involving the external walls of the flats could prevent access to both of these routes of escape at the same time.

Access was possible for firefighting by the fire and rescue, in line with normal expectations for a building of this height and size. As such, it would be expected that most firefighting operations would be carried out internally.

O.2.6 Outcome of the analysis of the risk and possible remedial action

Based on the “low-risk” outcome above, it was concluded that, under the circumstances:

- rapid external fire spread might occur by the very nature of the materials and wall build-up, but any fire would be of extremely limited extent and would not spread quickly to the other flat; and
- the potential for secondary fires in a flat resulting from a fire involving the external walls of the other flat was very limited, and it was considered highly unlikely that occupants would be harmed from secondary fires before escaping or being prevented from escaping; and
- there appeared to be no scope for the communal means of escape to be compromised before occupants could safely use them to escape.

Accordingly, no remedial action was considered necessary.

O.2.7 What if? – how would the outcome be affected by differences in the wall build-up or risk factors

The outcome would be affected as follows.

a) What if the flats are not set back?

This would place more emphasis on the nature of the walls of the offices below, and how likely it was that flames might impinge on the ACM above or spread via any continuous cavities in the walls extending to the flats above.

Nevertheless, even if ignition was more likely to occur by these mechanisms, it was still considered that the limited extent of the ACM and other combustible components of the walls, along with the other positive façade configuration factors and other positive fire strategy/fire hazards, were of such significance as not to alter the overall rating of the risk as “low”.

- b) What if the flats are not side by side but on top of each other?

This gives rise to the possible risk of spread from a lower flat to the one above, but, at most, this would be considered to place the risk in the “medium” band.

Provided that cavity barrier protection was found to be effective, the fact that only two levels are involved would be likely to result in the risk being considered at the lower risk end of the “medium” risk band and, therefore, tolerable. However, again, given the significance of the positive risk factors arising from consideration of the fire strategy/fire hazards, it was still possible to view the overall rating of the risk as “low”.

- c) What if cavity barriers did not project through insulation in line with compartment walls?

As fire is unlikely to spread rapidly horizontally, and spread is likely to be restricted and delayed by the large windows, it is likely that it could still be viewed as tolerable, even if the assessor considered that the potential for fire spread was heightened and that the risk ought to be placed in the “medium” band.

O.3 Case study 2: Eight-storey block of flats with an aluminium rainscreen cladding system incorporating polymeric foam insulation

O.3.1 Background

An FRAEW of this eight-storey building, measuring some 21 m above ground (when taken to the height of the top storey) was identified as being necessary following initial desktop investigations into the materials used in the external wall construction. An FRA was due to be undertaken and the fire risk assessor, noting that this initial investigation had identified that the building had a rainscreen cavity wall build-up with combustible polymeric insulation behind the cladding panels, drew the owner's attention to the need for an FRAEW in order for the FRA to be definitive in its consideration of the fire risk posed by the external walls.

Built circa 2012, the block appeared typical in terms of its basic construction, with a reinforced concrete structure with SFS external walls. There were a number of cluster flats, each with up to six bedrooms, arranged around a lobby-protected single staircase, fitted with natural smoke ventilation using automatic opening vents (AOVs). It was occupied as student accommodation and was fitted with a communal fire detection and fire alarm system. The entrance to the block was on the ground floor, but was entirely separate to the rest of the ground floor, which comprised retail units.

The student accommodation provider fitted the fire detection and fire alarm system not only to operate the AOVs in the staircase lobbies, but also to extend into the cluster flats to provide local warning of fire in the flat. The system was programmed to permit an initial stay put strategy, but to escalate to full evacuation in certain circumstances. There was also a manual facility to extend the alarm throughout all flats.

O.3.2 External wall construction

The rainscreen cladding system extended from the first floor level, some 3.5 m above ground, up the full height of the building on all four elevations. It was, therefore, anticipated that there would be a cavity throughout the full height of the rainscreen cladding system.

Balconies were present, with timber decking. These were fixed as attachments to the outside of the building.

At ground level, there was a mixture of window glazing and brick faced walls. The rainscreen cladding system appeared to project forward from the ground floor walls, possibly with a concrete slab soffit, but this was not clear.

From the owner's own initial review of the as-built information, it was evident that no product details were available for the metal cladding panels or the polymeric foam insulation, the latter being referred to as “phenolic/PIR” on the available as-built drawings. As a result, the owner had already sent off samples from the metal cladding panels to be tested, which confirmed that the panels were 3 mm solid aluminium and not ACM.

The drawings indicated that the external walls were supported from a lightweight SFS, with unspecified insulation within the studs, but with a cement particle board sheathing on the external cavity face and plasterboard linings on the internal wall face.

Although the cladding panels were solid metal, the presence of polymeric foam insulation alone was sufficient for it to be appropriate for the external walls of this building to be subject to an FRAEW in accordance with this PAS.

O.3.3 Findings from investigations

Given the lack of specificity regarding the insulation, the veracity of the as-built drawings was questionable. Intrusive inspection was deemed necessary to be able to proceed further. This was needed to determine, in particular:

- whether the drawings were essentially accurate (notwithstanding the vague material information);
- the nature of the polymeric insulation;
- the presence or otherwise of cavity barriers at key locations, such as at floor levels and around window and other openings; and
- the nature of the junction between the brick walls and the rainscreen cladding system and whether the cavity was continuous.

Site investigations determined the following:

- the insulation bore manufacturer's markings clearly identifying it as phenolic foam, specifically formulated to enhance its behaviour in fire. It had been installed to a good standard and remained in good condition;
- the details and dimensions of the wall build-up, including the thickness of the sheathing board and insulation, cavity depth, etc., largely matched the as-built drawings;
- insulation within the SFS was also polymeric, but of unknown type, and was lined internally with two layers of 12.5 mm plasterboard;
- the sheathing board was suitably fixed with close fitting joints and in good condition;
- effective cavity barriers were in place, at locations where they would be expected, and suitably fixed and in good condition;
- the brick walls were 100 mm thick and had a full fill of mineral fibre insulation in the cavity; and
- there was no continuous cavity between the brick walls and the rainscreen cladding system; the soffit was concrete.

O.3.4 Fire performance risk factors

The following notable positive and neutral risk factors were established during the appraisal.

- The cladding panels comprised a low melting point metal and were mechanically fixed on a low melting point metal support system.
- The manufacturer of the panels published evidence of it achieving a Class A2 rating in relation to the European classification for reaction to fire.
- The panels were flat, and gaps that were present between panels were less than 10 mm.
- Product literature searches confirmed the insulation was a product marketed as suitable for use on buildings over 18 m in height, subject to it being part of a system tested in accordance with BS 8414 and classified to BR 135 [15]. Indeed, the manufacturer of the insulation published details of a combination of aluminium with its insulation product, which had been classified to BR 135 [15] for a similar build-up, although not an exact match.
- The facing of the insulation was fully protected by a foil covering, in line with the manufacturer's recommendations.
- Cavity barriers appeared to be present, fully in line with expectations for a block of flats of this age.
- Product literature searches confirmed the sheathing board to be a Class B board.

From the knowledge of the external wall assessor, it was noted in the FRAEW that, in BS 8414 tests of similar combinations of materials, the aluminium has, in time, melted and allowed direct flame impingement onto the insulation.

Cavity barriers often delay spread via the cavity, but, at the point of melting of the aluminium panels, flames can bypass the barriers to attack the insulation above. Gap size has often proved critical in such tests. Nevertheless, it has been possible successfully to classify such build-ups, given that the rate of fire spread and the temperatures reached met the criteria in BR 135 [15].

The above was sufficient for the risk rating, based on fire performance factors alone, to be placed in the "medium" band. Based on the sampling carried out, a high standard of workmanship was observed and the condition of supports, cavity barriers and other components was good. It therefore had the potential for it to be considered as falling in the low end of the "medium" risk band.

This meant that it might be possible for the fire risk posed by the external walls on this building to be deemed tolerable, despite the heightened risk of fire spread that follows from it being considered a “medium” risk rating. However, to fully conclude this, the FRAEW assessor considered that further and more detailed investigation into the quality of construction would be necessary, with particular emphasis on the nature and location of cavity barriers, a feature that was deemed to be particularly critical to the performance of this build-up.

