

## **PAS 9980**

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

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## Foreword

### Publishing information

This PAS was sponsored jointly by MHCLG and the Home Office. Its development was facilitated by BSI Standards Limited and it was published under licence from The British Standards Institution. It came into effect on **XX Month 202X**.

Acknowledgement for the drafting of this PAS is given to DCCH Experts LLP and a team of experts comprising:

- Design Fire Consultants
- Expert Architect Studio
- Tenos

Acknowledgement and special thanks are given to C.S. Todd & Associates, who led the drafting of the first edition of this PAS.

Acknowledgement is given to the following organizations that were involved in the development of this PAS as members of the Steering Group:

- Building Research Establishment
- Building Safety Regulator
- Construction Products Association
- Fire Industry Association
- Fire Protection Association
- Institution of Fire Engineers
- London Fire Brigade
- Home Office
- Ministry of Housing, Communities and Local Government
- National Fire Chiefs Council
- National Housing Federation
- Royal Institution of Chartered Surveyors
- Scottish Government
- Society of Façade Engineering
- Welsh Government

Acknowledgement is also given to co-opted members of the Steering Group, together with the members of a wider review panel who were consulted in the development of this PAS.

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## **Supersession**

This PAS supersedes PAS 9980:2022, which is withdrawn. However, the changes made to this PAS are not intended to significantly alter the acceptability or otherwise of risk. Accordingly, reports prepared to PAS 9980:2022 can continue to be relied upon until they need to be updated/revisited in the normal way.

## **Relationship with other publications**

This PAS supplements the recommendations given in PAS 79-2<sup>1)</sup>, 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 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, 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.

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 cited throughout the PAS and listed in the Bibliography.

## **Information about this document**

This is a full revision of the document, and introduces the following principal changes.

- a) The PAS now addresses buildings that both do and do not need a fire risk appraisal of external walls (FRAEW), providing a methodology to establish whether the building or its external wall construction are inherently low risk in terms of external fire spread. It is anticipated that non-specialists, including fire risk assessors, will be able to undertake these assessments, aiding the triaging of when buildings do or do not require an FRAEW.
- b) The methodology for conducting FRAEWs has been more clearly set out using process diagrams.

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<sup>1)</sup> PAS 79-2 is withdrawn but is available for download at <https://www.bsigroup.com/en-GB/standards/pas-79-22020>. It is to be replaced by BS 9792, which is in preparation at the time of public consultation of PAS 9980

c) The following annexes have been deleted entirely:

- Annex C (informative) – Legislative context;
- Annex D (informative) – Requirement B4(1) (of Part B of Schedule 1 to the Building Regulations 2010) and associated recommendations of Approved Document B; and
- Annex P (informative) – Some history of standards, codes of practice and guidance relevant to external wall construction.

These annexes were included in the 2022 edition as they set out the context and thinking behind the original development of this PAS, but are now considered superfluous to the carrying out of FRAEWs, though their content remains correct. Where users of this PAS are interested in understanding or researching this context and thinking, they are encouraged to review these annexes within the 2022 edition.

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;
- leaseholders;
- local housing authorities;
- managing agents or facility managers;
- project managers; and
- valuers and mortgage lenders.

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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; and
- 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 version is limited, as described in Clause 1, primarily to multistorey blocks of flats but also to student accommodation, specialized housing and buildings converted into 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.

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.

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Where websites and webpages have been cited, they are provided for ease of reference and are correct at the time of publication. The location of a webpage or website, or its contents, cannot be guaranteed.

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### **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 Ministry for Housing, Communities and Local Government, and the devolved administrations.

## **0 Introduction**

### **0.1 Background**

It has been identified that there are many blocks of flats in the UK where the external walls have not been designed and/or built adequately to resist fire spread over the walls of the building. However, it has also been concluded that, in many instances, the burden of remediating for compliance with expectations (either currently or at the time of construction) is disproportionately high compared to the associated risk, and that as such, the external walls of existing blocks of flats need to be appraised to determine whether they adequately resist spread of fire or whether risk reduction is required to ensure adequate safety.

Additionally, risk of fire spread via external walls needs to be considered as part of duties under relevant legislation. It follows, therefore, that any fire risk assessment (FRA) of a multistorey, multi-occupied residential building needs to include consideration of risk of fire spread via the external walls of the building.

To these ends, this PAS provides guidance on:

- a) deciding whether an FRAEW is necessary:
  - 1) in buildings for which it can be concluded that the risk of fire spread via the external wall constructions is sufficiently low without the need for an FRAEW; and
  - 2) for wall constructions for which it can be concluded that the risk of fire spread via the external wall constructions is sufficiently low without the need for an FRAEW; and
- b) how to conduct an FRAEW, and in particular how to identify:
  - 1) whether any increased risk of fire spread is still low to be tolerated without residents being at undue risk of harm; and
  - 2) whether there are any risk proportionate actions that could be taken to reduce risk.

It is recognized that FRAEWs are not necessarily within the competence of the typical fire risk assessor who carries out typical FRAs for a block of flats (e.g. an FRA carried out in accordance with PAS 79-2), and that as such, specialist advice might be required. Equally, in many cases, it will be obvious to a competent fire risk assessor that certain buildings are manifestly low risk and/or the hazard 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 the fire risk associated with the external wall construction under the Regulatory Reform (Fire Safety) Order 2005 [16] (hereafter referred to as the Fire Safety Order) as part of the FRA. Clause 4 of this PAS sets out the approach to establishing whether or not a full FRAEW is necessary.

Therefore, whilst in some instances specialist advice will be required, it is also 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 requests or recommendations for FRAEWs would make significant demand on the 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.

### **0.2 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 competent persons to carry out FRAEWs.

While this PAS includes criteria for appraising 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, as noted in **0.1**, it is not expected that the necessary skills for FRAEWs 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 for the specifics of the appraisal at hand 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 outcome determined by the methodology contained in this PAS, how the risk outcome 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 buildup 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.

As stated both previously and later in this PAS, a risk-based approach is one that is not limited by matters of compliance. Compliance is typically measured against practical guidance such as ADB ([8], [9]); however even when "compliance" is truly achieved, risk will remain. In particular relation to buildings less than 18 m tall, the absence of any recommendations regarding reaction to fire performance or combustibility of materials incorporated into external wall construction means that a building could present an intolerable risk despite being entirely "compliant" with guidance. In addition, and in any event, it is well established now that many buildings do not in fact comply with the guidance that applied at the time of their construction, and so it is necessary to apply this PAS to establish whether risk reduction is required so that dutyholders can comply with their obligations for the ongoing use of these buildings.

Other approaches, such as assessment from first principles, are not covered in this PAS. Guidance on such approaches can be found in BS 7974.

### **0.3 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 persons conducting FRAEWs in communicating clearly the results of the 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 standard that underpins consistency in carrying out FRAEWs.

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.

#### **0.4 Structure of this PAS**

The PAS is structured so as to address some of 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. Users of this PAS are referred to the 2022 edition in the event that they wish to better understand the background to, and thinking behind, the original development of this PAS.

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, including whether a report in accordance with this PAS is needed that does not contain an FRAEW.

The competence of those carrying out FRAEWs is discussed in Clause 5, including the need for them to possess knowledge of the nature of fires involving external walls, the mechanisms of fire spread and the legislative context for FRAEWs. The principles and process of FRAEWs are described in Clause 6, including an overarching decision making process for arriving at risk outcomes.

Clause 7 deals with the actions that need to be taken depending upon the risk outcome reached.

Clause 8 and Clause 9 relate to the information needed to conduct an FRAEW, including information that might need to be obtained from surveys and inspections of the building. In Clause 10, the matter of how materials, systems and configurations of external walls perform in fire is considered, and in Clause 11, factors relating to the configuration of external wall systems are considered. Clause 12 deals with the impact of a building's fire strategy on risk.

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THIS DRAFT IS NOT CURRENT BEYOND **06 JUNE 2025**.

Clause **13** introduces tools which are available to use as part of an FRAEW.

In Clause **14** consideration is given to the content of reports prepared in accordance with this PAS that do not contain an FRAEW, while Clause **15** deals with FRAEW reports.

## 1 Scope

This PAS gives recommendations on:

- a) whether or not buildings are likely to require a fire risk appraisal of external walls (FRAEW); and
- b) guidance on undertaking an FRAEW of an existing multistorey, multi-occupied residential building.

This PAS covers FRAEWs that are undertaken for the purpose of:

- 1) assessing the risk to occupants from a fire spreading over or within the external walls of the building and the consequence that this can have in terms of:
  - i) means of escape;
  - ii) secondary fires; and
  - iii) fire and rescue service access; and
- 2) making a decision as to whether, in the specific circumstances of the building, remediation or other mitigating measures to address the risk are considered necessary.

This PAS 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 1 FRAEWs are particularly applicable to FRAs carried out in accordance with PAS 79-2<sup>2)</sup>, but they can be carried out independently of the PAS 79-2 FRA process.*

*NOTE 2 FRAEWs undertaken in accordance with this PAS might give rise to a need for building work to be carried out; however, PAS 9980 reports are not intended to demonstrate compliance with building regulations (e.g. the Building Regulations 2010 [7] in England), and attention is drawn to requirements applicable to building work. It is also not intended for the snagging of newly constructed buildings prior to occupation.*

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

This PAS applies predominantly to multistorey blocks of flats of any height, 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:

- i) student accommodation;
- ii) sheltered and other specialized housing; and
- iii) buildings converted into flats.

*NOTE 3 Within this PAS, the term “flat” is used to describe a separate and self-contained premises constructed or adapted for use for residential purposes and forming part of a building from some other part of which it is divided horizontally. 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 4 This is also intended to include blocks of flats that are part of a mixed-use building with, for example, shops or offices below.*

Certain types of building and external wall construction are within the scope of this PAS but are not expected to require an FRAEW:

- individual dwellinghouses;

<sup>2)</sup> PAS 79-2 is withdrawn but is available for download at <https://www.bsigroup.com/en-GB/standards/pas-79-22020>. It is to be replaced by BS 9792, which is in preparation at the time of public consultation of PAS 9980

- terraced or semi-detached dwellinghouses;
- blocks of flats having no more than two storeys above ground level; and
- blocks of flats having no more than three storeys above ground level, provided that these are traditionally constructed.

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

This PAS also covers attachments to the external walls of buildings.

The methodology in this PAS is intended to determine the need for any risk-proportionate actions in relation to external wall construction that are necessary 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. The methodology is not intended to address the safety of firefighters in the event of a fire on the premises. It is not intended to address protection of property (the premises and their contents) or the environment, or protection of a business against interruption.

This PAS does not include a methodology for assessing the risk of spread of fire arising from space separation between buildings (i.e. heat transfer via radiant heat). It also does not address the performance of external walls in terms of fire resistance, or the ability of the walls to maintain structural stability.

## **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 PAS<sup>3)</sup>. 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*

## **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 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* ACM is a particularly significant form of metal composite material (MCM) due to aluminium's low melting point.

#### **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**

concealed space enclosed by elements of a building (including a suspended ceiling) or contained within an element, but not a room, cupboard, circulation space, protected shaft or space within a flue, chute, duct, pipe or conduit

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<sup>3)</sup> Documents that are referred to solely in an informative manner are listed in the Bibliography.

[SOURCE: BS 4422:2024, **3.31**]

#### **3.1.4 cavity barrier**

construction provided to close a cavity against penetration of smoke or flame, or provided to restrict the movement of smoke or flame within such a space

[SOURCE: BS 4422:2024, **3.32**]

#### **3.1.5 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 1 Such systems are normally attached to the primary structure of a building, or to a secondary support system which in turn is supported off the primary structure, 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.*

*NOTE 2 Different jurisdictions have different definitions for cladding in their legislation and statutory guidance.*

#### **3.1.6 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 (**3.1.32**) or non-combustible (**3.1.36**)

#### **3.1.7 combustion modified**

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

#### **3.1.8 compartment floor**

fire-resisting floor used to separate one fire compartment from another

[SOURCE: BS 4422:2024, **3.40**]

#### **3.1.9 compartment wall**

fire-resisting wall used to separate one fire compartment from another

[SOURCE: BS 4422:2024, **3.41**]

#### **3.1.10 compartmentation**

division of a building into fire compartments for the purpose of containing a fire within the compartment of fire origin

[SOURCE: BS 4422:2024, **3.42**]

#### **3.1.11 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

#### **3.1.12 dry fire main**

water supply pipe installed in a building for firefighting purposes, fitted with inlet connections at fire and rescue service access level and outlet connections at specific points, which is normally dry but is capable of being charged with water, usually by pumping from fire and rescue service appliances

[SOURCE: BS 4422:2024, **3.56**]

### **3.1.13 dutyholder**

person or organization with specific legally prescribed responsibilities

*NOTE 1 The term “dutyholder” only has meaning within this PAS, and is used for convenience. It is not a term used in this context within fire safety legislation, in which the dutyholder could be a number of different parties according to circumstances, e.g. in England and Wales, the responsible person, to which the Fire Safety Order [16] makes reference, is one such dutyholder.*

*NOTE 2 The dutyholder can be determined from the relevant fire safety legislation.*

*NOTE 3 The dutyholder is normally an organization, such as an employer, rather than a specific named person.*

*NOTE 4 There might be more than one dutyholder within any premises. For example, in supported housing, dutyholders might comprise the service provider (as an employer), the landlord (as the person having control of the premises) and possibly even the local authority commissioners (as a result of their contract with the service provider). In the case of a purpose-built block of flats in England and Wales, dutyholders might comprise the freeholder and managing agents (as persons having control of the premises) and, possibly, even leaseholders (e.g. if, under their lease, they are responsible for maintenance and repair of their flat entrance doors).*

[SOURCE: BS 4422:2024, **3.57**, modified – notes added]

### **3.1.14 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

### **3.1.15 evacuation strategy**

series of agreed actions for occupants to take in the event of fire to enable the safe evacuation of the building

[SOURCE: BS 4422:2024, **3.84**]

### **3.1.16 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 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 Different jurisdictions have different definitions for external wall construction in their legislation and statutory guidance.*

### **3.1.17 fire load**

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

[SOURCE: BS 4422:2024, **3.119**]

### **3.1.18 fire main**

system of pipes and valves provided to carry water for firefighting purposes

*NOTE See also dry fire main (3.1.12) and wet fire main (3.1.53).*

[SOURCE: BS 4422:2024, **3.121**]

### **3.1.19 fire performance**

response of a material, product, assembly or structure in a fire

[SOURCE: BS 4422:2024, **3.123**]

### **3.1.20 fire risk**

combination of the likelihood of the occurrence of fire and consequence(s) likely to be caused by a fire

[SOURCE: BS 4422:2024, **3.133**]

### **3.1.21 fire safety engineering**

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

### **3.1.22 fire stopping**

closure of an imperfection of fit or design tolerance, or sealing of joints, service penetrations and cavities, to restrict the spread of fire and smoke

[SOURCE: BS 4422:2024, **3.147**]

### **3.1.23 fire strategy**

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

[SOURCE: BS 4422:2024, **3.148**]

### **3.1.24 firefighting shaft**

protected enclosure containing a firefighting stairway, firefighting lobbies, a fire main and, if provided, a firefighters lift together with any machinery space

[SOURCE: BS 4422:2024, **3.156**, modified – note omitted]

### **3.1.25 flashover**

sudden transition from a localized fire to the ignition of all exposed flammable surfaces within an enclosure

[SOURCE: BS 4422:2024, **3.168**]

### **3.1.26 general needs**

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

### **3.1.27 heat release rate**

thermal energy released per unit time by an item during combustion under specified test conditions

[SOURCE: BS 4422:2024, **3.178**]

### **3.1.28 infill panel**

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

### **3.1.29 insulation**

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.*

### **3.1.30 interim measure**

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

### **3.1.31 material**

substance, or mixture of substances, that is entirely homogenous

*NOTE 1 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.*

*NOTE 2 This PAS defines materials and products separately, but some jurisdictions treat the terms as interchangeable.*

### **3.1.32 material of limited combustibility**

either:

- a) a non-combustible material or product; or
- b) a material or homogenous product of density 300 kg/m<sup>3</sup> 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) a material of density less than 300 kg/m<sup>3</sup>, which when tested to BS 476-11, 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 of the furnace thermocouple is not more than 25 °C; or
- d) a 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
- e) 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.*

### **3.1.33 metal composite material (MCM)**

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

*NOTE 1 This PAS refers to different categories of MCM as follows:*

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

*NOTE 2 Two particularly significant forms of MCM are aluminium composite material (ACM) and zinc composite material (ZCM). These are significant due to being common forms of MCM and due to aluminium and zinc having low melting points. The categories above apply equally to ACM and ZCM.*

### **3.1.34 mitigation measures**

actions (interim or permanent) to reduce an identified risk as a proportionate alternative to remediating the hazard

### **3.1.35 multistorey**

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

### **3.1.36 non-combustible**

either:

- a) a 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) a 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; or
- f) products composed entirely of one or more of the materials considered as Class A1 without the need for testing, as defined in Commission Decision 96/603/EC of 4<sup>th</sup> 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

*NOTE* This term is included here given its use in relation to materials used in, and standards applicable to, existing buildings.

### **3.1.37 phased evacuation**

system of evacuation in which different parts of a building are evacuated in a controlled sequence of phases, those parts of the premises expected to be at greatest risk being evacuated first

[SOURCE: BS 4422:2024, **3.79**]

### **3.1.38 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

### **3.1.39 product**

item that is formed of one or more materials

*NOTE 1* 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-homogeneous 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 homogeneous.

*NOTE 2* This PAS defines materials and products separately, but some jurisdictions treat the terms as interchangeable.

### **3.1.40 professional judgement**

use of accumulated knowledge and experience, as well as critical reasoning, to make an informed decision

### **3.1.41 relevant person**

any person who is at risk from a fire on the premises, but not including a firefighter responding to a fire on the premises

### **3.1.42 sandwich panel**

two thin metal skins bonded together to an insulating core material

### **3.1.43 simultaneous evacuation**

system of evacuation in which all parts of a building are evacuated following a common fire alarm

[SOURCE: BS 4422:2024, **3.83**]

#### **3.1.44 smoke control**

technique used to control the movement of smoke and hot gases within a building in order to protect the structure, the contents or the means of escape, or to assist firefighting operations

[SOURCE: BS 4422:2024, **3.250**]

#### **3.1.45 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.*

#### **3.1.46 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 fire or smoke, or otherwise directed to leave by the fire and rescue service

*NOTE A stay put strategy does not preclude residents from leaving their flats or common areas at any time.*

[SOURCE: BS 4422:2024, **3.272**]

#### **3.1.47 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.*

#### **3.1.48 surface**

outside part or uppermost layer

*NOTE This definition is particularly important in the context of reaction to fire tests [see definitions for materials (3.1.31) and products (3.1.39), and Annex A].*

#### **3.1.49 thermal insulation**

ability of a fire-separating element, when exposed to fire on one side, to restrict the transmission of heat

[SOURCE: BS 4422:2024, **3.279**, modified – note omitted]

#### **3.1.50 thermoplastic material**

polymeric material that can be melted and recast almost indefinitely

#### **3.1.51 thermoset material**

polymeric material that is formed by irreversible hardening and that chars or decomposes on heating

#### **3.1.52 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

#### **3.1.53 wet fire main**

water supply pipe installed in a building for firefighting purposes, permanently charged with water from a pressurized supply and fitted with outlet connections at specific points

[SOURCE: BS 4422:2024, **3.289**]

### **3.1.54 zinc composite material (ZCM)**

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

*NOTE ZCM is a particularly significant form of metal composite material (MCM) due to zinc's low melting point.*

### **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><br><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.</i> |
| 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                                                                                                                                                                                                                                  |
| CRMP  | community 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**

*As set out in Clause 1, this PAS addresses the risk from fire spread over the external walls. It is primarily concerned with multistorey blocks of flats but can be applied to similar buildings of any height.*

*There are some buildings within the scope of PAS 9980 for which the risk of fire spread via the external walls is sufficiently low that an FRAEW is not expected to be required. The following buildings fall into this category.*

- a) Detached individual dwellinghouses. These are standalone buildings that contain a single family unit and often contain no or very little compartmentation. The fire detection and fire alarm provisions for dwellinghouses are expected to be capable of alerting all occupants to a fire and the need to evacuate at the very early stages of a fire. External fire spread is therefore not expected to impact risk significantly.*
- b) Terraced or semi-detached dwellinghouses. Provided that adjoining houses are separated from each other by a party wall including within the roof space (i.e. no dwelling or part thereof exists above another), the potential for external fire spread across the party wall line is expected to be very limited even in the event that combustible materials have been used in the external wall construction. This is because fire spreads horizontally much more slowly than vertically, so the time associated with building-to-building spread across the external walls, set against the expectations for detection and alarm [see item a) above] means the risk associated with this mechanism of spread will be low.*
- c) Blocks of flats having no more than two storeys above ground (i.e. ground floor and first floor only). The provisions for controlling external fire spread are premised on limiting the possibility of spread via the external wall construction, as opposed to fire emitting from a window and eventually reaching the window above. This means that fire spread from the storey of fire origin to the storey immediately above can only be avoided via successful fire and rescue service intervention. In the case of two-storey buildings, fire will always be able to reach from the ground floor to the first floor via windows, but the entire building being only two storeys high means it will be well within the reach of the fire and rescue service.*
- d) Blocks of flats having no more than three storeys above ground (i.e. ground floor, first floor and second floor only) are also likely to be inherently low risk, although limited investigation might be necessary. Such buildings are not expected to require an FRAEW unless they are clad in material(s) that are more likely to present a significant hazard or there is some other significant risk factor. Examples of materials that are more likely to present a significant hazard include MCM with unmodified polyethylene core, organic render over polystyrene insulation, and any other combustible cladding, where it cannot readily be confirmed that adequate cavity barriers are installed. Similar to two storey blocks of flats, there is only a limited prospect of the external walls contributing to external fire spread where their height is limited to three storeys, and the entire block is expected to be within reach of the fire and rescue service.*

*Similarly, certain forms of external wall construction are inherently low risk (regardless of how extensively they are used on a building), and as such are not expected to require an FRAEW. The following forms of external wall construction fall into this category.*

- 1) Solid masonry construction at least 150 mm thick where any insulation or other combustible materials are applied only as internal linings to rooms.*
- 2) Walls formed of two leaves of masonry each at least 75 mm thick, with a cavity in between that might contain combustible materials, where the cavity is closed at its edges including around openings. Materials used to close the cavity in this arrangement do not need to achieve a specific performance in relation to fire resistance and cavity barriers are not needed in line with compartment walls or floors. Other combustible materials can also be applied as internal linings to rooms, but not to the external face of the masonry.*
- 3) External walls that are, save for the exceptions below, entirely formed of materials that are of European classification A2-s1, d0 or A1, whether classified in accordance with the reaction to fire classification given in BS EN 13501-1 or covered by Classification Without Further Testing (CWFT). Materials covered by the CWFT process can be found by accessing the European Commission's website <https://eur-lex.europa.eu/>. The excepted components are:*
  - cavity trays when used between two leaves of masonry;*
  - any part of a roof;*
  - door frames and doors;*
  - electrical installations;*
  - fiberoptic cables;*
  - insulation and waterproofing materials used below ground level or up to 300 mm above ground level;*
  - intumescent and fire-stopping materials;*
  - membranes;*

- seals, gaskets, fixings, sealants and backer rods;
- components associated with a solar shading device (this does not include the components whose primary function is to provide shade or deflect sunlight such as the awning curtain or slats);
- thermal break materials;
- window frames and glass; and
- materials forming the top horizontal floor layer of a balcony that are of European classification A1fl or A2fl-s1 (classified in accordance with the reaction to fire classification given in BS EN 13501-1) provided that the entire layer has an impermeable substrate under it.

*In addition to the use of the above materials, in order to be deemed sufficiently low-risk not to need an FRAEW, cavity barriers need to be provided where any cavities within the external wall construction:*

- cross-compartment floors;
- cross-compartment walls; and
- terminate (e.g. around windows and other openings which pass through the entire external wall thickness, at the edges of cavities).

**NOTE 1** See Table N.4 for the various forms of construction that are acceptable for cavity barriers.

- 4) *External wall construction closely matching that which has been successfully tested to BS 8414-1 or BS 8414-2, and classified to BR135 based on this test data. Where the extended application rules in BS 9414 have been met as part of classification to BR135, then the wall construction would still be considered inherently low risk. Where an assessment to BR135 has been carried out or some form of extended application has been applied which falls outside of the scope of BS 9414, then some form of FRAEW will be necessary to verify independently whether or not this has been done properly and therefore can be relied upon. The outcome might still be that the external wall construction is inherently low risk, but in this latter scenario, the basis upon which such a conclusion has been reached will need to be recorded.*

*If all the external walls on a building comprise one of the above, then the building can be confirmed as being low risk in accordance with this PAS without the need for an FRAEW. In such a scenario a report will need to be prepared in accordance with Clause 14 which records the factual basis upon which it can be concluded that the building or its external walls are inherently low risk.*

**NOTE 2** While reports prepared in accordance with Clause 15 (i.e. reports that include an FRAEW) are expected to set out analysis to justify the risk rating arrived at by an appraiser, reports that are prepared in accordance with Clause 14 (i.e. reports that do not include an FRAEW) will generally be factual, setting out the manner in which a building meets one of the above scenarios.

*Alternatively, if only some of the walls on a building comprise one of the above, then those walls can be confirmed as being low risk without the need for an FRAEW. However, the manner in which these walls interact with other external wall construction might need to be considered (for example, a wall type that has poor fire performance might benefit in terms of façade configuration by being regularly broken up by bands of low risk wall type).*

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

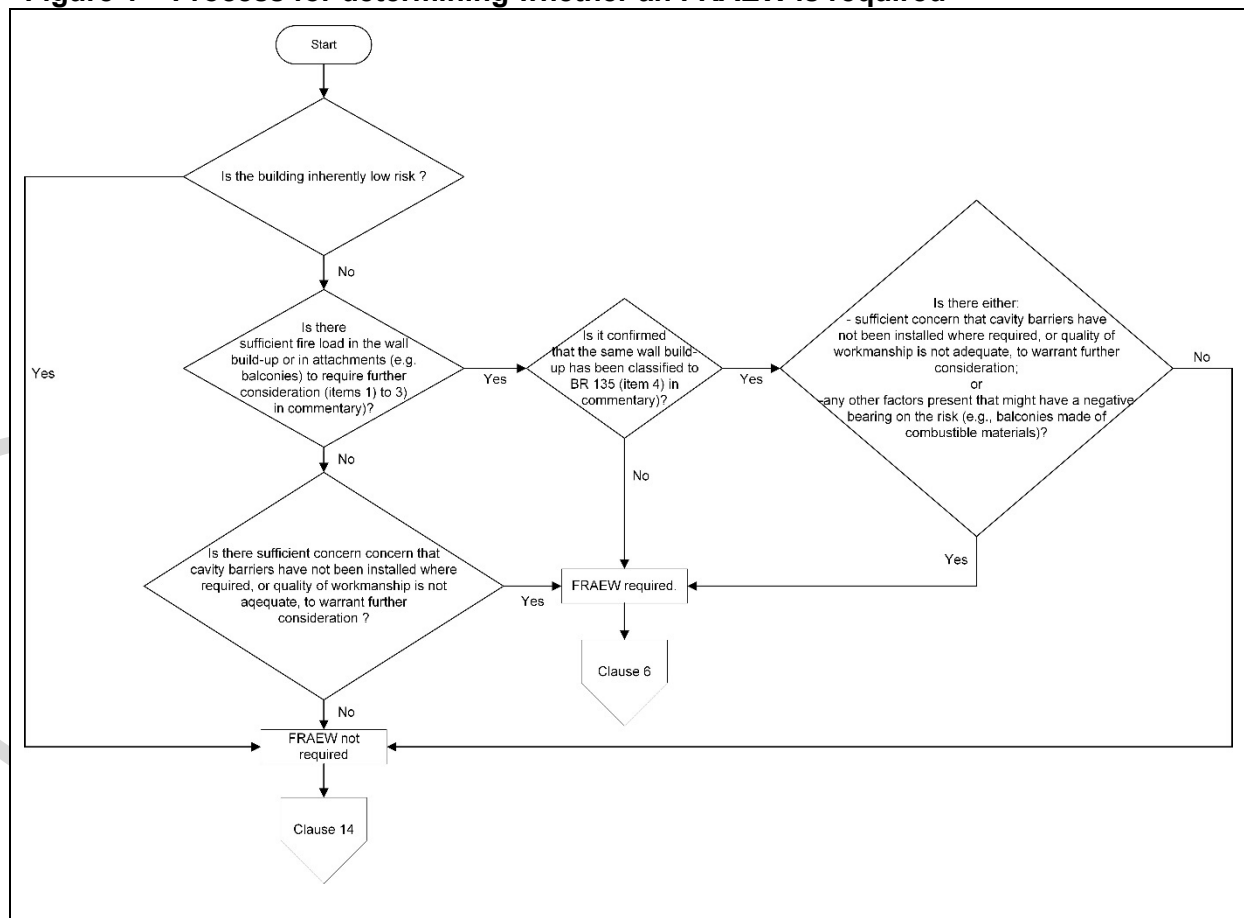
- The amount of investigation and analysis required to complete the FRAEW needs to be proportionate to the risk. There are some forms of external wall construction or façade configurations for which the risk is obviously so low or high that no investigation or analysis is necessary to better understand the risk.*
- An FRAEW is not specifically intended to address the safety of firefighters in the event of a fire spreading over the external walls. 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.*
- 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.*
- 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.*

- v) *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 3.1.38). Accordingly, it is not intended to constitute an alternative solution to meeting the requirements for fire performance of external walls of new buildings.*
- vi) *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).*

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

- a) the building requires an FRAEW, which should be determined using the process shown in Figure 1;
- b) the external walls of the building require an FRAEW, which should be determined using the process shown in Figure 1;
- c) the purpose of the FRAEW is to inform the building's FRA;
- d) 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;
- e) the objective of assessing the fire risk is to address the safety of all occupants; and
- f) they have the necessary competence to address the risks posed by the particular wall build-ups on the building (see Clause 5).

**Figure 1 – Process for determining whether an FRAEW is required**



**4.2** Where it is established, in accordance with **4.1** and Figure 1, that an FRAEW is not required, then appraisers should prepare a report in accordance with Clause **14**, setting out the reason(s) why an FRAEW is not needed.

*NOTE* While such a report will identify that the external walls do not give rise to a need for an FRAEW, it is expected to remain necessary for an FRA to be carried out to establish the building risk more generally.

**4.3** Before accepting a commission for an FRAEW, the person conducting the FRAEW 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 it is an iterative process in which work might need to be expanded to address uncertainty of risk (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
- 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.

**4.4** Persons conducting FRAEWs should make clients aware of the constraints, limitations and caveats that will apply to an FRAEW conducted in accordance with this PAS, including the expectations for competence of both the client and the person conducting the FRAEW (see Clause **5**).

**4.5** 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 takes 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.

## **5 Competence and ethics**

### **5.1 Professionalism and ethics**

#### **COMMENTARY ON 5.1**

*It is essential that persons carrying out work in accordance with this PAS 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 assessment of fire risk and to those carrying it out. Consequently, it is likely that persons conducting an FRAEW will come under pressure to provide an outcome that suits a client's commercial, financial or legal position. This could manifest itself as pressure to confirm that everything is compliant, usually by reference to building regulations and supporting guidance.*

*Conversely, the client might have an interest in future-proofing the value of the building asset against new building regulations and, where the client is pursuing a claim against another party or applying for funding, the client might apply pressure on the person conducting the FRAEW to exaggerate risks to bolster the client's position.*

*As set out in 5.3 and in the methodology in Clause 6, 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.*

*Persons conducting an FRAEW 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, persons conducting an FRAEW need to be mindful that the standard of behaviour that has been followed could ultimately be tested in a court of law. The user of this PAS is advised to approach their work 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 [17], which makes recommendations on assurance of competence and ethical practice. Since PAS 9980 was originally published, a suite of standards has been developed relating to competence in the built environment. This includes PAS 8673, which deals with competence requirements for the management of safety in residential buildings.*

*Whilst it is recognized that professional body memberships and professional qualifications do not guarantee ethical behaviour and competency, they do provide confidence to dutyholders and others with control of buildings regarding the competence of those engaged to carry out work in accordance with this PAS. This does not necessarily mean that those without such memberships and qualifications lack competence; 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, a determination of risk 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, such as the design principles of compartmentation, means of escape, smoke control systems, and fire detection and fire alarm provisions (to the extent relevant).*

*A person conducting an FRAEW, therefore, needs to possess knowledge of the fire strategy considerations and regulatory framework underpinning the fire safety design of such buildings.*

*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 to the level described by the methodology in Clause 6, let alone when an FRAEW necessitates a more detailed technical assessment, particularly one involving fire safety engineering analysis as discussed in Clause 13.*

*It is important that those commissioning work in accordance with this PAS seek evidence of competence with respect to those assessing the fire risk posed by external wall construction and cladding. In particular, clients*

*have a responsibility to take appropriate steps to appoint a person to conduct an FRAEW who has the necessary competence. As such, the guidance in this PAS in respect of competence is of relevance to those who are commissioning work in accordance with this PAS (i.e. the clients of persons conducting FRAEWs).*

*Guidance on relevant skills, knowledge and experience for the different roles of persons conducting an FRAEW, based on the National Qualifications Framework<sup>4)</sup>, is given in Annex B.*

*Clause 6 provides details of the methodology for consideration of the fire risk presented by external wall constructions; the guidance is scalable in that it provides an opportunity for rapid conclusion where it can be rapidly established that the risk is clearly high or low, but envisages a process for escalation. Experienced appraisers might be able to identify, with a high degree of confidence, the entire programme of work needed at the outset of a commission. However, the process as set out envisages an iterative process whereby the appraiser initially considers the information available to them and the level of risk that this indicates, while taking a reasonable worst-case approach to any unknowns. If, despite these unknowns, the risk can be deemed to be "low", then there is nothing to be gained from addressing these unknowns and the FRAEW can conclude. However, if further work is needed to reduce uncertainty in the hope of reducing perceived risk, then this needs to be carried out (subject to the further work being proportionate) and the risk needs to be reviewed based on the findings of the further work (noting the possibility that the reasonable worst case scenario might be reflected by reality, in which case uncertainty might reduce but not the risk).*

*The scope of work involved in appraising any one building in accordance with this PAS is expected to vary greatly. In addition to the range of competence that appraisers might need to possess depending on the work they are carrying out, there are a range of ways in which the work might need to be checked. Peer review is good practice when writing any technical report, and needs to be considered as part of the work carried out in accordance with this PAS. Whether peer review is carried out informally, as part of a formal quality control process within an organization, via an external provider to the author, or as an entirely independent third-party exercise commissioned by clients, will depend upon the circumstances in which a report is commissioned, the size and complexity of the building being appraised and the complexity of the analysis undertaken. Further guidance on what peer review might involve is provided in Annex C.*

*It is likely that those carrying out work 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.*

**5.1.1** Persons following the methodology in this PAS should determine that they have:

- a) adequate and relevant competence to undertake work in accordance with this PAS; and
- b) sufficient knowledge, skills and experience in relation to fire safety of external walls to be able to complete an appraisal at the level required.