O.3.5 Façade configuration risk factors

The appraisal clearly identified the scope for extensive fire spread by virtue of the building being over 18 m, fully clad from first floor level to the top floor, with a continuous cavity, and with all bedroom windows in line with the cladding. However, there were some notable positive and neutral risk factors, including:

- the cladding started at a height that reduced the scope for ignition by external fires;
- there was no scope for fire spread into the ground floor wall cavity to then spread, via that cavity, into the metal cladding system;
- ventilation systems in the flats did not include ductwork penetrating the cladding system; and
- balconies were limited in extent and residents were prohibited from storing rubbish and waste on the balconies or using barbecues.

It was also notable that the AOVs to the stair lobbies did not open directly onto the rainscreen cladding system, and those at the head of the stair were remote, being on the roof.

Overall, it was concluded that these façade configuration factors were not sufficient to alter the risk rating and it remained at “medium”.

O.3.6 Risk factors arising from fire strategy/fire hazards (and limitations of fire and rescue service intervention)

Although there was only a single staircase for escape, with natural ventilation using AOVs that were in line with the cladding, significant positive and neutral risk factors were identified as follows.

- Although the evacuation strategy was one of “stay put” whereby, initially, only the residents of the flat of fire origin need to escape immediately, there was a fire detection and fire alarm system that was programmed to escalate automatically to total evacuation under certain conditions, and manual control of the evacuation by 24 h on-site management was possible if deemed necessary as a result of a developing fire incident.

- AOVs to the stair lobbies did not open directly onto the rainscreen cladding system, and those at the head of the stair were remote, being on the roof, thus minimizing the scope for fire to spread directly into the means of escape.
- Access was possible for firefighting by the fire and rescue, in line with normal expectations for a building of this height and size. As such, it would be expected that most firefighting operations would be carried out internally.

Overall, these factors were sufficient to reposition the risk rating into the “low” band, without any further consideration of, or investigation into, the fire performance of the external wall construction and cladding.

O.3.7 Outcome of the analysis of the risk and possible remedial action

Based on the “low” risk outcome above, it was concluded that unduly rapid external fire spread was not anticipated, but, in any case:

- it was unlikely that occupants would be unduly harmed from secondary fires before escaping or prevented from escaping; and
- it was unlikely that the communal means of escape would be compromised before occupants could safely use them to escape.

Accordingly, no remedial action was considered necessary.

O.3.8 What if? – how would the outcome be affected by differences in the wall build-up or risk factors

The outcome would be affected as follows.

- a) What if the cladding panels were of a different material but essentially non-combustible, e.g. terracotta tiles and ceramic tiles?

Given that such materials would also not contribute to the heat released in a fire involving the external walls, and would also be expected to shield the insulation for a time and probably longer than a low melting point metal, it is likely that the fire performance of the walls would be improved, although some such panels can similarly fail relatively early in the fire, but by heat-induced fracture rather than melting. However, even where the performance is improved, this would not provide sufficient confidence to move the risk rating, based on fire performance factors alone (see O.3.4), to the “low” risk band.

- b) What if the insulation was different, e.g. a PIR or phenolic foam that was not specifically formulated to improve its behaviour in fire, was more readily ignited, had a greater calorific content and produced a higher heat release rate?

It is likely that, based on consideration of the fire performance risk factors, this would place the walls in the “high” risk band. Consideration of the façade configuration risk factors would not change this. However, the risk factors arising from consideration of the fire strategy/fire hazards are of such significance in this case that this might place the risk at the lower risk end of the “medium” band, suggesting that the heightened risk of fire spread was still tolerable and it might still not be necessary for any remedial action to be taken. A more in-depth technical assessment could be considered, but lack of data on the fire performance of the combination of materials would be likely to limit the value of this.

- c) What if there was no fire detection and fire alarm system present capable of initiating total evacuation of the building?

Based on the presence of specially formulated phenolic insulation, suitable provision of cavity barriers, etc., the external walls were considered to fall within “medium” risk band. Indeed, if the standard of workmanship and the condition of supports, cavity barriers and other components, which were observed to be good from the limited sampling undertaken, proved widespread, there might be a case for viewing the risk as the lower risk end of the “medium” band, and possibly deeming the risk as tolerable, even without the fire detection and fire alarm system.

Accordingly, given the criticality of the standard of workmanship, etc., further and more widespread intrusive inspection would be needed to establish that this was the case before this conclusion could be drawn. Hence, the risk might be concluded as falling in the higher risk end of the “medium” band.

If it was found not to be the case, and the standard of workmanship was found to be of concern over a substantial proportion of the building, the conclusion might be that the risk was higher and fell in the “high” risk band. As well as remediation of the cladding, a possible risk-proportionate action in this case might be to retrofit a suitable communal fire detection and fire alarm system capable of facilitating total evacuation of the block.

However, this is a measure that cannot be applied without a full understanding of whether it can be managed effectively and would be effective in eliciting the appropriate response from the

residents. These would be matters that would need to be highlighted so that they could be considered more broadly in the context of the building’s FRA.

Similarly, if the insulation were different, placing the walls in the “high” risk band to begin with, and there was no communal fire detection and fire alarm system present capable of facilitating total evacuation of the block, a risk-proportionate action in this case might be to retrofit a suitable communal fire detection and fire alarm system to enable simultaneous evacuation of the block.

However, again, it does not follow that such a measure would be appropriate, and there would need to be a full understanding of whether such an arrangement could be managed effectively and whether it would be effective in eliciting the appropriate response from the residents.

These would be matters that would need to be highlighted so that they could be considered more broadly in the context of the building’s FRA.

- d) What if the AOVs opened onto the cladding system?

AOVs opening onto combustible cladding systems present a risk that fire involving the cladding system (likely resulting from fire in the building) will lead to smoke being entrained into the common means of escape, thereby compromising the common means of escape. In this circumstance, consideration ought to be given to the replacement of cladding, which is sufficiently close to the AOVs that it might contribute to this effect.

O.4 Case study 3: Four-storey block of flats with a zinc cladding system incorporating polymeric foam insulation

O.4.1 Background

An FRAEW of this four-storey building, measuring some 10.5 m above ground (when taken to the height of the top storey), was recommended by the fire risk assessor for the building, who identified that there were unknown metal cladding panels on the top three floors.

Built in 2002, no information on the original build such as operation and maintenance manuals and as-built drawings were still in existence. However, the fire risk assessor had been able to identify that the block appeared typical in terms of its basic construction, with a steel frame and concrete floors and design based on a mixture of two- and three-bedroom flats, four on each floor with lobby access to a central stairwell, which was glazed on two opposing sides of the building.

There was natural smoke ventilation, using openable windows on both sides of the stairwell. These were under fire and rescue service manual control from electrical manual controls. As the building was under 11 m in height and had small lobbies, no ventilation of the lobbies to the stair was necessary. There were no issues with access for firefighting vehicles and access was possible for firefighters around the building.

The block was occupied as general needs accommodation and, accordingly, there was no communal fire detection and fire alarm system; each dwelling had its own local fire warning arrangement comprising smoke and heat alarms. The building was typical of blocks with a stay put strategy.

O.4.2 External wall construction

The cladding system extended from the first floor upwards on all four elevations. However, it was divided by the full height glazing of the stairwell, which effectively limited the extent of continuous cladding to half of the building on each side of the stairwell. Accordingly, if it were found to be a rainscreen system with a cavity, the cavity would not extend horizontally over the full extent of all elevations, even if it extended fully vertically up the building.

Balconies were present, with timber decking. These were fixed as attachments to the outside of the building.

At ground level, the walls were brick faced but these were in line with the metal cladding panels above.

The fire risk assessor had also recommended small-scale testing of the metal cladding panels to rule out ACM with a polyethylene core. That test confirmed it was not ACM and, in fact, comprised 3 mm zinc panels.

In the absence of any knowledge regarding the build-up of the walls, and given the cladding panels were zinc, it was possible that the only combustible material present might be timber battens used to fix and support the zinc panels. Were that to be the case, the nature and quantity of combustible material might be considered too small to warrant further appraisal, and, therefore, it would be concluded that an FRAEW within the scope of this PAS was not necessary. However, if combustible insulation or backing was found to be present, this would no longer be the case.