*NOTE Persons conducting an FRAEW 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 qualification<sup>4)</sup> in a science, engineering or construction-related subject.*

**5.1.2** Persons conducting an FRAEW should understand the principles of external fire spread set out in 5.2 and the legislative context surrounding the carrying out of FRAEWs set out in 5.3.

**5.1.3** Persons conducting an FRAEW 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.

**5.1.4** Persons undertaking 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

<sup>4)</sup> <https://www.gov.uk/what-different-qualification-levels-mean/list-of-qualification-levels>

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 carrying out the work in accordance with this PAS.

**5.1.5** Persons conducting an FRAEW 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 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.

**5.1.6** It is not suggested in this PAS that persons other than fire engineers cannot conduct FRAEWs in accordance with the methodology set out in Clause 6; however, such persons should be competent to appraise the nature of the construction of the external walls in terms of their fire performance and to 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.

**5.1.7** Persons undertaking a more detailed assessment as part of an FRAEW, such as one using fire safety engineering analysis, as described in Clause 13, 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 Persons undertaking a more detailed technical assessment, such as one using fire safety engineering analysis, as described in Clause 13, 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 5.1.1, 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 safety engineering).*

**5.1.8** Persons following the methodology in this PAS 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 more detailed 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 detailed technical assessment of the type described in Clause 13, and whether or not they have the necessary competence to conduct such an assessment.

**5.1.9** Persons following the methodology in this PAS 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.

**5.1.10** Persons conducting an FRAEW should adopt an appropriate peer review procedure as part of their quality assurance process for producing reports in accordance with this PAS.

## 5.2 Technical knowledge

### COMMENTARY ON 5.2

*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.*

*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, for example, BR 135 [15]. Further discussion on the mechanisms for such fire spread is provided in Annex D.*

*It is important that persons conducting an FRAEW 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 5.1). 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/or 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 (absent any contribution from the external walls) 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. Typically, this means that external walls need to withstand the fire attack that arises when any compartment fire is able to achieve flashover, resulting in significant heat and flame emitting from windows, such that it does not:*

- contribute to fire spread to the storey immediately above the compartment fire, any more quickly than would be the case from the heat/flaming alone (generally accepted to be around 15 min from the time when flashover/external flaming begins); or*
- contribute to fire spread beyond the storey immediately above the compartment fire.*

*Utilizing materials that are of limited combustibility or class A2-s3, d2 in accordance with BS EN 13501-1, or are non-combustible or class A1 in accordance with BS EN 13501-1, 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, it is not practical to expect to have documentary evidence of these for 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 6.*

**5.2.1** Persons conducting an FRAEW should be knowledgeable in relation to the history of notable fires involving significant external fire spread and the lessons learned.

**5.2.2** Persons conducting an FRAEW should understand the various mechanisms of fire spread giving rise to fires involving external wall construction and cladding.

**5.2.3** Persons conducting an FRAEW should have an in-depth understanding of the basis of controls and restrictions contained in standards and guidance relating to external fire spread.

**5.2.4** Persons conducting an FRAEW should understand what provisions are required within external walls to inhibit or delay fire spreading from compartment to compartment, either horizontally or vertically.

**5.2.5** Persons conducting an FRAEW should recognize and take account of:

- a) the fire performance of the external wall construction as a function of the system in question and the relative importance of its components;
- b) the likelihood of secondary fires;
- c) the rate at which secondary fires, if any, would be expected to occur;
- d) whether a secondary fire is likely to result in direct harm to occupants or prevent them escaping;
- e) the role of fire and rescue service intervention, its effectiveness and its limitations;
- f) the wider consequences of external fire spread on means of escape, internal fire spread and access and facilities for the fire and rescue service; and
- g) the extent and effectiveness of fire safety management for the building.

### **5.3 Knowledge of legislative context and proportionality**

#### **COMMENTARY ON 5.3**

*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.*

*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 [16]. 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.*

**5.3.1** Persons conducting an FRAEW 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.*

**5.3.2** Failure of a building to meet the benchmarks given in building 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.

**5.3.3** Persons conducting an FRAEW 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.

## **6 Principles and process for an FRAEW**

### **COMMENTARY ON CLAUSE 6**

*This clause sets out the principles and process for an FRAEW. The principal considerations are as follows.*

#### **a) Purpose of an FRAEW**

*Risk is a function of the probability of a hazard occurring that can result in harmful consequences and the seriousness of those consequences.*

*The appraisal carried out within an FRAEW is similar to, but ultimately distinct from, an assessment of risk. FRAEWs are not fire risk assessments in their own right, but are a significant piece of work that might need to be undertaken either to inform or as part of the wider fire risk assessment process.*

*PAS 9980 requires characterization of risk as a function of fire performance factor (analogous to hazard), façade configuration factor (analogous to probability) and fire strategy factor (analogous to consequence). Together, the fire performance, façade configuration and fire strategy factors are called the risk factors.*

*The principle of PAS 9980 is that the risk factors are used to determine the risk rating, which in turn is used to determine a risk outcome.*

#### **b) Structured approach**

*A typical FRAEW might involve the following process.*

- 1) Gather preliminary information; that which is immediately available from the client.*
- 2) Conduct a simplistic appraisal, making conservative assumptions to mitigate uncertainty as necessary (i.e. where there are unknowns, assume a reasonable worst case position).*
- 3) Where the appraisal in step 2) does not allow risk to be confirmed as tolerable or low, conduct further work to reduce uncertainty and the associated conservatism, subject to proportionality.*

*NOTE It is possible that, on completion of the simplistic appraisal or at any stage later during the FRAEW, the appraiser might conclude that a high risk outcome is sufficiently high that the client and/or dutyholder needs to be advised that immediate steps need to be taken to reduce the risk. In such a scenario, the appraiser needs to alert the client and/or dutyholder as soon as possible so that steps can be taken to address the very high risk.*

- 4) Once further work has been completed, refine the appraisal using the new information.*
- 5) Repeat the steps above until the risk outcome is "low" or it is determined that further work would not be proportionate.*
- 6) Determine the relevant action to take according to the risk outcome, as set out in Clause 7.*
- 7) In the event of a "tolerable" outcome where further work is not proportionate, implement any proportionate risk reduction measures. It might be that no proportionate risk reduction measures are available, in which case the risk will remain "tolerable".*

*The FRAEW is an iterative process. The following principles are fundamental to its correct application.*

- i) The risk-based methodology begins with hazard identification, i.e. the fire performance of each of the external wall constructions (see Clause 10). If the risk is inherently low as a result of all of the external walls presenting little or no inherent hazard, then it is not necessary to proceed to appraising the façade configuration.*
- ii) Assuming that a hazard exists in terms of the fire performance, the façade configuration portion of the appraisal considers the likelihood of the external wall systems becoming involved in fire, and whether in doing so they would provide a route for significant fire spread and/or secondary fires (see Clause 11). If the façade configuration is such that no significant fire spread can occur, then it is not necessary to proceed to appraising the fire strategy.*
- iii) Assuming that a hazard exists in terms of fire performance and there is a likelihood of fire taking hold and spreading significantly across the external walls, the fire strategy portion of the appraisal considers the extent to which relevant persons in and around the building could be exposed to harm in the event of a fire, i.e. consequence (see Clause 12). The extent to which the fire and rescue service might be able to respond to a fire is also relevant at this stage; this is covered in more detail in Annex E.*
- iv) At each of the above stages, the person conducting the FRAEW is expected to take a conservative approach to any uncertainty. If, for example, there is no or little information available concerning the adequacy of cavity barriers in the external walls, then the person conducting the FRAEW ought to assume these are in poor condition until inspections are carried out to confirm their condition. For some forms of external wall construction (e.g. double skin masonry construction and equivalent construction), it might be that a tolerable risk outcome can be achieved even with poor cavity barrier provisions,*

*whereas for others (e.g. rainscreen over combustible insulation), cavity barriers might be highly significant in terms of whether or not good performance will be achieved.*

**c) Proportionality**

*FRAEWs ought to be planned and conducted on the basis of proportionality, whereby the risk outcome is determined in the least costly and most expeditious manner. For example, there will be situations where it can be obviously concluded that risk is either high (e.g. extensive use of Category 3 ACM) or low (e.g. where combustible construction is limited to such an extent that it cannot be a medium for fire spread between flats or over the walls of the building) without the need for intrusive investigations or significant analysis.*

*Where the risk outcome is not obviously high or low, it is likely to be necessary for a more extensive FRAEW process to be carried out, though the FRAEW methodology is adaptable and scalable depending on the reasons why the risk outcome is not obviously high or low. Users are expected to take a proportionate approach to deciding what activities need to be carried out to better understand the risk posed by the external walls of the building (i.e. reducing uncertainty) and to exploring different ways in which a tolerable risk outcome can be achieved. Guidance on information gathering is given in Clause 8, and on site surveys and inspection in Clause 9.*

*Similarly, the methodology is not intended to be prescriptive and other available approaches might be more definitive or quantitative. It is broad ranging and adaptable in its approach, but is intended to be proportionate, and to eliminate from further action those buildings where it can be readily demonstrated that the risk outcome is low or tolerable. Accordingly, it is expected that an FRAEW can begin simply, and become more sophisticated as necessary.*

*Finally, the concept of proportionality also applies to verification, peer review and third-party checking. Where the risk outcome is obviously low, tolerable or high, there might not be any requirement for verification, peer review or third-party checking, but where the appraisal of risk is more complex and/or the risk outcome is less obvious, verification, peer review and/or third-party checking might be required.*

**d) Risk ratings and risk outcomes**

*The ultimate aim of the FRAEW is to rate the fire risk posed by the external wall construction and cladding on a scale of relative risk from “low” to “high” (the risk rating) and, from this, to determine the risk outcome in terms of whether proportionate action is necessary to address a level of risk that is considered unacceptable. To this end, PAS 9980 defines four risk outcomes: low, tolerable, medium and high. Risk outcomes are linked to but not the same as risk ratings. Risk rating is an expression of the hazard, probability and consequences of fire spread via an external wall construction, whereas the risk outcome is an expression of whether the risk rating is low or low enough to be tolerated and/or whether there is proportionate risk reduction action that needs to be taken.*

*Fundamental to this is that the specific circumstances of the building being assessed need to be considered, holistically, when assessing the risk rating. As such, the risk outcome might be sufficiently low to be tolerated even where compliance with the BR 135 [15] performance criteria cannot be evidenced or even achieved. Conversely, even where there is evidence of compliance with the BR 135 criteria, there might be other factors that influence the risk rating, 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 outcome.*

*Additionally, central to the concept of risk outcome is the question of whether there is proportionate action that can be taken to reduce risk. For example, there might be situations where the risk rating is medium and there are no proportionate risk reduction actions that can be taken, and consequently the risk outcome might be tolerable. Conversely, there might be situations where the risk rating is medium but there are proportionate risk reduction actions that could be taken. In these situations, the associated risk outcome would be medium.*

**e) Risk factors**

*In terms of fire performance risk factors, the extreme of “low” hazard at one end would equate to the likely fire performance (regardless of extent of coverage) of construction that does not include combustible materials or cavities, construction that does not include combustible materials and that has adequately subdivided cavities, or a double skin masonry wall (each leaf at least 75 mm thick). At the other extreme, the upper end of “high” hazard risk would equate to the fire performance of a cladding system with Category 3 ACM, which is generally regarded as unacceptable. The concept of the fire performance risk factors is to inform where an external wall system sits on the scale between low and high hazard.*

*However, to determine the risk rating in the context of this PAS, it is often necessary to consider more than just fire performance. Risk factors relating to the probability and consequences of fire spread need to be taken into account; indeed, with the possible exception of fire performance equivalent to Category 3 ACM, these risk factors might outweigh the concerns regarding fire performance risk factors.*

*For avoidance of doubt, while it could reasonably be considered that an external wall construction that achieves compliance with the BR 135 [15] performance criteria 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 outcome cannot be low or tolerable. It is the basic premise of this PAS that judgements on risk factors need to be made in the absence of evidence of compliance with the BR 135 criteria.*

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

*A range of considerations is set out in the examples given in Annex F (relating to fire performance risk factors), Annex G (relating to façade configuration risk factors) and Annex H (relating to fire strategy 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 5.2).*

*Typically, an external wall with a fire performance "in the normal range" used extensively on a building that does not have any exacerbating façade configuration features and that has adequate fire precautions for a block of flats with a stay-put fire strategy would have a dominance of neutral risk factors and lead to a tolerable or low risk outcome.*

- 1) *In the case of the risk 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.*

*The intent of the fire performance factors is to assist in determining where a wall system sits between low and high on a hazard scale, and as such, it might not be necessary or appropriate to consider the impact of all components in situations where an entire system can be placed on the scale by alternative means (e.g. where there is adequate large scale test data available).*

- 2) *In the case of the risk 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.*
- 3) *In the case of the risk 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.*

*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.*

#### **f) Weighting**

*Inherent in the use of risk factors is that there is variance in how positive or negative a factor might be. For example:*

- *Category 3 ACM would be more negative than timber cladding;*

- the combustibility of cladding might be more important than the combustibility of insulation; and
- a construction's extent of coverage (e.g. a system limited to a single storey) might be more significant than its location (e.g. a single storey located at the top of a tall building).

Therefore, any assessment of risk factors ought to consider the relative importance of each risk factor in relation to the specific wall system under consideration. These are not always quantifiable, but a qualitative judgement can nevertheless be made as to their relative impact on fire spread.

Where a risk factor is marked with an asterisk (\*) in the tables in Annex F, Annex G and Annex H, 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.

#### **g) Uncertainty**

With any 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, or the absence of fire performance test data on materials (whether individually or as composites), components or systems that make up the external walls.

Consequently, in existing buildings, whilst it might be possible to reduce uncertainty, doing so might not be practicable or proportionate. Therefore, in many cases, it will be necessary to accept that reducing uncertainty is not practical and instead include conservatism, and/or to accept that it might be more proportionate to mitigate a potentially (but not necessarily) heightened risk than to conduct further work to reduce uncertainty.

Similarly, it is reasonable to expect that clients, enforcing authorities and other stakeholders will accept that uncertainty cannot be eliminated, and as such, will avoid imposing conditions and restrictions on the terms within which an FRAEW is carried out. This would be detrimental to a risk-based assessment and would potentially restrict the willingness of the person conducting the FRAEW to express opinions on risk because of a fear of undue exposure to liability.

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.

Similarly, there is scope for new or further information to come to light that might change the outcome of the appraisal of fire risk. As such, it might become evident that further work is warranted because of, for example:

- 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 such that it is not possible to conclude anything other than the risk outcome is high or, at best, at the upper end of the medium scale, requiring further investigation to refine the assessment of risk; and/or
- the conclusion being highly dependent on the fact that the wall build-up is similar to, but not an exact match for, one classified to BR 135 [15], based on BS 8414 test data, but with walls that meet the pass criteria in BR 135 for this build-up being known to be particularly susceptible to changes in the parameters of their construction.

#### **h) Case studies**

Annex I 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.*

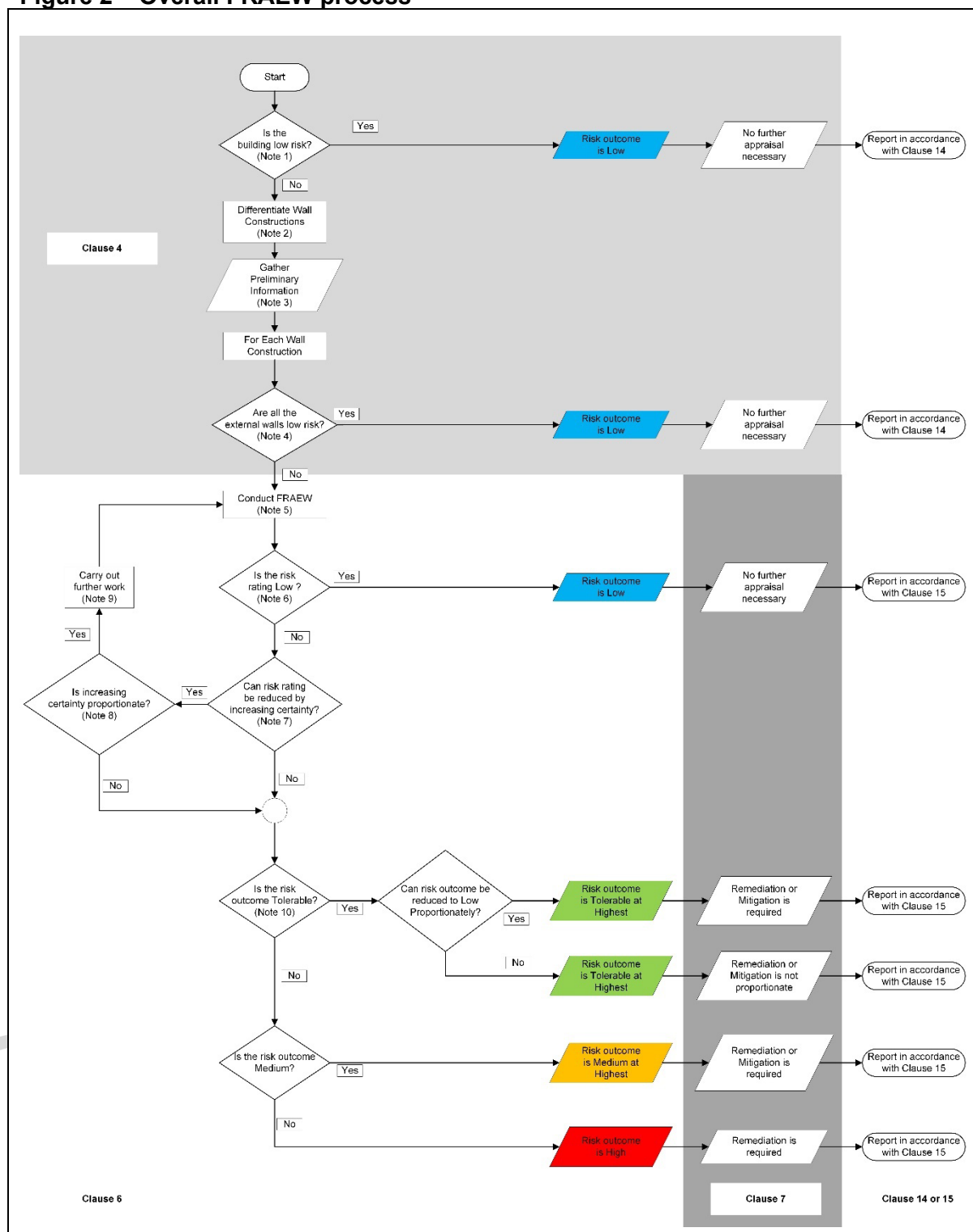
**6.1** The FRAEW should adopt a risk-based approach. It should include not only the fire behaviour of the materials, components and systems within the external walls, but also other risk factors, such as how the façades are configured on the building, the fire hazards in and around the building and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

**6.2** The FRAEW should follow the structured approach shown in Figure 2 and Figure 3 in order to determine an outcome with respect to the fire risk posed by the external wall construction. It should demonstrate that proportionate efforts have been made to determine and take into account:

- a) the likely performance of each of the external wall types in a fire (see Clause **10**);
- b) if, in respect of a), the external walls are not all low risk, 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 (see Clause **11**); and
- c) if, in respect of a) and b), the external walls and their configuration are not low risk, how such a fire could directly, or indirectly, cause harm to the occupants and impact on their ability to escape in time (see Clause **12**).

*NOTE In the interests of proportionality, the structured approach may be iterative, beginning by relying on the information that is immediately available, where more work is conducted in each iteration to increase certainty as necessary.*

**Figure 2 – Overall FRAEW process**



## **Figure 2 – Overall FRAEW process**

**NOTE 1** The parameters for determining whether the building is low risk are set out in Clause 4.

**NOTE 2** Guidance on how to differentiate the wall constructions and attachments is given in Annex J. The fire performance and façade configuration of each external wall construction need to be considered individually.

**NOTE 3** Enough preliminary information needs to be gathered regarding each external wall construction and any attachments to determine whether all are inherently low risk or to trigger a first iteration of an FRAEW (see Clause 4 and Clause 8). In some instances, very little information will be required (e.g. because the risk is likely to be low regardless of the as-built construction), but in others more detailed information might be required (e.g. because risk is likely to be highly sensitive to as-built construction details).

**NOTE 4** The parameters for determining whether the external walls and attachments are low risk are set out in Clause 4 and Clause 8.

**NOTE 5** The process of conducting the FRAEW is shown in Figure 3.

**NOTE 6** Where the current iteration of the FRAEW concludes that the risk is low, in spite of any uncertainty that might exist, then the process can conclude without any further work. Guidance on reporting of uncertainties is given in Clause 15.

**NOTE 7** If the risk is not low, further work and further iterations might be proportionate to reduce uncertainty and lower the risk outcome. This is because it is possible that actual risk rating is lower than that currently assessed, and that the assessed risk rating could be reduced by increasing certainty to reduce conservatism.

**NOTE 8** Certainty ought to be increased only when the benefit of doing so outweighs the cost/impact). In some situations, it might be more proportionate to reduce or mitigate a potentially (but not necessarily) heightened risk than to provide the increased certainty required to determine whether the risk is, in fact, heightened.

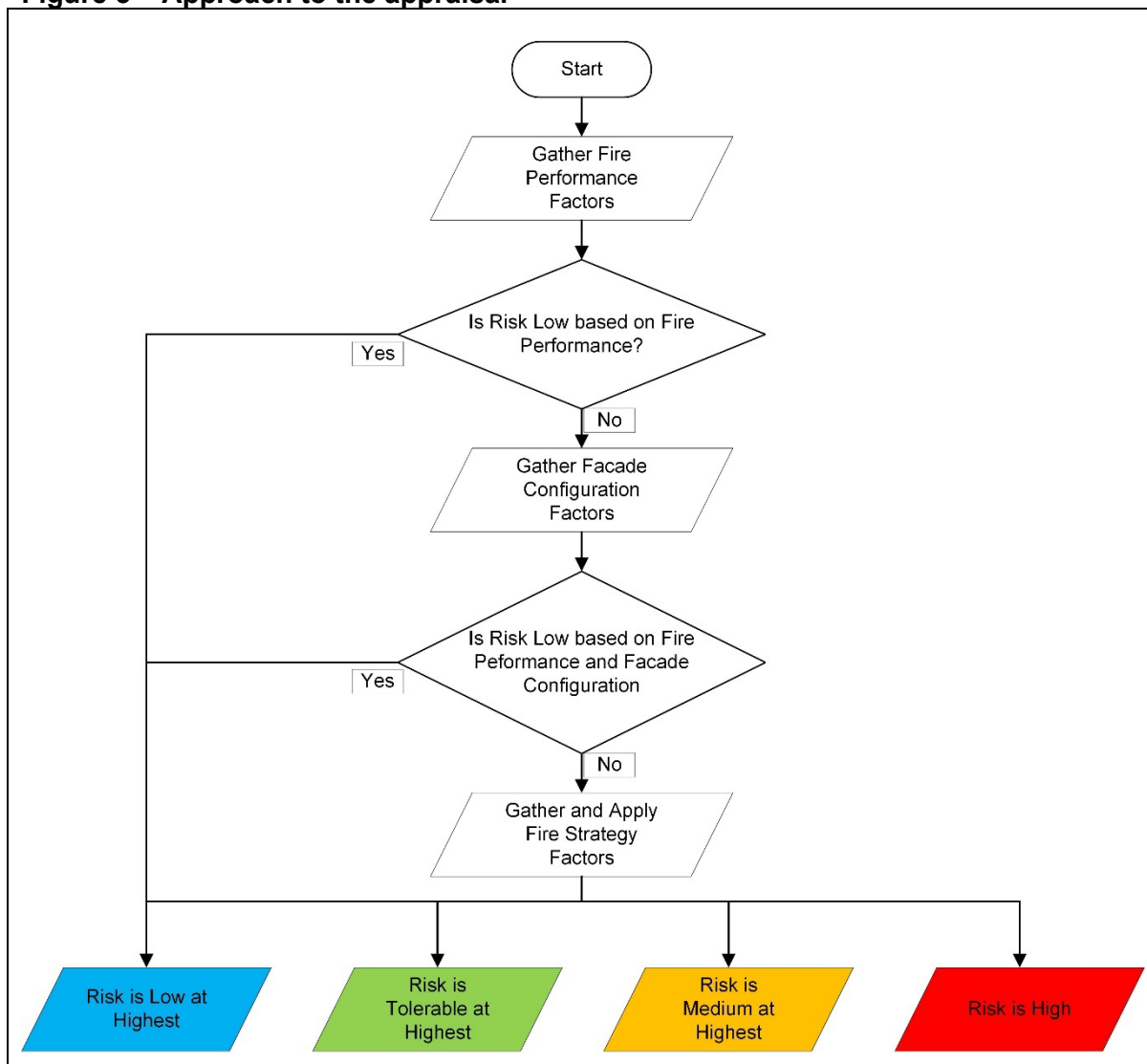
**NOTE 9** Further work that might need to be carried out (subject to proportionality; see Note 8) includes:

- gathering more information (see Clause 8);
- conducting intrusive inspections (see Clause 9);
- using more detailed analysis (see Clause 13); and
- commissioning fire testing to quantify performance (see Annex A and Annex K).

**NOTE 10** If the risk is not low and it is not proportionate to conduct further work, then:

- if the risk is tolerable, it might be proportionate to reduce the risk to low (see Clause 7); and
- if the risk is not tolerable, it needs to be reduced or mitigated (see Clause 7).

**Figure 3 – Approach to the appraisal**



**6.3** Persons conducting an FRAEW should take into account the principle of proportionality when formulating the specific investigations and analysis to carry out the FRAEW and when forming an opinion on the risk and the appropriate risk reduction and/or mitigation measures, including considerations of benefit gained, practicality and cost.

*NOTE* The requirements of the Fire Safety Order [16] 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.

**6.4** Buildings determined to be “low” risk, following the FRAEW completed with the initially available information, should be eliminated from further consideration in relation to the fire risk posed by the external walls of the building.

*NOTE* This PAS accepts that buildings might necessitate an FRAEW as a result of application of the decision making process at Clause 4. However, escalation to an FRAEW does not preclude the possibility that the FRAEW quickly establishes a low risk outcome.

**6.5** The relevant risk factors relating to fire performance, façade configuration and fire strategy/fire hazards, and their impact, should be evaluated both individually and 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 (see Figure 4). The following overarching steps should be taken.

- a) Each external wall construction present on the building should be individually appraised in terms of its fire performance (see Clause 10). All risk factors that are relevant to the fire performance of each external wall construction should be determined as being positive, neutral or negative, as informed by the guidance in this PAS.

*NOTE 1 Some examples are provided in Annex F.*

- b) Where necessary, the façade configuration of each external wall construction should be individually appraised, taking into account the fire performance previously established (see Clause 11). Where the façade configuration needs to be appraised, all relevant risk factors should be determined as being positive, neutral or negative, as informed by the guidance in this PAS.

*NOTE 2 Some examples are provided in Annex G.*

- c) The way in which a fire could directly or indirectly cause harm to the occupants and impact on their ability to escape in time, given the fire strategy and any other fire safety issues, should then be appraised (see Clause 12). Where the fire strategy and any other fire safety issues need to be appraised, all relevant risk factors should be determined as being positive, neutral or negative, as informed by the guidance in this PAS.

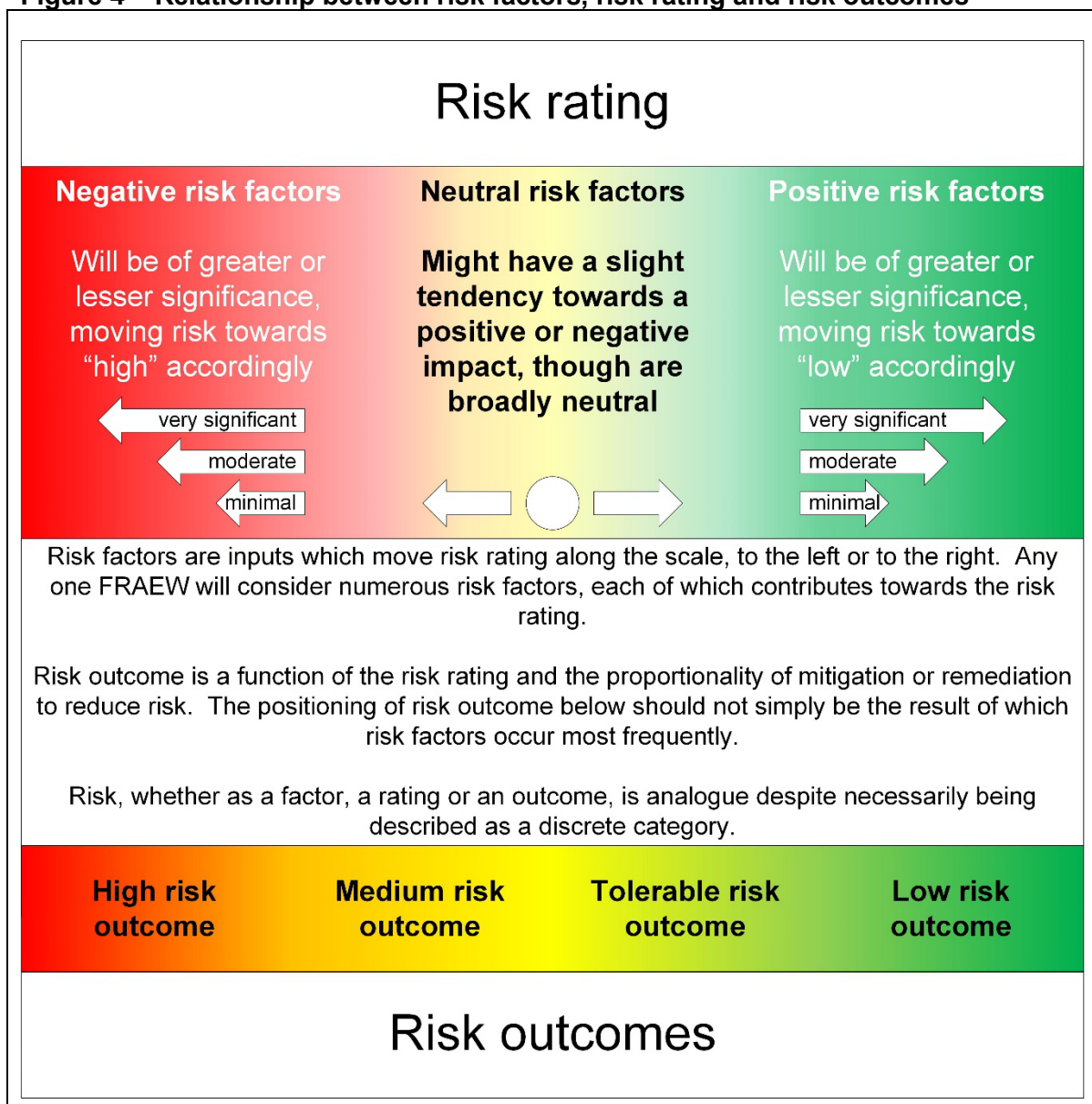
*NOTE 3 Some examples are provided in Annex H.*

- d) Finally, all of the above should be brought together to produce an overarching appraisal of the fire risk outcome arising from the external wall construction.

*NOTE 4 In any risk assessment there is unavoidable uncertainty and therefore appraisers should consider the possibility that risk exists within a range rather than being absolute. Appraisers should therefore satisfy themselves that the risk rating selected is appropriate in spite of uncertainty.*

**6.6** The risk factors should be weighted, according to their relative importance (see Figure 4), in order to determine how significant they are, collectively, in establishing whether each of the benchmark criteria in 5.2 have been met. Annex F, Annex G and Annex H contain example risk factors, but these should not be treated as absolute or definitive; appraisers should exercise (and then record) professional judgement as to the manner in which risk factors are applied and weighted in respect of a particular building and its circumstances.

**Figure 4 – Relationship between risk factors, risk rating and risk outcomes**



**6.7** 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, lead to:

- a) a “high” risk outcome, 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 outcome, where it cannot be confirmed with sufficient certainty that the risk is low enough to be tolerable, and risk reduction or mitigation is required; or
- c) a “tolerable” risk outcome, where 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
- d) a “low” risk outcome, 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 5.2 for commentary on risk-based benchmark criteria).

**6.8** Where the risk rating is determined not to be “low”, the person conducting the FRAEW should determine the value of conducting further work, in order to establish a more definitive risk rating. Such further work (see Note 9 to Figure 2) should be recommended to the client where deemed appropriate.

**6.9** In determining the level of risk, the person conducting the FRAEW 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 taken into account are discussed in Annex H.