O.4.3 Findings from investigations

In view of the above, it was necessary to undertake at least a basic intrusive inspection to establish whether more extensive combustible material was present or the FRAEW could be terminated as the walls were outside of scope.

It was decided that, if combustible insulation, etc. were found, the investigation would be expanded with more sampling to determine, in particular, the presence or otherwise of cavity barriers at key locations.

Site investigations determined the following:

- the zinc panels were supported on timber battens within a rainscreen cavity system;
- there was insulation which bore manufacturer's markings clearly identifying it as a PIR foam;
- the insulation was fixed to a masonry wall comprising a double skin brick cavity wall, the brick skins each being 100 mm thick;
- cavity barriers were present behind the zinc, as expected, but the condition of a small proportion was poor, and some appeared to have moved or fallen away, being only held in place by compression, but possibly as a result of the opening up works to investigate the cladding; and
- there was a continuous cavity in the masonry wall up the entire height of the building.

O.4.4 Fire performance risk factors

A mix of both positive and negative risk factors was established during the appraisal, including that:

- the cladding panels comprised a low melting point metal and were mechanically fixed, although onto timber battens;
- gaps were present between panels, but were less than 10 mm;
- the PIR insulation was not of a type specifically formulated to improve its behaviour in fire; and
- the separation between the cladding system and the interior of the building comprised a masonry wall.

The fact that the combustible insulation was behind non-combustible panels would shield it from involvement in the fire initially, but, given the low melting point of the metal, the insulation and timber battens would become involved. The risk rating was placed in the "high" risk band, but at the lower end of the scale, as it was not considered to present the potential for extremely rapid fire spread.

O.4.5 Façade configuration risk factors

For a building of this height (less than 18 m), there have, traditionally, been no explicit restrictions on the combustibility of the external wall construction. It is inherently possible, therefore, that external fire spread would occur in buildings where elements of the external walls were combustible. This, ordinarily, might suggest that the risk could move to the “low” risk band.

As evaluation of the fire performance of the external wall construction and cladding concluded that there was not the potential for extremely rapid fire spread, this premise was still considered appropriate.

Indeed, the appraisal noted significant positive risk factors reinforcing this, including:

- the cladding started at a height that reduced the scope for ignition by external fires;
- the building was only 10.5 m high and the extent of cladding was notably less than could be present on a low-rise building, in relation to which there have traditionally been no restrictions on the combustibility of the cladding; and
- the extent to which fire could spread horizontally was also limited and fire could not involve more than half the building.

Balconies, although with timber decking, were very limited in extent, and, therefore, their presence was not a negative factor.

However, the poor condition of some cavity barriers was a negative factor and, in view of this, it was considered that fire might spread more extensively through the cavity in the wall build than would normally be anticipated. Nevertheless, it was clear that this was not a universal problem and further investigative work to quantify the extent of deficient barriers would disturb more and exacerbate the issue.

This was sufficient to conclude that the risk rating could not be placed in the “low” risk band, but, instead, would be more appropriate in the “medium” risk band, though at the lower end, still suggesting that, overall, the risk could be tolerable.

O.4.6 Risk factors arising from fire strategy/fire hazards (and limitations of fire and rescue service intervention)

Although there was only a single staircase for escape, there were no negative risk factors relating to the fire safety design of the building. Access was possible for firefighting vehicles, in line with normal expectations for a building of this height and size, and there was no undue exposure to external fires.

While not considered sufficient to reposition the risk rating into the “low” band, this nonetheless reinforced the view that the risk ought to fall at the lower end of the “medium” risk band and, therefore, the residual risk resulting principally from the concerns regarding cavity barriers could be tolerated without any need for remedial action.

O.4.7 Outcome of the analysis of the risk and possible remedial action

Based on the “medium” risk outcome above, it was concluded that, under the circumstances:

- unduly rapid external fire spread was not anticipated, although the condition of some of the cavity barriers meant it might be more rapid than if full and effective cavity barrier protection were in place;
- it was unlikely that occupants would be unduly harmed from secondary fires before escaping or being prevented from escaping;
- it was unlikely that the communal means of escape would be compromised before occupants could safely use them to escape; and
- the residual risk remaining from the deficiencies in the cavity barrier installation, although not ideal, was tolerable, especially given the extensive works that would be necessary to rectify such deficiencies.

Accordingly, no remedial action was considered necessary.

O.4.8 What if? – how would the outcome be affected by differences in the wall build-up or risk factors

The outcome would be affected as follows.

- a) What if there were no cavity barriers in the cavity behind the zinc?

This change would result in the risk being considered significantly higher, such as to place it at least at the high end of the “medium” risk band and suggest that rapid fire spread would occur. It would no longer be tolerable, but the extent to which full cavity barrier protection might need to be introduced would need to be considered carefully, so as to avoid unduly intrusive works to mitigate the risk. It might be acceptable to conduct more limited works to reduce the rate of fire spread, subject to the specific form of external wall construction.

- b) What if the insulation was fixed to a sheathing board fixed to an SFS wall?

This change would be unlikely to result in the risk being considered significantly higher to place it at the high end of the “high” risk band and suggest that extremely rapid fire spread would occur.

Accordingly, the overall view on the risk rating would remain that it fell in the lower end of the “medium” risk band and was tolerable.

- c) What if the rainscreen was of a Category 3 ACM or ZCM?

The use of an ACM or ZCM with an unmodified polyethylene core might have been seen as compliant with the building regulations at the time of construction, as no explicit restrictions on the combustibility of the external wall construction would have applied. However, such materials can lead to extremely rapid external fire spread and therefore present a significant hazard.

This is a case where the original design principles that permitted use of Category 3 ACM/ZCM are now seen as far removed from those acceptable today in terms of the standards on combustibility and propensity for fire spread of external walls. Accordingly, it would be expected that the FRAEW would conclude the cladding in this case would need to be replaced.

O.5 Case study 4: Seven-storey block of flats with high pressure laminate (HPL) panels and polymeric foam insulation

O.5.1 Background

An FRAEW of this seven-storey building, measuring some 19 m above ground, was required by the landlord of the block, as it was apparent to them that there was a combustible form of facing to the cladding. It was built in 2016 and as-built drawings were available, from which it was determined quickly by the landlord that the facings were of HPL panels.

It was a building with 20 flats, occupied as general needs accommodation and, accordingly, there was no communal fire detection and fire alarm system; each dwelling had its own local fire warning arrangement comprising smoke and heat alarms. The building was typical of blocks with a stay put strategy.

The means of escape was typical for a block of flats of this size and vintage, and included suitable smoke control to protect the single staircase route.

O.5.2 External wall construction

The extent of the HPL cladding panels was notable in that all areas of the building were covered, with no breaks in the façade on any of the elevations. All windows opened onto the cladding, including the windows of the staircase.

The knowledge regarding the build-up of the walls appeared to be very good, given the block was only four years old. As-built record information suggested lightweight SFS walls spanned the concrete floors, onto which there was an external wall build-up comprising a 9 mm Class B cement particle board sheathing, a layer of 80 mm of phenolic foam insulation of a type specifically formulated to enhance its behaviour in fire, a 50 mm cavity and facings of 9 mm Class B HPL panels, referred to as a so-called “FR grade” panel. The details of the metal support structure and bracketry suggested that it was robustly supported and suitably mechanically fixed.

The external wall assessor was aware that combinations of HPL and combustible insulation are considered as potentially presenting a similar risk to unsafe systems using Category 3 ACM. On this basis, without further consideration, they informed the client that it would be highly likely that the outcome of the basic level of assessment they had been commissioned to undertake would be to give the walls a “high” risk rating.

This was also based on the other knowledge they had so far that the façade configuration, with its extensive coverage of the cladding system and all windows overlooking the cladding, offered little scope to reduce the risk, nor did consideration of the risk factors arising from the fire strategy/fire hazards. Indeed, the potential for an external fire to readily impinge on the lower levels of the cladding was a significant negative factor in this regard.

However, the external wall assessor was aware of BS 8414 test evidence of a very similar combination of Class B HPL panels and the particular type of foam used. Although, in that particular case, it did not fully meet the acceptance criteria in BR 135 [15] for it to be classified, the test revealed that temperatures exceeded 600 °C by only 50 °C, with no flaming above the top of the rig.

Accordingly, the client was advised that an in-depth technical assessment using fire engineering principles might be able to be more definitive on the fire performance of the wall build-ups on the building and the fire risk this posed.

As the external wall assessor did not have the necessary competence to conduct such an in-depth assessment, they intended to end the FRAEW at that point to allow the client to appoint a suitably competent chartered engineer. However, the client requested that they complete the information gathering stage and carry out the site survey and inspection, as planned, to be able to present the fire engineer conducting the in-depth assessment with all necessary information.

0.5.3 Findings from investigations

Given the apparent quality of, and detail in, the as-built information, only limited sampling was considered necessary. This focused primarily on confirming the make and manufacturer of the materials and products used and verifying the wall build-up. It was considered that, with only two sampling points, the opening up would facilitate this and also allow a brief check of cavity barrier provision.

However, site investigations revealed that product substitution had taken place and that, in a number of aspects, the walls were very different to those anticipated, including:

- the HPL panels were from a different manufacturer and, from labelling, it was possible to ascertain that this was a Class D product in the manufacturer's "standard grade" range;
- the insulation was 100 mm PUR foam;
- the cavity was narrower; and
- the HPL panels were supported on a timber structure and not on metal brackets.

The only positive finding was that suitable cavity barriers were in place in the cladding system.

0.5.4 Outcome of the analysis of the risk and possible remedial action

On this basis, the external wall assessor was of the opinion that the actual build-up was so far removed from any form that they knew had been tested that further in-depth technical assessment was unlikely to be capable of refining the risk; the overall conclusion that the walls fell within the "high" risk band was reinforced.

Accordingly, the FRAEW was curtailed and the client advised of the conclusion that, under the circumstances:

- unduly rapid external fire spread was highly likely, even despite the full and effective cavity barrier protection in place;
- it was possible that occupants would be exposed to significant harm from secondary fires before escaping, or be prevented from escaping, given the speed with which fire and smoke could spread;
- it was also possible that the communal means of escape would be compromised before occupants could safely use them to escape, because of the ease and speed with which rapid fire spread could impinge on staircase windows; and
- the rate of fire spread could readily be such as to limit the scope for the fire and rescue service to intervene effectively.

Accordingly, remedial action was considered necessary to address the risk, and removal and replacement of the cladding system, in its entirety, was the most appropriate means to achieve this. The external wall assessor advised the client to notify the local fire and rescue service of the risk.

0.6 Case study 5: 15-storey block of flats with ETICS comprising rendered EPS

0.6.1 Background

An FRAEW of this 40-year-old, 15-storey building, measuring some 42 m above ground level, was required because concern had been raised by the local fire and rescue authority that the building had numerous forms of cladding, including some metal cladding panels, on the two top floors comprising penthouse flats. This was a large building with over 100 flats and its fire safety design was typical for a block of this vintage, with a single staircase, and smoke control in the form of manually ventilated lobbies to the stair. As expected, it operated with a stay put evacuation strategy, limiting the need for only those at immediate risk to evacuate initially.

The social housing provider of these rented general needs flats had already undertaken a review of the as-built drawings and operation and maintenance manuals from the time the building was overclad and the penthouse flats added in 2012. They had, as a result, satisfied themselves that the materials and systems used to improve the energy efficiency of the building were not detrimental to fire safety.

They had concluded that a rendered insulation system (ETICS) had been used, which was mineral wool-based and, therefore, not combustible. The metal on the top two storeys was understood to be in the form of an insulated core sandwich panel with a polymeric core, but these were of a type that were fire rated.

Although the fire and rescue authority had requested an up-to-date FRA addressing the risk posed by the external wall construction, the client's fire risk assessor recognized that the level of detail being requested was beyond their competence. Accordingly, they recommended to the client that an FRAEW be completed, ahead of any revision to the building's previous FRA.

O.6.2 External wall construction

The rendered insulation extended from ground level vertically all the way up the building, stopping only at the penthouse levels. It had been applied to the original concrete external walls of the building.

It was only broken in vertical alignment by concrete balconies, but, nevertheless, were it to be combustible, fire could spread to involve all levels and every flat window.

The two penthouse levels were set back 500 mm from the concrete walls of the floor below, having been built on top of the original concrete roof. The metal panels were ribbed and had the appearance of a composite insulated panel of some form, but without further investigation it was not possible to confirm the manufacturer of the panel and its particular fire properties.

Although it was believed that the rendered insulation was essentially non-combustible and consequently not of concern, the presence of insulated core sandwich panels with polymeric foam insulation alone was sufficient for it to be appropriate for the external walls of this building to be subject to an FRAEW in accordance with this PAS.

O.6.3 Findings from investigations

Intrusive inspection was deemed necessary at a basic level to remove a metal panel on a penthouse level to determine if product markings could be found that would identify the manufacturer and particular panel type. A single panel was to be removed from a location that would also enable sampling to confirm the presence or otherwise of cavity barriers at the floor junction between the upper and lower level of flats.

It was also considered prudent to confirm that the understanding as to the type of insulation of the ETICS was correct and that it was an essentially non-combustible mineral wool. It was recognized that the exact composition of the render might not be readily apparent, given the complexity of the build-ups of some finishes on ETICS, but it would certainly be evident if it were cement-based, and confirmation of the presence of mineral wool would add weight to the veracity of the as-built information.

Site investigations enabled the manufacturer of the composite panels to be identified and sufficient labelling allowed determination of the particular panel from the manufacturer's range. It was determined that it was a fully encapsulated steel faced composite panel, with 50 mm of PUR foam insulation.

Review of documentary evidence from various sources, including the manufacturer's website, available certification based on the product's performance data and listing by the LPCB, confirmed that this product had been subject to large-scale fire testing and that it met the criteria within LPS 1181, Part 1 [33] and LPS 1208 [34], and was classified Grade EXT-A. It was also evident, from the location where a panel was removed, that suitable cavity barriers were in place and in good condition.

However, unexpectedly, the single sample of the ETICS revealed it was not a rendered mineral wool insulation system, but an acrylic rendered EPS system. Three manufacturers of ETICS systems were contacted, and one confirmed that they had provided the product and forwarded details of the system. This was so significant a finding that it led the external wall assessor to request to carry out more extensive sampling and to vary the locations for samples so that they were taken at various heights and on all sides of the building.

Sample points were also aligned with locations where cavity barriers would be expected in an EPS ETICS. This confirmed that the acrylic rendered EPS ETICS had been used to cover the entire building. Because of this, the external wall assessor considered that there might be the need for a more in-depth technical assessment of the cladding system.

O.6.4 Fire performance risk factors

Given the consequences of delamination of the facings of an insulated composite panel, with a polymeric core, it was a particularly positive risk factor that there was evidence of large-scale fire testing of the panels and that the panels had the Grade EXT-A rating. Although not equivalent to a BS 8414 test and classification to BR 135 [15], this, in combination with adequate cavity barrier protection, was seen as sufficient to position the penthouse flats in the “low” risk band.

However, in relation to the remainder of the building, the discovery of an EPS-based ETICS was of significant concern and, given the technical data sheets from the manufacturer, it was not one that had been classified to BR 135 [15]. This was reinforced by the absence of cavity barriers at locations normally provided with fire barrier protection on ETICS that have been tested to BS 8414 and successfully classified to BR 135 [15].

Overall, the above was sufficient for the risk rating to be considered in the “high” risk band, with a significant potential for rapid fire spread. The potential need for a more in-depth technical assessment of the cladding system by a fire engineer with specialist knowledge was one possible outcome from this.

O.6.5 Façade configuration risk factors

The limited extent of the metal insulated core panels, given that they were only on the two penthouse levels, albeit that these were the top two floors and, therefore, over 30 m above ground, was seen as a significant positive risk factor and further reinforced the view that the metal insulated core panels of the penthouse flats were correctly in the “low” risk band.