## **7 Outcomes and actions from an FRAEW**

### **COMMENTARY ON CLAUSE 7**

*The primary purpose of an FRAEW is to appraise the risk of fire spread of existing external wall construction and determine whether risk reduction is required (as opposed to defining the appropriate risk reduction). This is because risk reduction needs to be proportionate and is likely to require input from multiple stakeholders. Notwithstanding, PAS 9980 can be used to identify and evaluate whether risk reduction options would adequately reduce risk, by repeating an assessment on the assumption that a particular risk reduction measure has been actioned.*

*Where an FRAEW determines that the risk outcome is “low”, it can be concluded that fire spread involving the external walls will be no worse than the benchmark expectations set out at 5.2 and, as a result, no further action is needed. However, given that an FRAEW has been carried out (as either the building or some of its external walls are not inherently low risk), there will be a need for some degree of periodic review of the FRAEW to provide ongoing confidence that the risk remains “low”. This might involve the person conducting the FRAEW setting a review interval based on the specific wall types that have been appraised and expectations as to the long-term performance/degradation of these systems, or simply requiring the dutyholder to monitor the condition of the external walls on a regular basis and commission an FRAEW review where there is any sign of change in the external walls, or where changes are made to them.*

*Where an FRAEW concludes that the risk outcome is “tolerable”, consideration needs to be given to proportionate means by which the risk can be further reduced to “low”; there will, however, be many cases where it is not proportionate to do so. This might involve immediate actions such as remediating a small number of cavity barriers at locations that are particularly significant in terms of fire or smoke spreading to means of escape, but would not be expected to include wholesale remediation of cavity barriers. Longer-term actions to reduce risk also need to be considered, such as recommending that future planned preventative works incorporate specific actions to reduce risk; this might include recommending upgrading the performance of external wall components if/when there is any refurbishment of the external walls in future. Options for mitigation need to be considered, but the immediate and long-term costs of these need to be taken into account and weighted. It might, for example, be proportionate to make modifications to an existing fire detection and fire alarm system so that it provides early warning in the event of fire involving the external walls, but it would not be proportionate (or desirable) to alter fundamentally the evacuation strategy of a building via installation of a new fire detection and fire alarm system. Provision of a waking watch is not proportionate to a “tolerable” risk outcome given the high cost and limited benefits associated with it.*

*Equally, it might be concluded that there are no proportionate actions that can be identified; in this case the risk outcome simply remains “tolerable”. As with the “low” risk outcome, there needs to be periodical review of the FRAEW that includes an appraisal of the condition of the building and whether the risk outcome remains accurate.*

*Where an FRAEW concludes that the risk outcome is “medium”, either mitigation or some degree of remediation will be necessary to reduce risk to either “tolerable” (at which point the considerations above apply) or “low”. 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, this could involve 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. Annex J provides guidance on the various approaches that might be taken in mitigating risk.*

*Where an FRAEW concludes that the risk outcome is “high” then remediation is likely to be the only viable option for reducing risk outcome to a “tolerable” or “low” risk outcome. In the context of an FRAEW, a high risk outcome might be very high, such as:*

- *a scenario where fire spread is likely to be both very rapid and extensive, and where there is a high likelihood of fire occurring; or*
- *a scenario where there would be no realistic prospect of evacuation in the event of fire, such as if extended dead end means of escape has been justified by AOVs, but these open onto very poor performance cladding.*

*As with all of the risk outcomes, “high” risk covers a range and it is expected there will be a range of approaches to and urgency of remediation.*

**7.1** Where the FRAEW establishes that risk is very high, the person conducting the FRAEW should notify the dutyholder as soon as possible, giving details of mitigating measures that might be appropriate. It is necessarily the case that, if there is a very high risk, there will be significant findings in the FRAEW, and the person conducting the FRAEW 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 deemed appropriate.

**7.2** For external walls where the risk outcome is “high” or “medium”, the person conducting the FRAEW should highlight where there is the potential for further work to reduce uncertainty and consequently lower the risk rating.

*NOTE Further work might include further inspections to better understand the external wall construction, e.g. the rate of any deficiencies in construction and how significant these are.*

**7.3** The person conducting the FRAEW should determine whether mitigation measures need to be implemented in order to address either a known risk or uncertainty.

*NOTE Uncertainty might exist as a result of lack of data, and reducing that uncertainty might be more expensive than simply implementing mitigation measures.*

**7.4** Where it is concluded, following further work, that the risk is still greater than “tolerable”, the person conducting the FRAEW should make the client and the fire risk assessor fully aware of the implications 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.

**7.5** Where a “tolerable” risk outcome is established, the FRAEW should be kept under review at a frequency determined by the person conducting it. 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 person conducting the FRAEW should recommend that the action plan within the building’s FRA identifies the need for such a review.

**7.6** Where a “low” risk outcome is established, some degree of periodic review of the FRAEW might need to be set by the FRAEW, taking into account reasonably foreseeable circumstances why the external walls might change in a way that impacts fire performance, for example service life and significant changes being made to the wall construction.

**7.7** The outcome of the FRAEW 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 assessment of the fire risk posed by the external walls.

## **8 Information gathering**

### **COMMENTARY ON CLAUSE 8**

*As set out in Clause 4 and Clause 6, information needs to be gathered as part of any work carried out in accordance with this PAS. This includes details of the building as well as materials, components and systems forming the external walls and how they have been configured on the building. The extent to which information needs to be gathered needs to be guided by risk, uncertainty and proportionality. For example, where it is established that a building is inherently low risk due to its use and size, it is expected that very little information will need to be gathered regarding the external wall construction (other than, for example, a cursory check that there are no obviously unsuitable materials used in the external wall construction). Similarly, where it is established that the form of construction being appraised is not reliant upon the provision of adequate cavity barriers to be of low risk, then inspections of cavity barriers will not be necessary. Conversely, external wall constructions that are highly reliant on proper detailing and high quality workmanship (such as expanded polystyrene render systems incorporating fire barriers) will need to be inspected to establish whether or not the as-built construction is adequate.*

*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 need be undertaken between the standards that apply at the time of appraisal and those that applied at the time the building was constructed. Nevertheless, the extent to which a building met 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 established.*

*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:*

- a) the different types of external wall build-up and attachment (e.g. balconies);*
- b) 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;*
- c) 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*
- d) the building's fire strategy<sup>5)</sup>; and*
- e) the building's fire risk assessment.*

*Further guidance on information gathering is given in Annex L.*

*Persons conducting an FRAEW can 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 person conducting the FRAEW would be expected to take responsibility for the input of others, so that the tasks*

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<sup>5)</sup> 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.

*required to enable all necessary information needed for the FRAEW can be clearly defined and delegated, and that the expectations placed on the output of others are clearly understood by them. The person conducting the FRAEW would be expected to verify that others assisting them in this way are suitably competent (see Clause 5).*

*It is also likely that persons conducting an FRAEW 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, persons conducting an FRAEW 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 a person conducting an FRAEW 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 included in an assessment when following the methodology set out in Clause 6.*

*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, a person conducting an FRAEW would be expected to verify key information from this where it is critical to the FRAEW and its outcome.*

**8.1** Persons conducting an FRAEW 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.

**8.2** Where details of 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 9).

**8.3** 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.*

**8.4** Where others, with the necessary resources or specialist knowledge, are engaged to assist in gathering information, the person conducting the FRAEW 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 person conducting the FRAEW 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.

**8.5** 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, the person conducting the FRAEW 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. Persons conducting an FRAEW 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.

## **9 Site surveys and investigations**

### **COMMENTARY ON CLAUSE 9**

*No matter how comprehensive the original design information for the external walls of a building might be, it can only ever show what was intended to be constructed. The construction as-built can be, and often is, quite different. Product substitution is not uncommon, and sometimes there are substantial differences between the fire performance of the products identified in the design and those present in the construction as-built.*

*Site survey and inspection is, therefore, essential to gain accurate knowledge of the composition and construction of the external walls and cladding as-built.*

*The extent of site surveys and investigations required to complete an FRAEW varies and is determined by the nature and extent of the information required. The purpose of each specific investigation depends on the results of the information gathering stage and the study of available drawings and other documents (see Clause 8). In any event, site surveys and investigations are likely to include some, or all, of the following activities:*

- *removal of components to reveal the wall build-up and determine what materials and products have been installed. This also allows the identity of the specific products, and their respective manufacturers, to be established;*
- *removal of samples 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;*
- *removal of external panels and/or finishes (including fixings and supports) at key locations to establish:*
  - *the presence of specific components such as cavity barriers;*
  - *the methods of construction used; the standard of workmanship;*
  - *the condition of components; and any evidence of deterioration of the cladding system; and*
- *checking whether the construction as-built is in accordance with the design described in the specification, drawings, etc. or any other design documents viewed as part of the document study (see Clause 8).*

*Where limited site investigations show that the construction as-built is not in accordance with the design described in the specification, drawings, etc., further detailed analysis of the construction as built will be needed to establish its likely performance in the event of fire.*

*This analysis could involve the removal of materials and/or components from the external wall for testing to establish:*

- *the physical characteristics of materials that are unidentified, or unbranded, and for which there is no reliable technical information, so that their performance can be compared with that of materials specified but not used; and*
- *the performance or reaction to fire of a material or component, to enable an assessment to be made 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.*

*Testing of this type can be time-consuming and expensive. In many cases, relatively limited site surveys and investigations will suffice to establish what materials and components have been installed 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 number and extent of site surveys and investigations needed to assess the fire risk posed by the external walls cannot be stipulated in this PAS. The person conducting the FRAEW needs to make a professional judgement as to what is appropriate for the building being assessed. It is unlikely to be possible to determine the number and extent of site surveys and investigations at the outset of an FRAEW; clients therefore need to be made aware of the need to be flexible in this regard.*

*The number and extent of site surveys and investigations is influenced by a several 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 overclad;*
- *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 the number and extent of site surveys and investigations needed, it is expected that proposed locations for sampling, and other relevant information needed by those conducting the investigation work, would*

*be recorded before 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 carrying out site surveys and investigations need to have sufficient survey skills and experience to conduct, or direct others to conduct, the investigations required. They also need to have broad knowledge and experience of external wall design and construction so that, when components of walls are removed and samples taken, undue damage can be avoided, and effective reinstatement and/or repairs can be achieved.*

*Reports of investigations carried out by others prior to the FRAEW being commissioned can also influence the number and extent of site surveys and investigations that need to be carried out as part of the FRAEW.*

*Persons conducting an FRAEW need to judge the extent to which they rely on the work of others. This judgement involves their perception of the quality of the work carried out and whether it is likely to be sufficient in terms of its scope and the items it has addressed.*

*A person conducting an FRAEW ought to satisfy themselves of the veracity of any information contained in reports prepared by third parties. In some circumstances, it might be necessary to undertake a visual inspection of the building to verify 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, though this might be limited in extent.*

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

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

**9.1** Surveys and investigations in relation to an FRAEW should be planned to minimize the extent of opening-up work and maximize the benefit obtained. Arrangements should be made for these plans to be communicated to the relevant parties.

*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.*

**9.2** An appropriate number of inspection locations should be established, taking into account the purpose of the opening up work and any other relevant factors.:

**9.3** Where reports of investigations carried out by others prior to an appraisal being commissioned are made available, the person conducting the appraisal should use their own surveys and investigations to assess the veracity of the information they contain.

*NOTE Wholesale repetition of opening-up work conducted by others is generally to be avoided. However, an increase in the number of the opening-up locations, 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 others.*

**9.4** Persons undertaking site survey and inspection work should have sufficient and appropriate skills, knowledge and experience of the construction of external walls to be able to conduct, or direct others to conduct, the investigations required without causing undue damage and to undertake, or direct, effective reinstatement works.

**9.5** Persons undertaking site survey and inspections should accurately record their findings in a form suitable for inclusion in a report. Persons reading the report should easily be able to identify:

- a) the locations where opening up took place;
- b) the precise locations from which photographs were taken;
- c) the precise locations from which samples of materials and components were removed;
- d) the identity of all samples removed for testing;
- e) the nature and extent of deficiencies, deterioration of products and workmanship issues identified, and the locations where they were observed; and
- f) any differences between the original design intent for the external wall and the construction of the external wall as-built.

*NOTE It is preferable for the findings to be recorded using proprietary software designed for the purpose.*

## **10 Fire performance of external walls and attachments**

### **COMMENTARY ON CLAUSE 10**

*In 5.2, 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. The present clause is concerned with estimating the potential hazard arising from the external wall construction and any attachments, relative to the benchmark criteria set out in 5.2.*

*Having identified that the external walls contain combustible material, the person conducting the FRAEW 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 type of system in question, the associated hazards, the components that influence overall performance and the associated hazard mitigation strategies (further details are given in Annex J). They will then need to determine the overall fire performance as a function of the relative importance of the components (see Annex F) that influence overall performance.*

*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 hazard and therefore the risk posed by the external walls on a building, or decisions to be taken regarding what is an appropriate action in response.*

*Ultimately, the aim 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 determining whether the walls provide an acceptable level of fire performance.*

*When assessing existing buildings, it is likely that other components will 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 might be that the external wall construction being assessed is obviously low hazard.*

*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 likely to be acceptable if:*

- *they are only present where other main components, such as the cladding or insulation, are non-combustible or of limited combustibility; or*
- *they do not form a complete framing and support system, e.g. timber battens when used in isolation, rather than an extensive support system; or*
- *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 a building in which the external walls are potentially low hazard by virtue of the above, further assessment might be required if there are concerns that the quality of construction might be poor, that there are insufficient cavity barriers or that cavity barriers are missing. 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.*

*The ranking of fire performance needs, to the extent available, to take into account the outcome of small, intermediate and large-scale fire tests where these give directly relevant results. Any additional testing ought to be conducted only where proportionate.*

*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.

*Further information on fire performance factors is given in Annex F.*

*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]. Annex K provides specific guidance on how to use data from BS 8414 tests and BR135 classification in the context of this PAS.*

*Annex N 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 the product-specific information takes precedence over the information in this annex.*

*Annex O provides further commentary relating to fire performance considerations of different external wall materials, systems and configurations. Information can also be obtained from other sources, such as the Cladding Materials Library operated by the University of Queensland (<https://claddingmaterialslibrary.com/>).*

**10.1** When the person conducting an FRAEW has identified that combustible material is present, they should then establish the significance of that material on the likely rate and potential extent of fire spread, based on an understanding of the hazards associated with the system in question, the quantity of the material, its location within the wall build-up and its behaviour in fire.

**10.2** 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 deemed to give rise to either acceptable risk or unacceptable risk, should be used to place the anticipated performance of the walls in context. The influence of each risk factor 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 6. Appropriate weight should be attached to each one, by virtue of whether it has scope to influence the outcome positively or negatively.

*NOTE Establishing the fire performance factor for each external wall construction is likely to involve use of the risk tables in Annex F, the principles in Annex J, Annex N and Annex O and/or empirical evidence.*

**10.3** Where two different constructions are so interlinked that they effectively comprise a single wall type (e.g. bands of one form of construction at floor level, with areas of different construction between floors) then the person conducting the FRAEW should appraise how each of the forms of construction come together in terms of supporting fire spread and development.

## **11 Façade configurations of external walls and attachments**

### **COMMENTARY ON CLAUSE 11**

*Where it has not been possible to conclude that the hazard of fire spread is sufficiently low, it is necessary to assess the potential for fire spread to result in secondary fires or to compromise routes for means of escape or fire and rescue service access. This is addressed by considering the configuration of wall types and attachments across the façades. For avoidance of doubt, an external wall system that has been found to be low hazard in terms of fire performance cannot become higher hazard as a result 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 lateral extent of the cladding (although lateral fire spread is 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 or combustible materials provide a continuity regardless of the construction of the soffit or separating compartmentation lines);*
- 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 façade configuration factors for a building that can be used in the overall assessment of the risk rating. This is set out in Annex G. 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 person conducting the FRAEW 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 5).*

*As discussed in Annex G, 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 greater potential for 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 building that has more than six floors, 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 building with fewer than six storeys. On the other hand, if only the top six storeys of a building with more than six storeys 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).*

**11.1** 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.

**11.2** 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 6. Appropriate weight should be attached to each one, by virtue of whether it has scope to influence the outcome positively or negatively.

*NOTE* Establishing the façade configuration factor for each external wall construction is likely to involve use of the risk tables in Annex G and the principles in Annex J.

**11.3** Where two different constructions are adjacent to each other, such that the performance of one might impact the other, the person conducting the FRAEW should appraise how each of the forms of construction come together in terms of supporting fire spread and development.

## **12 Impact of a building's fire strategy on the risk arising from external walls**

### **COMMENTARY ON CLAUSE 12**

*In the context of a risk-based approach, as outlined in this PAS, if appraisal of fire performance and configuration of the external walls concludes that some form of external fire spread is to be expected (i.e. the risk is not low) then the extent to which such a fire could impact the safety of relevant persons needs to be examined further.*

*Consequence factors arising from fire strategy/fire hazards (including limitations of fire and rescue intervention) are those that 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 strategy;*
- *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, although there might in some circumstances be an evacuation alert system for use by the fire and rescue service. 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.*

*FRAs (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 11 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.*

*FRAs might also identify shortcomings in other aspects of a building, such as in compartmentation or the operation of active systems (whether as a result of defects or general wear and tear). Any such shortcomings will necessarily impact on the overall level of risk and whether or not it can be tolerated. FRAEWs need to consider both the current risk outcome (including the impact of the shortcomings) and the risk outcome once those shortcomings have been resolved. In most cases, it is expected that resolving internal issues identified in the FRA will be easier and less costly than undertaking mitigation or remedial works relating to the external walls; however, dutyholders need to be provided complete information regarding the various risks and potential actions, so that they can act accordingly.*

*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. fire 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 H. This includes those relating to fire and rescue service intervention (see also Annex E).*

**12.1 Risk factors relating to the fire strategy of the building should be determined, in order to establish the extent to which fire spread via the external walls, and any secondary fires resulting from these, might impact the safety of people in and around the building.**

*NOTE Establishing the fire strategy factors for the building is likely to involve use of the risk tables at Annex H and the principles in Annex J.*

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**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 6. Appropriate weight should be attached to each one, by virtue of whether it has scope to influence the outcome positively or negatively.