However, given how extensive the rendered insulation was, there were no façade risk factors that were able to mitigate the risk and move the risk rating of the building away from the “high” risk band.

O.6.6 Risk factors arising from fire strategy/fire hazards (and limitations of fire and rescue service intervention)

Although there was only a single staircase for escape, there were no negative risk factors relating to the fire safety design of the building. There was some exposure to external fires if deliberately set, but not from accidental fires involving, for example, vehicles or waste skips. Access and facilities for firefighting were in line with normal expectation for a building of its age and height. As such, it would be expected most firefighting operations would be carried out internally.

Because the extent of the metal insulated core panels was limited to the top two storeys, the safety of occupants did not rely on the fire and rescue service controlling fire spread over the external walls of the building.

Equally, there were no positive risk factors that might offset the “high” risk rating from the rendered EPS system to any significant degree. It would not be expected, in a general needs block of this nature, that there would be a communal fire detection and fire alarm system. The block predated any requirement for sprinkler protection, although the penthouse flats were fitted with domestic sprinkler installations. While this further reinforced the positioning of the walls to the penthouses in the “low” risk band, it was of no significance to the risk posed by the rendered EPS system to the remainder of the building.

Given the extent of the façades with the rendered EPS system, it would be impractical for the fire and rescue to control fire spread over the external walls by external firefighting, and the limitations of what could be achieved in terms of fire and rescue service intervention were significant considerations.

O.6.7 Outcome of the analysis of the risk and possible remedial action

No action was deemed necessary in relation to the cladding on the penthouse flats, which was the main concern of the fire and rescue service in highlighting the need for the external wall construction to be addressed in the building’s FRA. However, based on the “high” risk outcome for the rendered EPS system, it was concluded that, under the circumstances:

- unduly rapid external fire spread was anticipated;
- secondary fires on numerous upper levels could occur in a relatively rapid period and it was possible that occupants could be harmed from these fires before escaping; and
- it was possible that the communal means of escape could be compromised before occupants could all safely use them to escape.

Accordingly, remedial action was considered likely to address the risk, and removal and replacement of the rendered EPS system was the most appropriate means to achieve this. However, the FRAEW drew attention to the possible benefit of further in-depth technical assessment of the ETICS by a fire engineer with specialist knowledge in that form of cladding system. The external wall assessor also advised the client to notify the local fire and rescue service of the risk.

O.6.8 What if? – how would the outcome be affected by differences in the wall build-up or risk factors

The outcome would be affected as follows.

a) What if there were two staircases?

This would reduce the likelihood that the communal means of escape could be compromised before occupants could all safely use them to escape, but, overall, it was not considered sufficient to change the risk rating from “high”.

b) What if a fire detection and fire alarm system were to be fitted?

While not reducing the likelihood that secondary fires will occur on numerous upper levels, it would reduce the potential for occupants to be harmed from these fires before escaping. It would also reduce the potential for external fire spread to compromise the communal means of escape before occupants could all safely use them to escape. While this would, at least theoretically, reduce the risk level, there was a practical issue to consider.

Given the rapid fire spread expected, early detection of any fire spreading back into the building would necessitate fire detectors in every room with a window onto the cladding. In other words, there would need to be a fully comprehensive system extending throughout the flats. The practicality of managing and maintaining such a system would need to be considered by the client and the fire risk assessor. This, and doubts over the effectiveness of a simultaneous evacuation in such a large block of general needs flats, would bring into question whether it is a realistic alternative to replacing the rendered EPS system.

c) Would fitting sprinklers be a more effective alternative?

Sprinklers within the flats would significantly reduce the likelihood of a flashover fire giving rise to window breakage and direct flame impingement on the rendered EPS. There would also be scope to monitor the operation of the sprinklers through flow switches and link the system to an alarm receiving centre to facilitate prompt attendance by the fire and rescue service.

However, in the event that the rendered EPS were to be involved, prompt evacuation of all occupants of the block might become necessary. Concerns that this would place over-reliance on the fire and rescue service would need to be recognized. Facilities to assist with evacuation, e.g. an evacuation alert system conforming to BS 8629, might be seen as beneficial in this regard, but an evacuation alert system would only be of assistance if used as part of the overall package of measures in conjunction with sprinklers and remote monitoring of alarm by an alarm receiving centre. Evacuation alert systems alone are not intended to be installed as a risk mitigation measure.

It would be likely that, before agreeing that such a solution could mitigate the risk sufficiently, the external wall assessor would need to be satisfied that the rendered EPS was not likely to give rise to the extremely rapid degree of fire spread equivalent to that of ACM with an unmodified polyethylene core. This would require further in-depth technical assessment of the ETICS by a fire engineer with specialist knowledge in that form of cladding system.

Annex P (informative)

Some history of standards, codes of practice and guidance relevant to external wall construction

This annex sets out some of the history of the relevant legislation (predominantly in England) and, where relevant, guidance on the construction of external walls, beginning with the Model Byelaws of 1953 [37] (used as the basis for byelaws throughout the UK, though local byelaws will supersede these). In relation to London, the London Building Acts 1930–1939 [38] and London Building (Constructional) Bye-laws [39] issued under these made various provisions similar to the Model Byelaws [37] but ultimately afforded the District Surveyor control over what was acceptable in terms of the cladding system, but not the entirety of the external wall construction.

Table P.1 to Table P.9 have been arranged to group together the provisions that would have applied under any particular set of regulations. The tables cover:

- Table P.1: Model Byelaws 1953 [37];
- Table P.2: Building Regulations 1965 [1];
- Table P.3: Building Regulations 1972 [2];
- Table P.4: Building Regulations 1976 [3];
- Table P.5: Building Regulations 1985 [4] and Approved Document B 1985 [14];
- Table P.6: Building Regulations 1991 [5] and Approved Document B 1992 [13];
- Table P.7: Building Regulations 2000 [6] and Approved Document B 2000 [12];
- Table P.8: Building Regulations 2000 [6] and Approved Document B Volume 2 2006 ([10], [11]); and
- Table P.9: Building Regulations 2010 [7] and Approved Document B Volume 1 2019 ([8], [9]).

Text within the tables that is a direct quotation from the relevant regulations or relevant edition of ADB is indicated in italic.

This annex and the tables within it are neither exhaustive nor definitive; they are provided to assist external wall assessors by indicating the provisions that might have applied to the original construction or subsequent refurbishment of any external wall systems being assessed, as well as how such provisions evolved over time.

NOTE While Table P.8 has been prepared using the text in the 2006 edition of Approved Document B Volume 2, it would be near identical for the 2007, 2010 and 2013 amendments, the only change being that the reference to BS EN 13501-1 was updated from its 2002 edition to its 2007 edition in the 2010 amendment to ADB.

Anyone seeking to rely upon the contents of this annex is advised to consult the original legislation or guidance, particularly as each was provided with transitional provisions, setting out particular circumstances and dates relating to building work that might or might not lead to the legislation or guidance actually being in effect.

Table P.1 – Model Byelaws 1953

Parameter	Provision
Critical height for additional provisions	Two or more storeys
Surface and/or cladding provisions above critical height	Non-combustible throughout
Underlying construction provisions	Non-combustible throughout
Baseline fire resistance requirements (absent any space separation or loadbearing requirements)	2 h fire resistance
Non-combustible definition	<i>“ non-combustible material ” means material which satisfies the test for noncombustibility prescribed in British Standard 476 : 1953 Fire Tests on Building Materials and Structures</i>
Limited combustibility definition	N/A
Class 0 definition	N/A
Co-existence of UK and European standards?	No – UK standards only
Large-scale test as alternative to small-scale?	No