### **13 Tools for more detailed analysis as part of assessment**

#### **COMMENTARY ON CLAUSE 13**

*As explained in Clause 6, 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.*

*The primary method for establishing risk, as set out in Clause 6, is likely to rely upon the information in the tables in Annex F, Annex G and Annex H. This method 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, still tolerable.*

*However, in some instances, it might be necessary and appropriate to either replace or augment the method with more detailed analysis. This might involve, for example, using alternative analytical tools, empirical data or evidence and/or 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 usually a practical proposition for routinely determining the fire risk posed by external walls on an existing block of flats.*

*Annex P provides additional information on tools for more detailed analysis and Annex K provides additional information on using BS 8414 test data, BS 9414 and the BR 135 [15] performance criteria. For the avoidance of doubt, this PAS accepts that data from BS 8414 tests can be used to inform the fire performance factor (even if the test specimen is not an exact representation of the as-built construction), and it is not a provision of this PAS that BS 9414 be applied. Similarly, any usage of BS 8414 test data to inform the fire performance factor does not purport to be an assessment in lieu of test (which is beyond the scope of this PAS).*

*The level of competence necessary to apply advanced tools or fire safety engineering analysis is greater than that required for the FRAEWs based solely on the risk tables in Annex F, Annex G and Annex H. This is discussed in Clause 5. Persons conducting an FRAEW need to have the competence to be able to conduct such an assessment, and to be able to demonstrate this to their clients and, where appropriate, enforcing authorities and other stakeholders.*

**13.1** Where it is not possible to conclude, from an FRAEW conducted in accordance with Clause 6, that the risk is “low” or “tolerable”, the person conducting the FRAEW should determine whether a more detailed analysis would enable the risk to be refined.

*NOTE 1 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.*

*NOTE 2 The tools for conducting a more detailed analysis are set out in Annex P.*

**13.2** If it is determined that a more detailed analysis is necessary, the person conducting the FRAEW should advise the client on the nature of such analysis.

*NOTE For example, where concerns over the particular nature of the cladding, or the complexity of the wall construction, lead the person conducting the FRAEW 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.*

**13.3** Where a detailed analysis is undertaken, it should be carried out by a person with the appropriate level of competence.

*NOTE Annex P gives guidance on some tools that can be used for detailed analysis.*

## **14 Scope and format of reports that do not contain an FRAEW**

### **COMMENTARY ON CLAUSE 14**

*Reports prepared in accordance with this PAS need not follow a prescribed format, and this PAS does not contain a proforma for a report.*

*Reports that do not contain an FRAEW are expected to be largely factual in nature, setting out the nature of a building or of its external wall construction, and confirming that this accords with one of the options set out in the Commentary on Clause 4 where the risk is inherently low risk, thus negating the need for an FRAEW.*

**14.1** The report should make clear that it is intended to inform the building's FRA, i.e. that its findings are to be interpreted in the context of the ongoing legislative control over the building under the relevant legislation.

*NOTE* In England and Wales, the relevant legislation is the Fire Safety Order [16].

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

*NOTE* The report might identify relevant standards and guidance that supported the building regulations at the time when the building was constructed (e.g. ADB), as a reference point.

**14.3** Where the building or all of its external walls are determined to be inherently low risk in accordance with Clause 4 (i.e. the report does not need to contain an FRAEW), and where this determination has been made by applying the process shown in Figure 1, the report should include a statement of the competence of the report's signatories to use and apply this PAS to the building for which the report has been commissioned.

**14.4** The report should set out, as a minimum:

- a) the name of the appraiser and the organization they work for;
- b) the date the report was completed and the date(s) of any inspection(s);
- c) the address of the building being appraised;
- d) the use or uses of the building;
- e) the dimensional metrics of the building;
- f) the age of the building (this may be approximate);
- g) an explanation as to how a low risk outcome has been arrived at (see Clause 4); and
- h) summary form information that might assist dutyholders in complying with relevant statutory duties (for example, the Fire Safety (England) Regulations 2022 [18]).

## **15 Scope and format of reports containing FRAEWs**

### **COMMENTARY ON CLAUSE 15**

*Reports need not follow a prescribed format, and this PAS does not contain a proforma for a report. However, it is important that reports containing FRAEWs include sufficient explanation for readers about the process followed in producing the FRAEW.*

*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** The report should make clear that it is intended to inform the building's FRA, i.e. that its findings are to be interpreted in the context of the ongoing legislative control over the building under the relevant legislation.

*NOTE* In England and Wales, the relevant legislation is the Fire Safety Order [16].

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

*NOTE* Report might identify relevant standards and guidance that supported the building regulations at the time when the building was constructed (e.g. ADB), as a reference point.

**15.3** The report should clearly state that the FRAEW addresses life safety and not property protection, specifically in relation to the appraisal of the fire safety of the external walls of the building.

**15.4** The report should clearly state that, being a risk-based assessment reliant on professional judgment, the FRAEW cannot guarantee that a particular outcome will occur in the event of a fire. However, the FRAEW should provide readers with an evidence-based rationale for, and therefore confidence in, the conclusions reached.

**15.5** 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.

**15.6** The report should include a statement of the competence of the FRAEW report signatories to use and apply this PAS to the building for which the FRAEW has been commissioned. This statement should provide clear information of the relevant professional experience of the person conducting the FRAEW and other persons signing the report in a review or authorizing capacity.

*NOTE 1* This statement ought not to refer to applications for qualifications or professional body membership that are in progress or pending award as evidence of competence.

*NOTE 2* A list of postnominals is not, in and of itself, evidence of competence. Postnominals are used by professional organizations to demonstrate a level of membership.

**15.7** The report should set out at least the following information before the substance of the FRAEW:

- a) the name of the appraiser and the organization they work for;

- b) the date the report was completed and the date(s) of any inspection(s);
- c) the address of the building being appraised;
- d) the use or uses of the building;
- e) the dimensional metrics of the building;
- f) the age of the building (this may be approximate);
- g) the basic form of construction of the building (e.g. concrete frame, timber frame, modular);
- h) a description of the wall types and their location/extent of coverage across the building; and
- i) details as to how the as-built condition of each wall type has been established (e.g. drawings, photographs, intrusive inspections, operation and maintenance manuals).

*NOTE Some of this will necessarily duplicate information that is given in the executive summary (see 15.16).*

**15.8** The report should make clear the constraints and limitations that have applied in conducting the FRAEW and arriving at a risk rating. Relevant limitations and sources of uncertainty should be set out, 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.

**15.9** The 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 (see 6.5 in particular), including:

- a) the performance of the materials, components and systems forming each 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) where necessary, 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) where necessary, 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 enable residents to leave safely before the onset of untenable conditions in the flats and in the common parts used for escape.

**15.10** It is not expected that the weight attached to the factors set out in **15.9** 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.

**15.11** The report should state the risk outcome and contain an explanation of the basis for the risk outcome that is deemed to apply, including the relative weight of risk factors and an explanation of any professional judgements that have been made as part of the FRAEW. The explanation should relate to the benchmark criteria described in **5.2**.

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

- a) 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.*

**15.13** Where the risk outcome of the FRAEW is that the external wall construction is “low” risk, or “tolerable” risk without further action, the 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.

**15.14** The report should set out the necessity for, urgency of, and nature of any interim measures that are considered appropriate; and recommendations for mitigation or remediation considered necessary.

**15.15** 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) if the external wall reaches the end of its expected service life or appears materially aged/worn; and/or
- c) in the event of a fire incident, if the fire involved the external wall construction; and/or
- d) 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.

**15.16** The report should include an executive summary, which should contain:

- a) the address of the building being appraised;
- b) the use or uses of the building;
- c) the dimensional metrics of the building;
- d) the age of the building (this may be approximate);
- e) the number of wall types and attachments, a brief description of each and the risk outcome for each;
- f) the overall risk outcome;
- g) a short explanation as to how the risk outcome has been arrived at;
- h) a summary of any recommendations for action (e.g. options for mitigation or remediation); and
- i) summary form information which might assist dutyholders in complying with relevant statutory duties (for example, the Fire Safety (England) Regulations 2022).

*NOTE Some of this will necessarily duplicate information that is given in the main report (see 15.7).*

**15.17** Persons authorizing or otherwise signing the report should satisfy themselves that the report is a piece of work that they themselves would be happy to provide.

## **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).

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

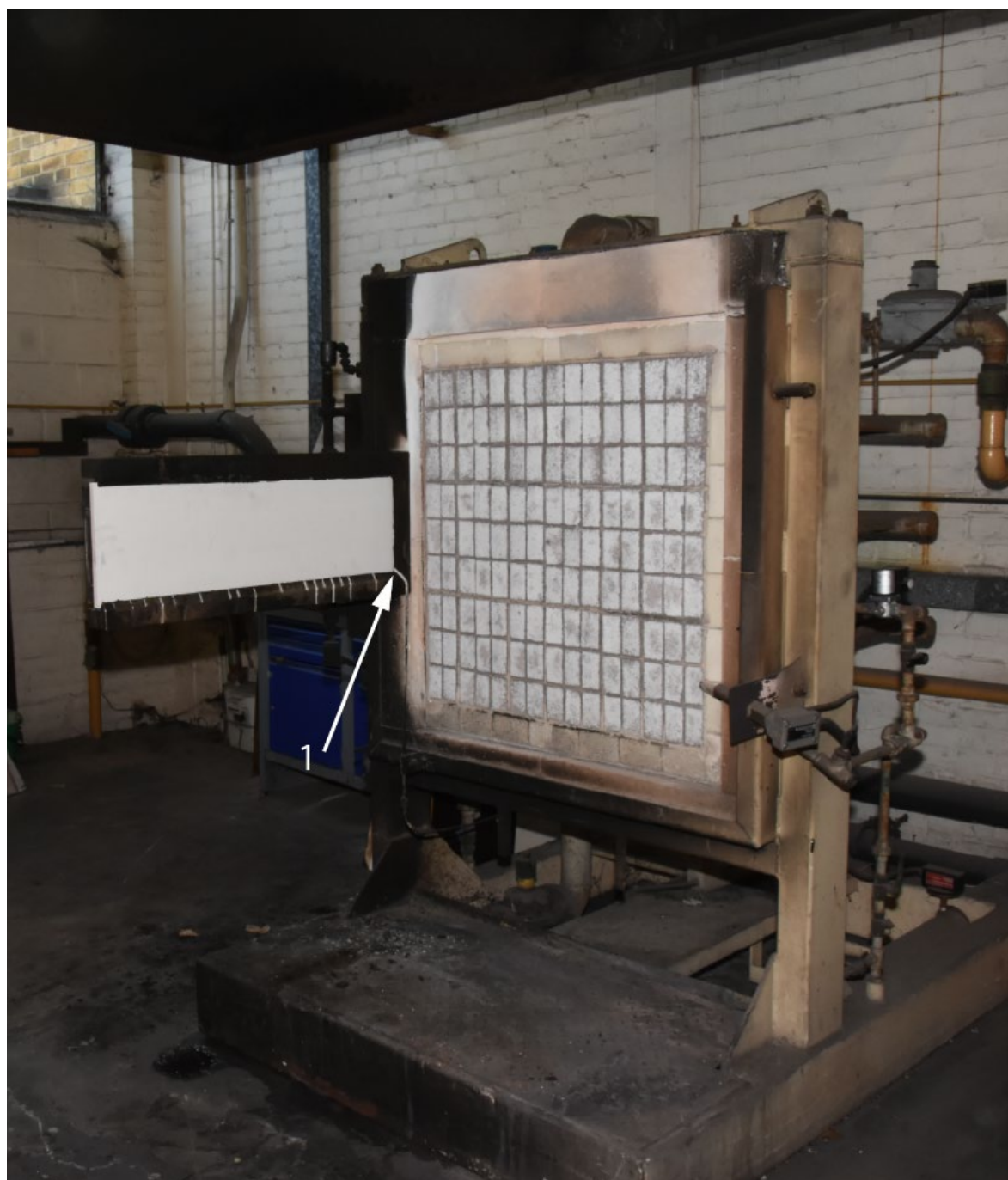
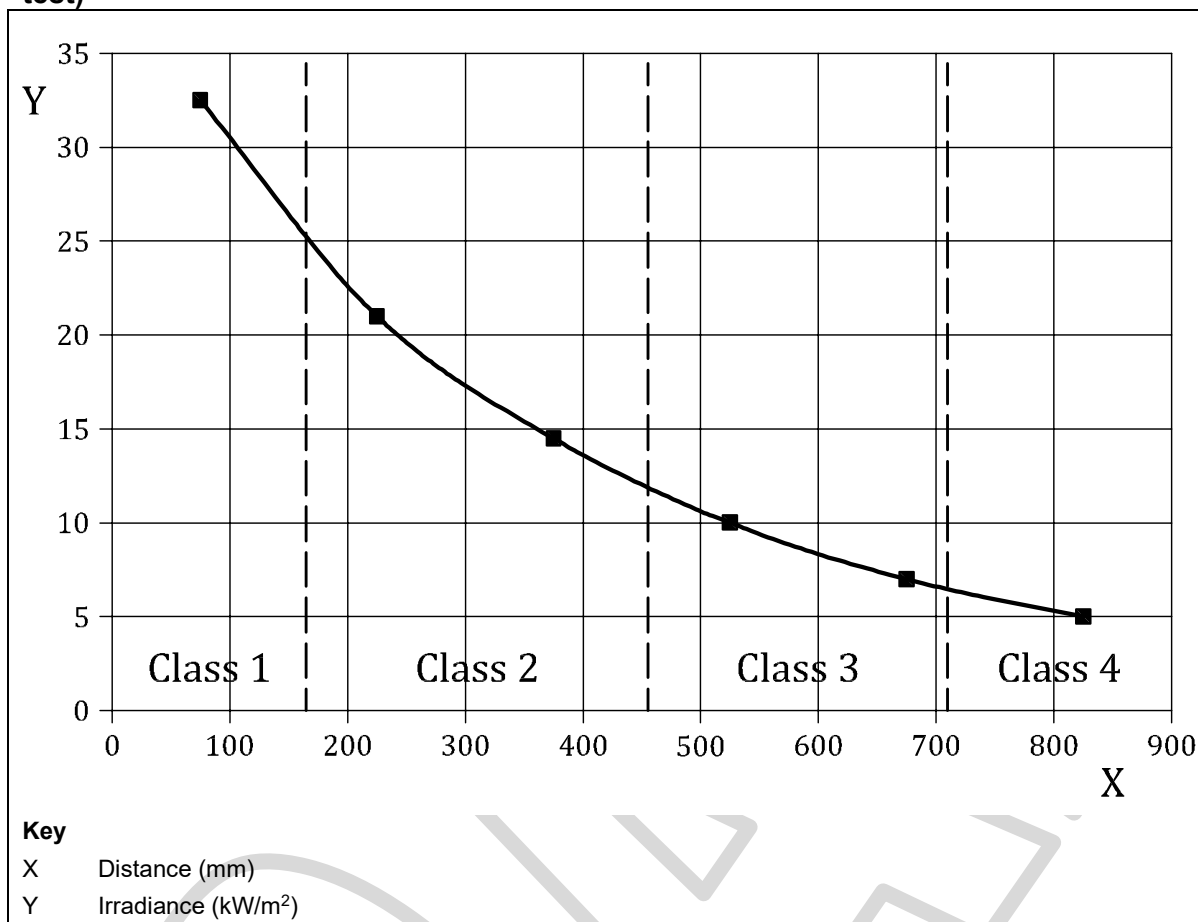


Image courtesy of DCCH Experts LLP

**Key**

1 Pilot flame

**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)**



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 the limits by the distances set out below with the sample still being classified to that class.

**Table A.1 – Classification of spread of flame**

| Classification | Spread of flame at 1.5 min       |                                           | Final spread of flame limit      |                                           |
|----------------|----------------------------------|-------------------------------------------|----------------------------------|-------------------------------------------|
|                | Limit<br>mm                      | Limit for one specimen<br>in sample<br>mm | Limit<br>mm                      | Limit for one specimen<br>in sample<br>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 |                                           |

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**).

#### **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 ( $i_1$ ) 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**).

**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.1.3 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/m<sup>3</sup> 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/m<sup>3</sup>; 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.

### **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 building regulations, 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.*

#### **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 building regulations, the data produced by the test are then used for classification to BS EN 13501-1 (see A.2.2).

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



Image courtesy of DCCH Experts LLP

#### **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 building regulations, the data produced by the test are then used for classification to BS EN 13501-1 (see **A.2.2**).