Table P.2 – Building Regulations 1965

Parameter	Provision
Critical height for additional provisions	50 feet (15.24 m)
Surface and/or cladding provisions above critical height	Cladding to be non-combustible, regardless of height, if situated within 3 feet of the relevant boundary Cladding to be Class O where above 50 feet, except any part below 50 feet which may be timber not less than $\frac{3}{8}$ inch (9.5 mm) finished thickness
Underlying construction provisions	Non-combustible save for internal linings and external cladding (other provisions affect these)
Baseline fire resistance requirements (absent any space separation or loadbearing requirements)	30 min (expressed as $\frac{1}{2}$ hour) fire resistance
Non-combustible definition	Indirectly defined: <i>“combustible” means capable of being classified as combustible if subjected to the test for combustibility prescribed in BS 476 : Part I : 1953 ; and “non-combustible” shall be construed accordingly</i>
Limited combustibility definition	N/A
Class 0 definition (Note: Class 0 was, at this time, Class O; with a letter not a number)	<i>where the surface is required to be of Class O, the material shall–</i> <i>(i) be non-combustible throughout ; or</i> <i>(ii) comprise a base or background which is non-combustible with the addition of a surface not exceeding $\frac{1}{32}$ inch thick so that the spread of flame rating of the combined product is not lower than Class I in clause 7 of BS 476 : Part I : 1953 ; or</i> <i>(iii) comprise a base or background which is combustible but with any exposed face finished with a layer not less than $\frac{1}{8}$ inch thick of non-combustible material and with the other face not exposed to air</i>
Co-existence of UK and European standards?	No – UK standards only
Large-scale test as alternative to small-scale?	No

Table P.3 – Building Regulations 1972

Parameter	Provision
Critical height for additional provisions	15 m
Surface and/or cladding provisions above critical height	Cladding to be Class O, regardless of height, if situated within 1 m of relevant boundary Cladding to be Class O where building exceeds 15 m height, except any part below 15 m which may be timber not less than 9 mm finished thickness or having an Index not exceeding 20 when tested to BS 476-6
Underlying construction provisions	Non-combustible save for internal linings and external cladding (other provisions affect these)
Baseline fire resistance requirements (absent any space separation or loadbearing requirements)	30 min (expressed as 1/2 hour) fire resistance
Non-combustible definition	<i>“non-combustible” means capable of being classified as non-combustible if subjected to the test for non-combustibility prescribed in BS 476: Part 4: 1970; and “combustible” shall be construed accordingly</i>
Limited combustibility definition	N/A
Class 0 definition (Note: Class 0 was, at this time, Class O; with a letter not a number)	<i>any reference to a surface being of Class O shall be construed as a requirement that–</i> <i>(i) the material of which the wall or ceiling is constructed shall be non-combustible throughout, or</i> <i>(ii) the surface material (or, if it is bonded to throughout to a substrate, the surface material in conjunction with the substrate) shall, when tested in accordance with BS 476: Part 6: 1968, have an index of performance (I) not exceeding 12 and a sub-index (i₁) not exceeding 6:</i> <i>Provided that the face of a plastics material having a softening point less than 120°C when tested by method 102C of BS 2782: 1970 shall only be regarded as Class O if–</i> <i>(i) the material is bonded throughout to a substrate which is not a plastics material and the material in conjunction with the substrate satisfies the test criteria prescribed [above (Index I not exceeding 12 and sub-index i₁ not exceeding 6)]; or</i> <i>(ii) the material satisfies the test criteria prescribed [above (Index I not exceeding 12 and sub-index i₁ not exceeding 6)] and is used as a lining of a wall so constructed that any surface which would be exposed if the lining were not present satisfies the said test criteria and is the face of a material other than a plastics material having a softening point less than 120°C</i>
Co-existence of UK and European standards?	No – UK standards only
Large-scale test as alternative to small-scale?	No

Table P.4 – Building Regulations 1976

Parameter	Provision
Critical height for additional provisions	15 m
Surface and/or cladding provisions above critical height	Cladding to be Class O, regardless of height, if situated within 1 m of relevant boundary Cladding to be Class O where building exceeds 15 m height, except any Part Below 15 m which may be timber not less than 9 mm finished thickness or having an Index not exceeding 20 when tested to BS 476-6
Underlying construction provisions	Non-combustible save for internal linings and external cladding (other provisions affect these)
Baseline fire resistance requirements (absent any space separation or loadbearing requirements)	None
Non-combustible definition	<i>NON-COMBUSTIBLE means capable of being classified as non-combustible if subjected to the test for non-combustibility prescribed in BS 476: Part 4: 1970; and COMBUSTIBLE shall be construed accordingly</i>
Limited combustibility definition	N/A
Class 0 definition (Note: Class 0 was, at this time, Class O; with a letter not a number)	<i>any reference to a surface being of Class 0 shall be construed as a requirement that–</i> <i>(i) the material of which the wall or ceiling is constructed shall be non-combustible throughout; or</i> <i>(ii) the surface material (or, if it is bonded to throughout to a substrate, the surface material in conjunction with the substrate) shall have a surface of Class 1 and, if tested in accordance with BS 476: Part 6: 1968, have an index of performance (I) not exceeding 12 and a sub-index (i_s) not exceeding 6:</i> <i>Provided that the face of any plastics material Type 1 shall not be regarded as a surface of Class 0 unless:</i> <i>(a) The material is bonded throughout to a substrate which is not a plastics material and the material in conjunction with the substrate satisfies the test criteria prescribed [above]; or</i> <i>(b) The material satisfies the test criteria prescribed [above] and is used as a lining of a wall so constructed that any surface which would be exposed if the lining were not present satisfies the said test criteria and is the face of a material other than a plastics material Type 1</i>
Co-existence of UK and European standards?	No – UK standards only
Large-scale test as alternative to small-scale?	No

Table P.5 – Building Regulations 1985 and Approved Document B 1985

Parameter	Provision
Critical height for additional provisions	15 m
Surface and/or cladding provisions above critical height	Cladding to be Class 0, regardless of height, if situated within 1 m of relevant boundary Cladding to be Class 0 where building exceeds 15 m height, except any part below 15 m which may be timber not less than 9 mm thick or having an Index not exceeding 20 when tested to BS 476-6
Underlying construction provisions	Limited combustibility if the building is more than 15 m tall, or is more than three storeys (excluding basements) and within 1 m of the relevant boundary
Baseline fire resistance requirements (absent any space separation or loadbearing requirements)	None
Non-combustible definition	<p>(a) Any material which when tested to BS 476: Part II, does not flame and there is no rise in temperature on either the centre (specimen) or furnace thermocouples.</p> <p>(b) Totally inorganic materials such as concrete, fired clay, ceramics, metals, plaster and masonry containing not more than 1 per cent by weight or volume of organic material. (Use in buildings of combustible metals such as magnesium/aluminium alloys should be assessed in each individual case).</p> <p>(c) Concrete bricks or blocks meeting BS 6073: Part I: 1981.</p> <p>(d) Products classified as non-combustible under BS 476: Part 4:1970.</p>
Limited combustibility definition	<p>(a) Any non-combustible material listed [above].</p> <p>(b) Any material of density 300 kg/m³ or more, which when tested to BS 476: Part II, does not flame and the rise in temperature on the furnace thermocouple is not more than 20°C</p> <p>(c) Any material with a non-combustible core of 8 mm thick or more, having combustible facings (on one or both sides) not more than 0.5 mm thick. (Where a flame spread rating is specified, these materials must also meet the appropriate test requirements.)</p> <p>(d) Any material of density less than 300 kg/m³, which when tested to BS 476: Part II, does not flame for more than 10 seconds and the rise in temperature on the centre (specimen) thermocouple is not more than 35°C and the furnace thermocouple is not more than 25°C</p>
Class 0 definition	A Class 0 materials or the surface of a composite product is either: (a) composed throughout of materials of limited combustibility, or (b) a Class 1 material which has a fire propagation index (I) of not more than 12, and (i1) no more than 6.
Co-existence of UK and European standards?	No – UK standards only
Large-scale test as alternative to small-scale?	No