#### **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.

**WARNING.** THIS IS A DRAFT AND MUST NOT BE REGARDED OR USED AS A PUBLISHED PAS.  
THIS DRAFT IS NOT CURRENT BEYOND **06 JUNE 2025**.

**Figure A.6 – BS EN ISO 1182 test apparatus**



Image courtesy of DCCH Experts LLP

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 building regulations, the data produced by the test are then used for classification to BS EN 13501-1 (see **A.2.2**).

## **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 ( $i_1$ ) 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].

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 **3.1.31**) 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 M); 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.

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

| Class | Tests required                         | Criteria <sup>A)</sup>                                                                                                          |
|-------|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| A1    | BS EN ISO 1182                         | $\Delta T \leq 30\text{ }^{\circ}\text{C}$<br>$\Delta m \leq 50\%$<br>$t_f = 0\text{ s}$                                        |
|       | BS EN ISO 1716                         | $PCS \leq 2.0\text{ MJ/kg}$                                                                                                     |
| A2    | BS EN ISO 1182<br>or<br>BS EN ISO 1716 | $\Delta T \leq 50\text{ }^{\circ}\text{C}$<br>$\Delta m \leq 50\%$<br>$t_f \leq 20\text{ s}$                                    |
|       | BS EN 13823                            | No lateral flame spread to edge of specimen<br>$FIGRA (= FIGRA_{0,2MJ}) \leq 120\text{ W/s}$<br>$THR_{600s} \leq 7.5\text{ MJ}$ |
| B     | BS EN 13823                            | No lateral flame spread to edge of specimen<br>$FIGRA (= FIGRA_{0,2MJ}) \leq 120\text{ W/s}$<br>$THR_{600s} \leq 7.5\text{ MJ}$ |
|       | BS EN ISO 11925-2                      | 30 s flame exposure<br>No flame spread in excess of 150 mm within 60 s                                                          |
| C     | BS EN 13823                            | No lateral flame spread to edge of specimen<br>$FIGRA (= FIGRA_{0,4MJ}) \leq 250\text{ W/s}$<br>$THR_{600s} \leq 15\text{ MJ}$  |
|       | BS EN ISO 11925-2                      | 30 s flame exposure<br>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<br>No flame spread in excess of 150 mm within 60 s                                                          |
| E     | BS EN ISO 11925-2                      | 15 s flame exposure<br>No flame spread in excess of 150 mm within 20 s                                                          |
| F     | BS EN ISO 11925-2                      | 15 s flame exposure<br>Flame spread in excess of 150 mm within 20 s                                                             |

A) The criteria are expressed as follows:

$\Delta T$  is the change in temperature;

$\Delta m$  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.

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

| Class | Tests required                                                                           | Criteria <sup>A)</sup>                                                                |
|-------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| s1    | BS EN 13823                                                                              | SMOGR $\leq 30 \text{ m}^2/\text{s}^2$<br>TSP <sub>600s</sub> $\leq 50 \text{ m}^2$   |
| s2    |                                                                                          | SMOGR $\leq 180 \text{ m}^2/\text{s}^2$<br>TSP <sub>600s</sub> $\leq 200 \text{ m}^2$ |
| s3    | Products for which no performance is declared or which do not meet criteria for s1 or s2 | —                                                                                     |

<sup>A)</sup> The criteria are expressed as follows:

SMOGR is the maximum quotient of smoke production rate from a specimen at the time of its occurrence; and

TSP<sub>600s</sub> 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.

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

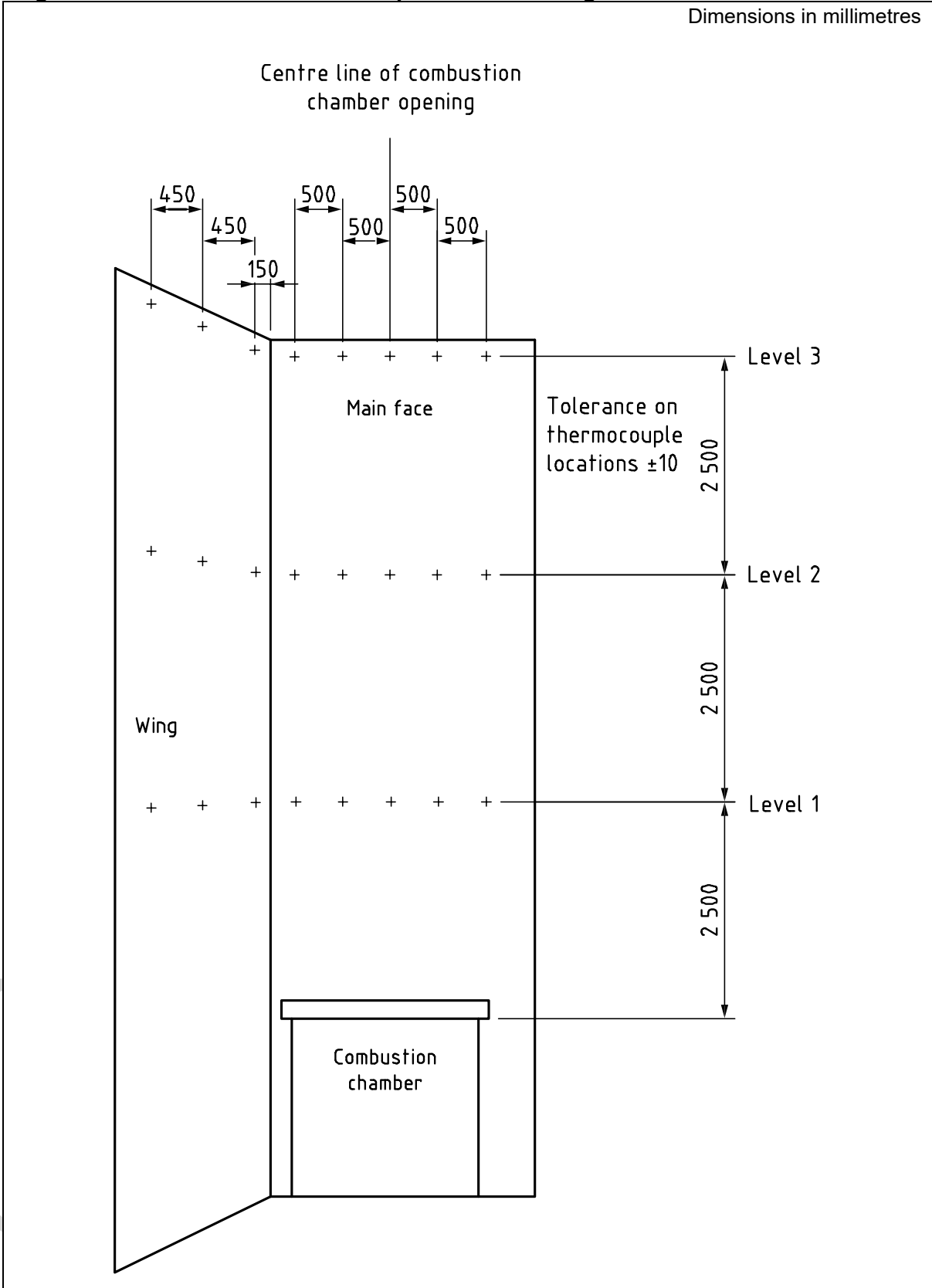
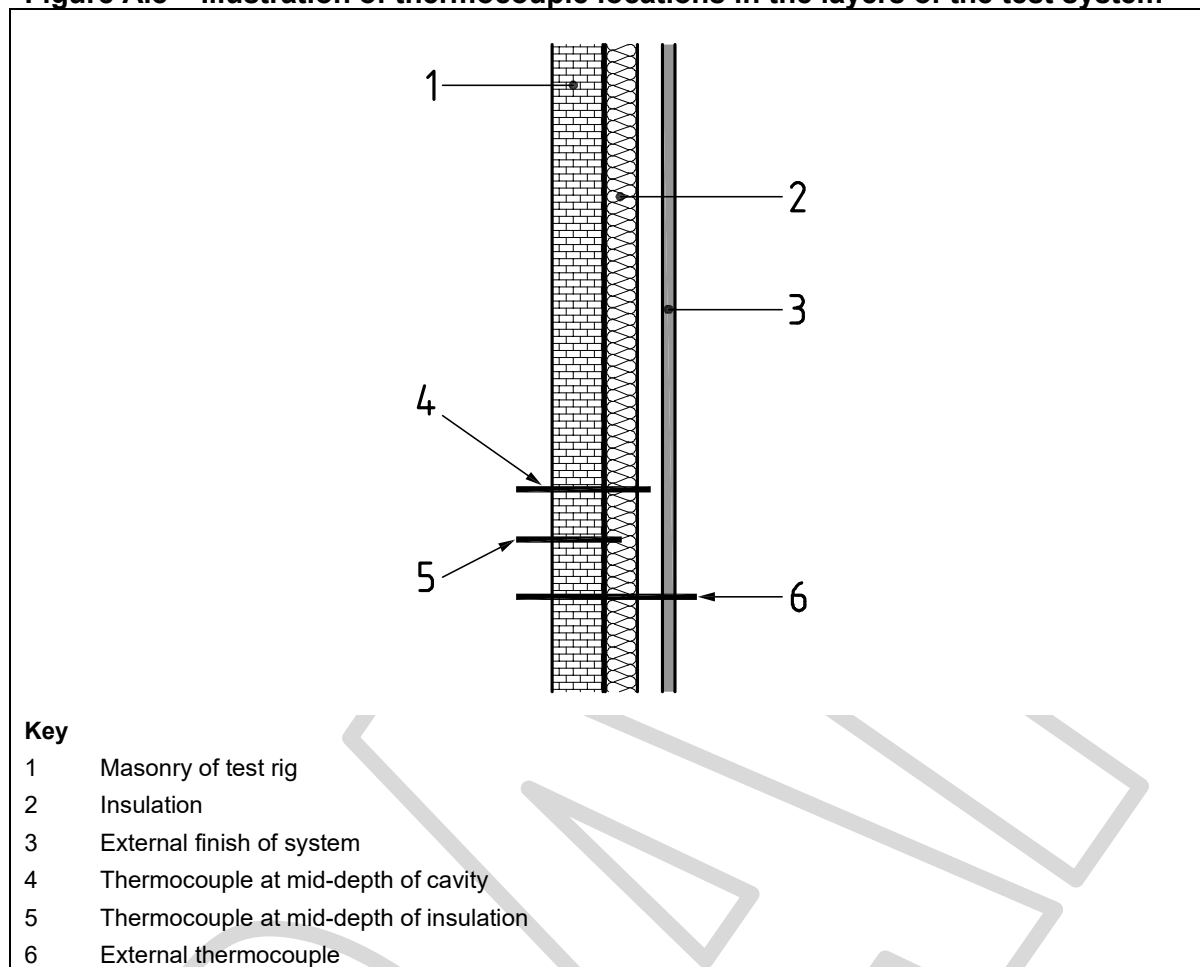


**Figure A.8 – Illustration of thermocouple locations in the layers of the test system**



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.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.

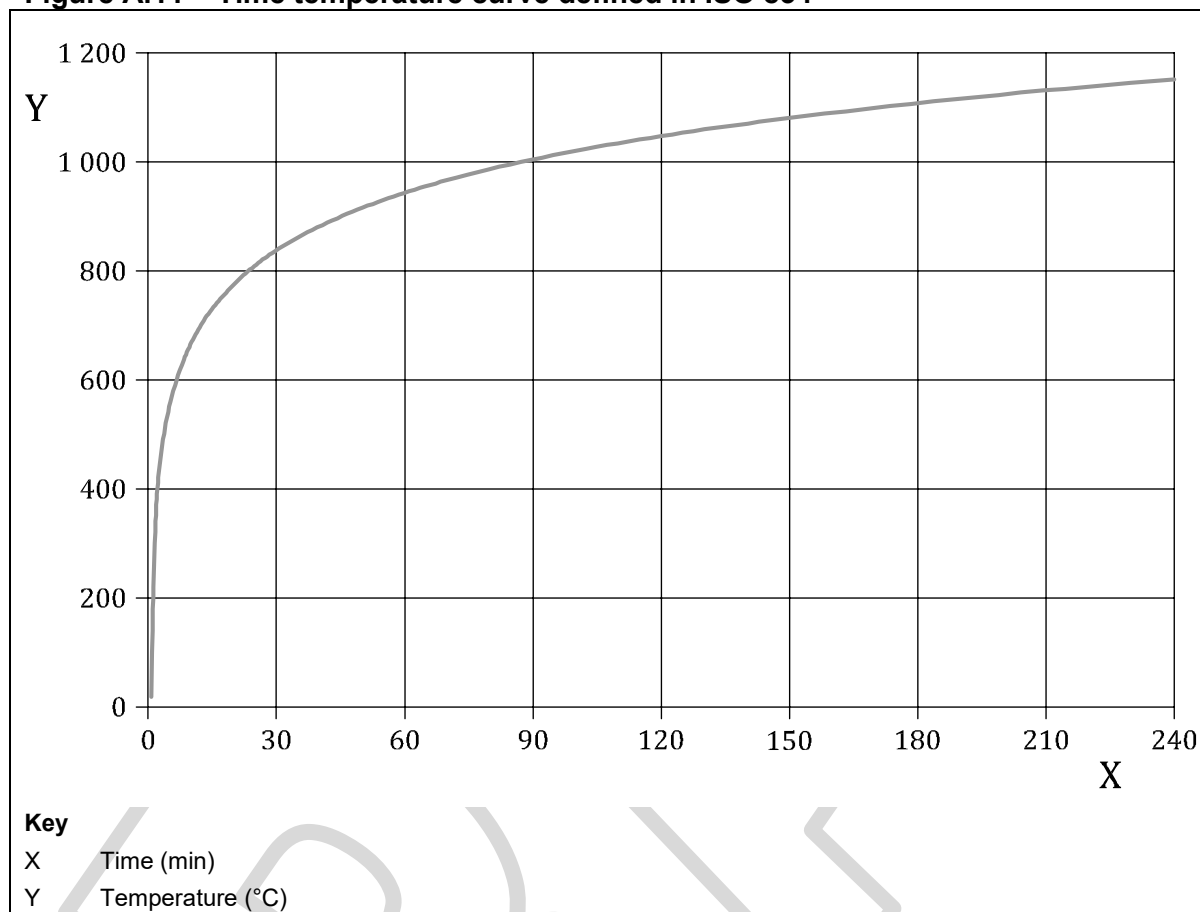
There are various fire resistance tests that can be employed, depending upon the particular component or system being tested, and the particular aspect of fire resistance that is of interest. In relation to external walls, the following tests are most likely to be relevant:

- 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.

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



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.

## **Annex B (informative)**

### **Expected skillsets of a person conducting tasks within this PAS**

Table B.1 sets out the skillsets typically expected of persons undertaking different tasks or levels of assessment during the course of applying the methodology in this PAS.

This includes indicative expected skillsets based on the National Qualifications Framework<sup>6)</sup>.

**Table B.1 – Expected skillsets of a person conducting tasks within this PAS**

| <b>Task</b>                                                                                                  | <b>Typical professional recognition</b>                                                                                                      | <b>Expected skillset</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Establishing whether a building is inherently low risk (Clause 4)                                            | No professional recognition necessary                                                                                                        | Not applicable. Establishing whether a building is one of the three types listed in Clause 4 that can be regarded as inherently low risk is a factual exercise that can be addressed by the dutyholder, managing agent or similar.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Establishing whether all of the external walls of a building are inherently low risk (Clause 4 and Figure 1) | Registered fire risk assessor or full member of a relevant professional body such as a surveyor, architect, façade engineer or fire engineer | <p>Knows the limitations of their skillset and can draw in additional skills as required.</p> <p>Able to undertake a 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.</p> <p>Able to communicate accurately and reliably.</p> <p>Takes personal responsibility for their work.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Information gathering (Clause 8)                                                                             | 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> |

<sup>6)</sup> Further details of this framework are available from <https://www.gov.uk/what-different-qualification-levels-mean/list-of-qualification-levels>.

**Table B.1 – Expected skillsets of a person conducting tasks within this PAS**

| Task                                                             | Typical professional recognition                                                | Expected skillset                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------------------------------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Site survey and inspection (Clause 9)                            | Surveyor or other building professional such as an architect or façade engineer | <p>Able to conduct on-site inspection and gather accurate factual information regarding the as-built construction of the building.</p> <p>Able to identify types of construction products as set out at Annex N.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| FRAEW based on risk factor tables (Annex F, Annex G and Annex H) | Full member of a relevant professional body                                     | <p>Knows the limitations of their skillset and can draw in additional skills as required.</p> <p>Knowledge of the underlying concepts and principles associated with fire safety 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> |

**Table B.1 – Expected skillsets of a person conducting tasks within this PAS**

| Task                                                                                                                      | Typical professional recognition | Expected skillset                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| FRAEW making use of advanced tools and/or fire safety engineering in a more detailed analysis (see Clause 13 and Annex P) | Chartered engineer               | <p>Possesses a systematic understanding of key aspects of fire safety 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 safety 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 safety 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 safety 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 safety 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 C (informative)**

### **Review of reports**

There are five overarching purposes for which reviews of reports are normally carried out. Whether or not a review needs to address one or more of these purposes will depend on the specific circumstances, scale and complexity of the appraisal.