Table P.6 – Building Regulations 1991 and Approved Document B 1992

Parameter	Provision
Critical height for additional provisions	15 / 20 m
Surface and/or cladding provisions above critical height	Cladding to be Class 0, regardless of height, if situated within 1 m of relevant boundary Cladding to be Class 0 where building exceeds 20 m height, except any part below 20 m which may be timber not less than 9 mm finished thickness or having an Index not exceeding 20 when tested to BS 476-6
Underlying construction provisions	Original text <i>In a building with a storey at more than 15 m above ground level, insulation material used in the external wall construction should be of limited combustibility (See Appendix A). This restriction does not apply to masonry cavity wall construction which complies with Diagram 28 in Section 9.</i> From second impression with amendments onwards <i>In a building with a storey at more than 20 m above ground level, insulation material used in the external wall construction should be of limited combustibility (See Appendix A). This restriction does not apply to masonry cavity wall construction which complies with Diagram 28 in Section 9.</i>
Baseline fire resistance requirements (absent any space separation or loadbearing requirements)	None
Non-combustible definition	<ul style="list-style-type: none"> a. Any material which when tested to BS 476: Part 11, does not flame and there is no rise in temperature on either the centre (specimen) or furnace thermocouples. b. Totally inorganic materials such as concrete, fired clay, ceramics, metals, plaster and masonry containing not more than 1 per cent by weight or volume of organic material. (Use in buildings of combustible metals such as magnesium/aluminium alloys should be assessed in each individual case). c. Concrete bricks or blocks meeting BS 6073: Part 1: 1981. d. Products classified as non-combustible under BS 476: Part 4:1970.
Limited combustibility definition	<ul style="list-style-type: none"> a. Any non-combustible material listed [above]. b. Any material of density 300 kg/m³ or more, which when tested to BS 476: Part 11, does not flame and the rise in temperature on the furnace thermocouple is not more than 20°C c. Any material with a non-combustible core at least 8 mm thick, having combustible facings (on one or both sides) not more than 0.5 mm thick. (Where a flame spread rating is specified, these materials must also meet the appropriate test requirements.) d. Any material of density less than 300 kg/m³, which when tested to BS 476: Part 11, does not flame for more than 10 seconds and the rise in temperature on the centre (specimen) thermocouple is not more than 35°C and the furnace thermocouple is not more than 25°C.

Table P.6 – Building Regulations 1991 and Approved Document B 1992 *continued*

Parameter	Provision
Class 0 definition	<p>The highest product performance classification for lining materials is Class 0. This is achieved if a material or the surface of a composite product is either:</p> <p>a. composed throughout of materials of limited combustibility, or</p> <p>b. a Class 1 material which has a fire propagation index (I) of not more than 12, and (i,) no more than 6.</p> <p>Note: Class 0 is not a classification identified in any British Standard test.</p>
Co-existence of UK and European standards?	No – UK standards only
Large-scale test as alternative to small-scale?	No, until the second impression amendments which introduced a reference to the 1st edition of BR 135 [40], though there was no reference to a large-scale test method per se

Table P.7 – Building Regulations 2000 and Approved Document B 2000 (consolidated with 2000 and 2002 amendments)

Parameter	Provision
Critical height for additional provisions	18 m
Surface and/or cladding provisions above critical height	<p>Cladding to be Class 0 (or Class B-s3, d2 or better – European), regardless of height, if situated within 1 m of relevant boundary</p> <p>Cladding to be Class 0 (or Class B-s3, d2 or better – European) where building exceeds 18 m height, except any part below 18 m which may be timber not less than 9 mm finished thickness or having an Index not exceeding 20 when tested to BS 476-6 (or Class C-s3, d2 or better – European)</p>
Underlying construction provisions	<p>In a building with a storey at more than 18 m above ground level, insulation material used in ventilated cavities in the external wall construction should be of limited combustibility (see Appendix A). This restriction does not apply to masonry cavity wall construction which complies with Diagram 32 in Section 10.</p>
Baseline fire resistance requirements (absent any space separation or loadbearing requirements)	None

Table P.7 – Building Regulations 2000 and Approved Document B 2000 (consolidated with 2000 and 2002 amendments) *continued*

Parameter	Provision
Non-combustible definition	<p>National Class</p> <ul style="list-style-type: none"> a. <i>Any material which when tested to BS 476: Part 11, does not flame and there is no rise in temperature on either the centre (specimen) or furnace thermocouples</i> b. <i>Totally inorganic materials such as concrete, fired clay, ceramics, metals, plaster and masonry containing not more than 1% by weight or volume of organic material. (Use in buildings of combustible metals such as magnesium/aluminium alloys should be assessed in each individual case).</i> c. <i>Concrete bricks or blocks meeting BS 6073: Part 1</i> d. <i>Products classified as non-combustible under BS 476: Part 4</i> <p>European Class</p> <ul style="list-style-type: none"> a. <i>Any material classified as Class A1 in accordance with BS EN 13501-1:2002, Fire classification of construction products and building elements, Part 1-Classification using data from reaction to fire tests.</i> b. <i>Products made from one or more of the materials considered as Class A1 without the need for testing, as defined in Commission Decision 96/603/EC of 4th October 1996 establishing the list of products belonging to Class A1 "No contribution to fire" provided for in the Decision 94/611/EC implementing Article 20 of the Council Directive 89/106/EEC on construction products. None of the materials shall contain more than 1.0% by weight or volume (whichever is the lower) of homogeneously distributed organic material.</i> <p><i>Note: The National classifications do not automatically equate with the equivalent classifications in the European column, therefore products cannot typically assume a European class unless they have been tested accordingly.</i></p>

Table P.7 – Building Regulations 2000 and Approved Document B 2000 (consolidated with 2000 and 2002 amendments) *continued*

Parameter	Provision
Limited combustibility definition	<p>National class</p> <ul style="list-style-type: none"> a. Any non-combustible material listed [above]. b. Any material of density 300 kg/m³ or more, which when tested to BS 476: Part 11, does not flame and the rise in temperature on the furnace thermocouple is not more than 20°C c. Any material with a non-combustible core at least 8mm thick, having combustible facings (on one or both sides) not more than 0.5mm thick. (Where a flame spread rating is specified, these materials must also meet the appropriate test requirements.) d. Any material of density less than 300 kg/m³, which when tested to BS 476:Part 11, does not flame for more than 10 seconds and the rise in temperature on the centre (specimen) thermocouple is not more than 35°C and the furnace thermocouple is not more than 25°C. <p>European class</p> <ul style="list-style-type: none"> a. Any material listed [in the non-combustible definition above]. b. Any material/product classified as Class A2-s3, d2 or better in accordance with BS EN 13501-1:2002, Fire classification of construction products and building elements, Part 1-Classification using data from reaction to fire tests. <p>Notes:</p> <ol style="list-style-type: none"> 1. The National classifications do not automatically equate with the equivalent classifications in the European column, therefore products cannot typically assume a European class unless they have been tested accordingly. 2. When a classification includes “s3, d2”, this means that there is no limit set for smoke production and/or flaming droplets/particles.
Class 0 definition	<p>The highest National product performance classification for lining materials is Class 0. This is achieved if a material or the surface of a composite product is either:</p> <ul style="list-style-type: none"> a. composed throughout of materials of limited combustibility; or b. a Class 1 material which has a fire propagation index (I) of not more than 12, and (i,) no more than 6. <p>Note: Class 0 is not a classification identified in any British Standard test.</p>
Co-existence of UK and European standards?	Yes from 2002 amendment
Large-scale test as alternative to small-scale?	BRE Fire Note 9 [41] in relation to surfaces and 1st edition of BR 135 [40] in relation to underlying construction

Table P.8 – Building Regulations 2000 and Approved Document B 2006

Parameter	Provision
Critical height for additional provisions	18 m
Surface and/or cladding provisions above critical height	Cladding to be Class 0 (or Class B-s3, d2 or better – European), regardless of height, if situated within 1 m of relevant boundary Cladding to be Class 0 (or Class B-s3, d2 or better – European) where building exceeds 18 m height, except any part below 18 m which may be timber not less than 9 mm finished thickness or having an Index not exceeding 20 when tested to BS 476-6 (or Class C-s3, d2 or better – European)
Underlying construction provisions	<i>In a building with a storey 18 m or more above ground level any insulation product, filler material (not including gaskets, sealants and similar) etc. used in the external wall construction should be of limited combustibility (see Appendix A). This restriction does not apply to masonry cavity wall construction which complies with Diagram 34 in Section 9.</i>
Baseline fire resistance requirements (absent any space separation or loadbearing requirements)	None
Non-combustible definition	<p>National Class</p> <ol style="list-style-type: none"> Any material which when tested to BS 476: Part 11:1982, does not flame and there is no rise in temperature on either the centre (specimen) or furnace thermocouples Totally inorganic materials such as concrete, fired clay, ceramics, metals, plaster and masonry containing not more than 1% by weight or volume of organic material. (Use in buildings of combustible metals such as magnesium/aluminium alloys should be assessed in each individual case). Concrete bricks or blocks meeting BS EN 771-1:2003 Products classified as non-combustible under BS 476: Part 4:1970 <p>European Class</p> <ol style="list-style-type: none"> Any material classified as Class A1 in accordance with BS EN 13501-1:2002, Fire classification of construction products and building elements, Part 1-Classification using data from reaction to fire tests. Products made from one or more of the materials considered as Class A1 without the need for testing, as defined in Commission Decision 2003/424/EC of 6th June 2003 amending Decision 96/603/EC establishing the list of products belonging to Classes A1 “No contribution to fire” provided for in the Decision 94/611/EC implementing Article 20 of the Council Directive 89/106/EEC on construction products. None of the materials shall contain more than 1% by weight or volume (whichever is the lower) of homogeneously distributed organic material. <p>Note: The National classifications do not automatically equate with the equivalent classifications in the European column, therefore products cannot typically assume a European class unless they have been tested accordingly.</p>

Table P.8 – Building Regulations 2000 and Approved Document B 2006 *continued*

Parameter	Provision
Limited combustibility definition	<p>National class</p> <ul style="list-style-type: none"> a. Any non-combustible material listed [above]. b. Any material of density 300 kg/m³ or more, which when tested to BS 476: Part 11:1982, does not flame and the rise in temperature on the furnace thermocouple is not more than 20°C c. Any material with a non-combustible core at least 8mm thick, having combustible facings (on one or both sides) not more than 0.5mm thick. (Where a flame spread rating is specified, these materials must also meet the appropriate test requirements.) d. Any material of density less than 300 kg/m³, which when tested to BS 476:Part 11:1982, does not flame for more than 10 seconds and the rise in temperature on the centre (specimen) thermocouple is not more than 35°C and the furnace thermocouple is not more than 25°C. <p>European class</p> <ul style="list-style-type: none"> a. Any material listed [in the non-combustible definition above]. b. Any material/product classified as Class A2-s3, d2 or better in accordance with BS EN 13501-1:2002, Fire classification of construction products and building elements, Part 1-Classification using data from reaction to fire tests. <p>Notes:</p> <ol style="list-style-type: none"> 1. The National classifications do not automatically equate with the equivalent classifications in the European column, therefore products cannot typically assume a European class unless they have been tested accordingly. 2. When a classification includes “s3, d2”, this means that there is no limit set for smoke production and/or flaming droplets/particles.
Class 0 definition	<p>The highest National product performance classification for lining materials is Class 0. This is achieved if a material or the surface of a composite product is either:</p> <ul style="list-style-type: none"> a. composed throughout of materials of limited combustibility; or b. a Class 1 material which has a fire propagation index (I) of not more than 12, and (i,) no more than 6. <p>Note: Class 0 is not a classification identified in any British Standard test.</p>
Co-existence of UK and European standards?	Yes
Large-scale test as alternative to small-scale?	BS 8414-1 and BS 8414-2 with classification to Annexes of 2nd edition of BR 135 [42]

Table P.9 – Building Regulations 2010 and Approved Document B 2019

Parameter	Provision
Critical height for additional provisions	18 m
Surface and/or cladding provisions above critical height	External surface to be Class B-s3, d2, regardless of height, if situated within 1 m of relevant boundary Class A2-s1, d0 or better (imposed on relevant buildings by the regulations since 2018)
Underlying construction provisions	Class A2-s1, d0 or better (imposed on relevant buildings by the regulations since 2018)
Baseline fire resistance requirements (absent any space separation or loadbearing requirements)	None
Non-combustible definition	Term no longer used Definitions in previous edition carried over via transposition table (Table B1 of ADB)
Limited combustibility definition	Term no longer used Definitions in previous edition carried over via transposition table (Table B1 of ADB)
Class 0 definition	Term no longer used Definitions in previous edition carried over via transposition table (Table B1 of ADB)
Co-existence of UK and European standards?	No – European standards only
Large-scale test as alternative to small-scale?	Not for relevant buildings

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 476:1953 (withdrawn), *Fire tests on building materials and structures*

BS 476-4:1970, *Fire tests on building materials and structures – Part 4: Non-combustibility test for materials*

BS 476-6, *Fire tests on building materials and structures – Part 6: Method of test for fire propagation for products*

BS 476-7, *Fire tests on building materials and structures – Part 7: Method of test to determine the classification of the surface spread of flame products*

BS 476-11, *Fire tests on building materials and structures – Part 11: Method for assessing the heat emission from building materials*

BS 476-20, *Fire tests on building materials and structures – Part 20: Method for determination of the fire resistance of elements of construction (general principles)*

BS 476-21, *Fire tests on building materials and structures – Part 21: Methods for determination of the fire resistance of loadbearing elements of construction*

BS 476-22, *Fire tests on building materials and structures – Part 22: Method for determination of the fire resistance of non-loadbearing elements of construction*

BS 476-23, *Fire tests on building materials and structures – Part 23: Methods for determination of the contribution of components to the fire resistance of a structure*

BS 2782:1970 (withdrawn), *Methods of testing plastics*

BS 5839-1, *Fire detection and fire alarm systems for buildings – Part 1: Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises*

BS 5839-6, *Fire detection and fire alarm systems for buildings – Part 6: Code of practice for the design, installation, commissioning and maintenance of fire detection and fire alarm systems in domestic premises*

BS 8414-1, *Fire performance of external cladding systems – Part 1: Test method for non-loadbearing external cladding systems fixed to, and supported by, a masonry substrate*

BS 8414-2, *Fire performance of external cladding systems – Part 2: Test method for non-loadbearing external cladding systems fixed to, and supported by, a structural steel frame*

BS 8458, *Fixed fire protection systems – Residential and domestic watermist systems – Code of practice for design and installation*

BS 8579, *Guide to the design of balconies and terraces*

BS 8629, *Code of practice for the design, installation, commissioning and maintenance of evacuation alert systems for use by fire and rescue services in buildings containing flats*

BS 8899, *Improvement of fire-fighting and evacuation provisions in existing lifts – Code of practice*

BS 9251, *Fire sprinkler systems for domestic and residential occupancies – Code of practice*

BS 9414:2019, *Fire performance of external cladding systems – The application of results from BS 8414-1 and BS 8414-2 tests*

BS 9991:2015, *Fire safety in the design, management and use of residential buildings – Code of practice*

BS 9999, *Fire safety in the design, management and use of buildings – Code of practice*

BS EN 1363-1, *Fire resistance tests – Part 1: General requirements*

BS EN 1363-2, *Fire resistance tests – Part 2: Alternative and additional procedures*

BS EN 1364-1, *Fire resistance tests for non-loadbearing elements – Part 1: Walls*

BS EN 1364-2, *Fire resistance tests for non-loadbearing elements – Part 2: Ceilings*

BS EN 1364-3, *Fire resistance tests for non-loadbearing elements – Part 3: Curtain walling – Full configuration (complete assembly)*

BS EN 1364-4, *Fire resistance tests for non-loadbearing elements – Part 4: Curtain walling – Part configuration*

BS EN 1364-5, *Fire resistance tests for non-loadbearing elements – Part 5: Air transfer grilles*

BS EN 1365-1, *Fire resistance tests for loadbearing elements – Part 1: Walls*

BS EN 1365-2, *Fire resistance tests for loadbearing elements – Part 2: Floors and roofs*

BS EN 1365-3, *Fire resistance tests for loadbearing elements – Part 3: Beams*

BS EN 1365-4, *Fire resistance tests for loadbearing elements – Part 4: Columns*

BS EN 12845, *Fixed firefighting systems – Automatic sprinkler systems – Design, installation and maintenance*

BS EN 13501-1:2018, *Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests*

BS EN 13823, *Reaction to fire tests for building products – Building products excluding floorings exposed to the thermal attack by a single burning item*

BS EN 62305-1, *Protection against lightning – Part 1: General principles*

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