- **Compliance:** A peer review to confirm any purported compliance with PAS 9980. Compliance is primarily focussed on the methodology and outcomes.
- **Comprehensibility and logic:** To check that the report makes sense and conveys the author's intent to the reader. This can generally be achieved by checking that there is a train of logic which proceeds through the report; the findings and conclusions reached are logical outcomes of the information and propositions that have been presented. If this is not the case, then it might be that a typographical error has changed the fundamental meaning of text (e.g. omitting a "not" from a sentence) or that there are leaps in logic or instances of "black box science" where the thinking of the author has not been properly expressed.
- **Accuracy:** A peer review to check that the assessment and outcomes are accurate based on the information available and any assumptions made. It might well be that, to a lay reader, the author has presented a logical argument (see "Comprehension" above) but there might be some fundamental technical error that undermines the findings of the report.
- **Reassurance:** To provide reassurance in circumstances where the reader (e.g. client) is in need of this but does not possess the necessary competence to be able to check the accuracy of the report themselves. This purpose carries an inherent assumption that having more, independent, people involved in reviewing an FRAEW, one is more likely to get a competent assessment. Whether or not this is the case depends on the competence of all involved.
- **Uncertainty:** To obtain consensus from two or more competent appraisers to reduce uncertainty. As set out elsewhere in this PAS, appraisers are expected to identify areas of uncertainty within their reports. Involving additional appraisers via a peer review process necessarily involves the addition of new perspectives and experience, which can enable reduction in uncertainty.

*NOTE It is not normally the purpose of a review to substantively repeat the work that has been carried out as part of an appraisal. Accordingly, reviews ought not to seek to determine whether the reviewer would reach the exact same conclusions if they had done the work themselves. The extent and detail of the review need to be proportionate to its purpose, as defined by the points above. There might be circumstances where a review concludes that a more detailed check of some or all of the work in an FRAEW is required, including reinspection, but this is beyond the scope of a normal review as described above.*

Reviews can be conducted by various different people; the following examples are given in order of increasing significance/complexity of the FRAEW:

- team member – someone else working on the assessment;
- internal independent – someone who was not involved in the assessment at all;
- external – someone from a different organization, appointed by the author or their organization; or
- third party – someone from a different organization, appointed by the client, an enforcing authority or some other organization in receipt of the FRAEW.

## **Annex D (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 D.1 depicts fire spread that is restricted in its extent and development in line with this scenario. By contrast, Figure D.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.

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

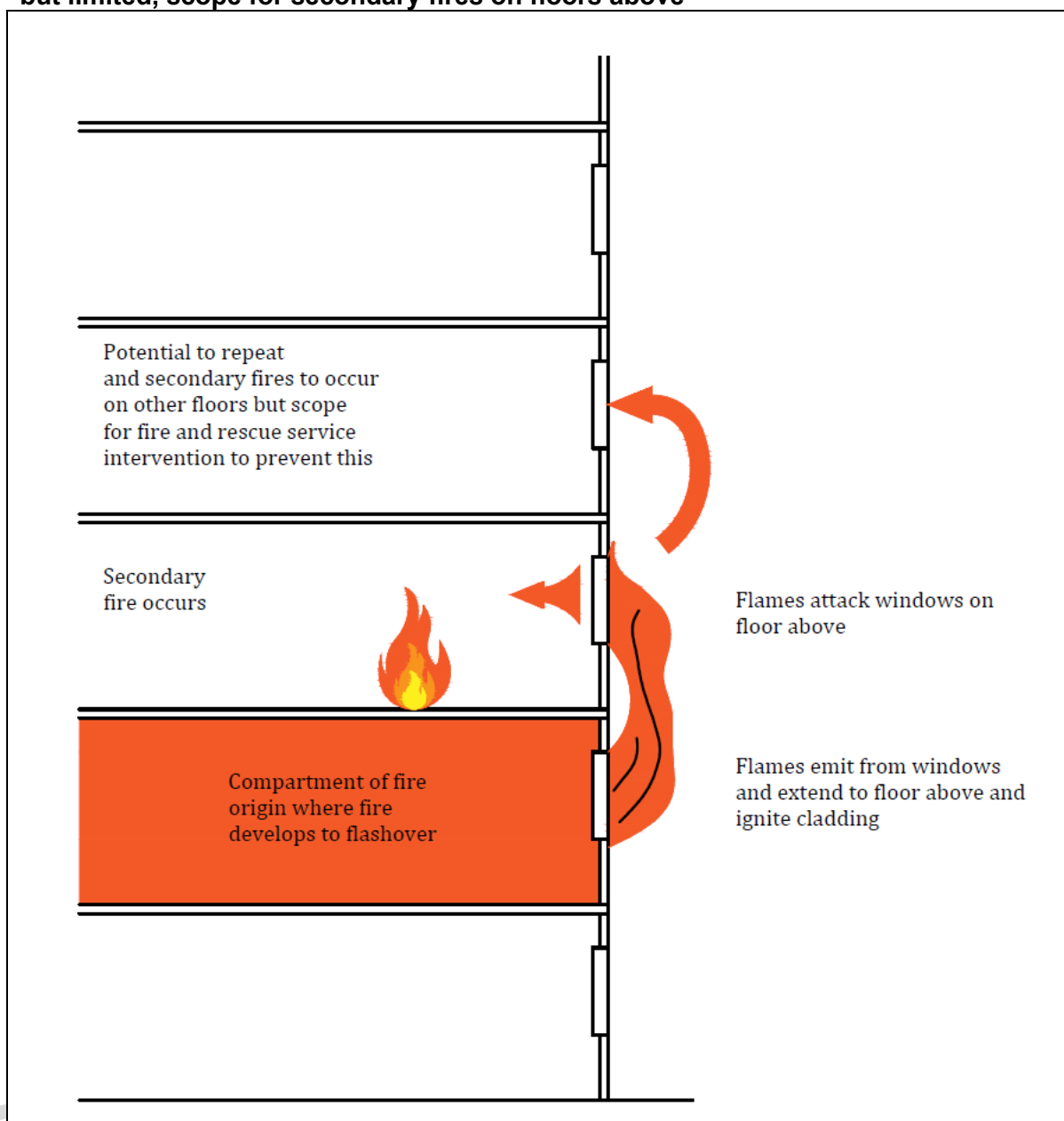
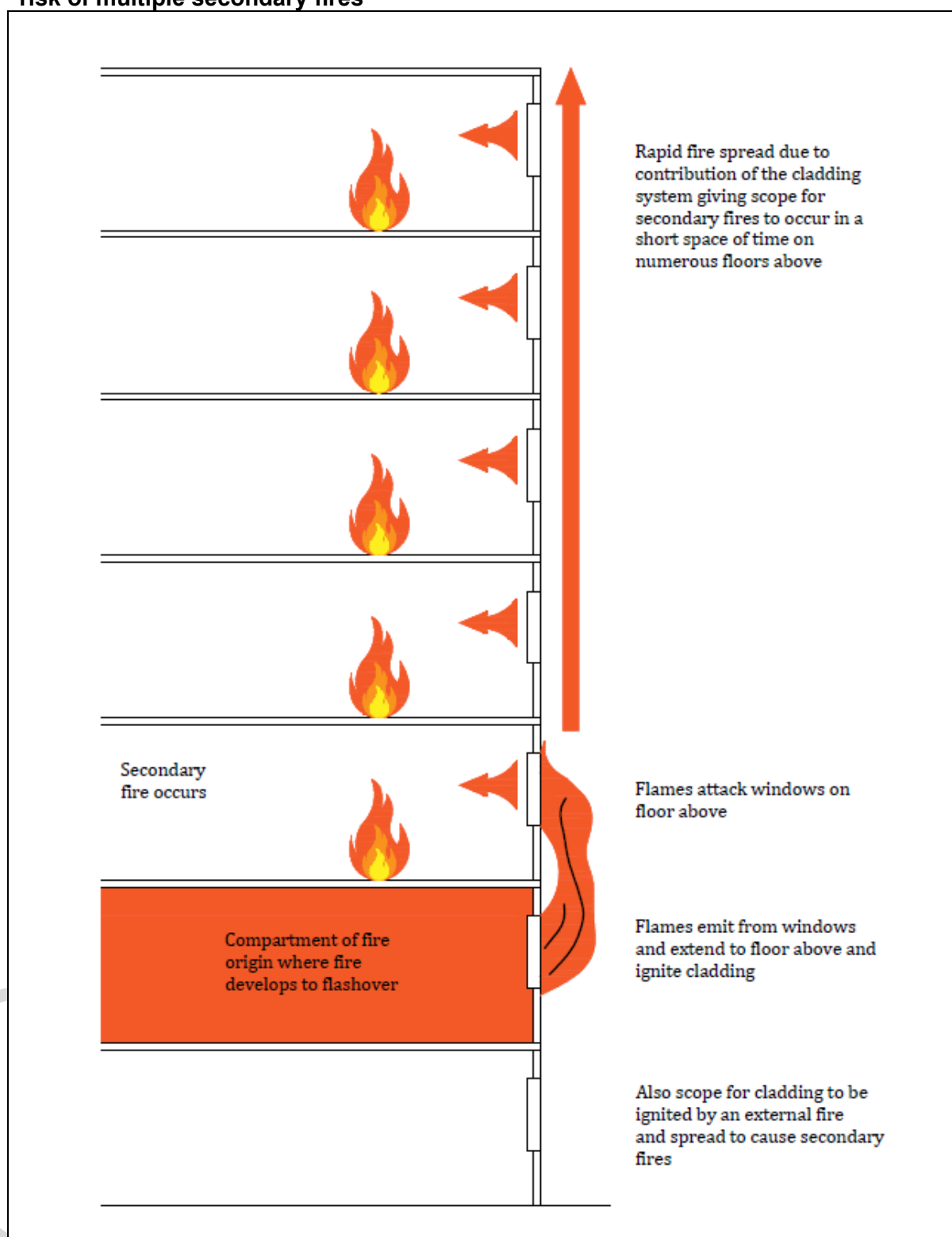


**Figure D.2 – Potential scenario resulting in rapid external fire spread and significant risk of multiple secondary fires**



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 D.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.

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.

The key points to note in Figure D.1 and Figure D.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 D.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 D.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 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 D.4).

**Figure D.4 – Fire at Shepherd’s Court, London**



Image courtesy of London Borough of Hammersmith and Fulham

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 D.5) has highlighted that this can be highly significant in terms of the fire risk posed by external wall construction and cladding.

**Figure D.5 – Fire at Samuel Garside House, Barking**

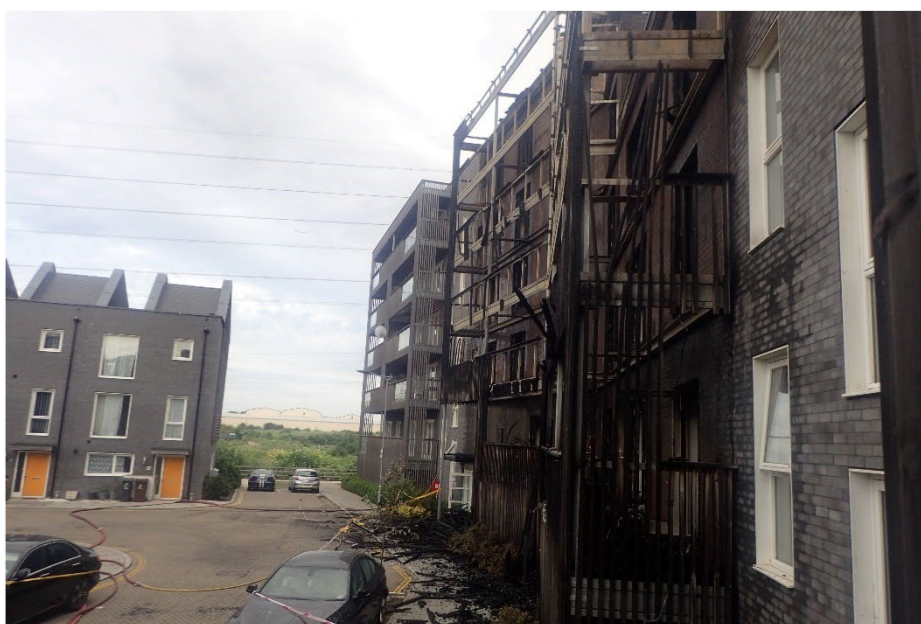


Image courtesy of London Fire Brigade

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 D.6). This student accommodation building had an HPL cladding system, which was implicated in the extensive fire spread that occurred.

**Figure D.6 – Fire at the Cube, Bolton**



Image courtesy of Greater Manchester Fire and Rescue Service

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 cladding panels had been installed on hundreds of other 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 D.7 (cited in BRE report *External fire spread – Part 1: Background research* [20]). 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.

**Figure D.7 – Fire in block resulting in limited external spread**



Image courtesy of BRE Global

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 service<sup>7)</sup>.

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.

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<sup>7)</sup> Home Office data.

## **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. A person conducting 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 community risk management plan (CRMP). 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, persons conducting an FRAEW 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 an FRAEW (see Annex H), it is important that the person conducting the FRAEW 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 persons conducting an FRAEW need 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 CRMP 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)**

### **Fire performance risk factors**

Table F.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 and attachments on buildings.

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 (Annex N provides guidance on the relative importance of system components for different types of external wall systems). Where numeric values are given in Table F.1, these are only intended to be indicative as to the possible influence the particular factor might have in a risk-based assessment.

In particular, it is important to take into account the relative importance of the various ignition and combustion metrics and to be confident that products are appropriately characterized as a function of the way in which they are used within an external wall system. For example:

- a) calorific value is an indicator of how much heat could be produced by a product if it burns, but it not necessarily an indicator of whether a product would in fact burn. The combustible material in some products is bound in materials that are not combustible (e.g. sheathing boards where wood fibres are bound in cement), some products are faced by materials that would prevent or inhibit combustion (e.g. some architectural wall panels), and products can be sandwiched between other products that would prevent or inhibit combustion (e.g. insulation within SFS);
- b) similarly, calorific value is expressed per unit mass of material. As such, it is not (on its own) an indicator of the total heat that can be produced by a product; and
- c) reaction to fire classes are indicators of ignitability and surface spread of flame, but not necessarily of overall contribution to fire. Some products, such as combustion modified, thermoset, charring insulants are readily ignitable (because they have a low thermal inertia), but might not contribute to overall fire spread (because they char and do not burn significantly beyond the original fire source).

Similarly, it is important to consider the importance of system components as a function of the system typology (refer to Annex J for further information). For example:

- 1) the fire resistance of the substrate is important in cavity wall construction, but the importance of adequacy of cavity barriers is low;
- 2) the fire resistance of the substrate is not important for compartment continuation, but the adequacy of fire stopping is highly important; and
- 3) the importance of the combustibility of insulation in cavity wall construction and compartment continuation is low, but it is highly important for ETICS.

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 F.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. Equally, the factors in Table F.1 are focussed on external walls and therefore materials which are vertically

oriented. Where attachments are being considered, the person conducting the FRAEW might need to adapt the risk factors to account for whether materials are oriented horizontally, vertically or both.

Factors influencing the scope for an external wall fire to circumvent compartmentation are also given in Annex O.

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

**Table F.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.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                             |                                                                             |
| <b>F.1 General</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                             |                                                                             |
| Materials with a calorific value (gross heat of combustion) of $\leq 3$ MJ/kg                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Materials with a calorific value (gross heat of combustion) $> 3$ MJ/kg and $\leq 35$ MJ/kg | Materials with a calorific value (gross heat of combustion) of $> 35$ MJ/kg |
| <p><i>NOTE 1</i> Calorific values are to be based on BS EN ISO 1716 test results.</p> <p><i>NOTE 2</i> 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 person conducting the FRAEW 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 detailed analysis in accordance with Clause 13 would be needed to fully utilize the values for individual components and their contribution to the wall build-up as a whole.</p> |                                                                                             |                                                                             |

**Table F.1 – Fire performance risk factors**

| 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. For example:</p> <ul style="list-style-type: none"> <li>any combination or system which has been classified to BR 135 [15] for same build-up, albeit not an exact match; or</li> <li>any combination or system which has passed an alternative large-scale test (e.g. LPS 1181, Part 1 [21]).]</li> </ul> <p><i>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.</i></p> <p><i>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 9).</i></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"> <li>subject to intermediate-scale tests (e.g. ISO 13785-1, NFPA 285) and/or ad-hoc fire tests, but not large-scale tests; or</li> <li>components classified to BS EN 13501-1 but not complete system/configuration.]</li> </ul> | <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"> <li>not tested in large-scale or intermediate-scale fire tests (e.g. BS 8414);</li> <li>not classified to BS EN 13501-1; or</li> <li>no ad-hoc testing.]</li> </ul> |

**F.2 External surfaces: reaction to fire classes**

|                         |         |                           |
|-------------------------|---------|---------------------------|
| Class A1/A2*<br>Class B | Class C | Class D, Class E, Class F |
|-------------------------|---------|---------------------------|

*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 detailed analysis in accordance with Clause 13 would be needed to fully utilize the values for individual components and their contribution to the wall build-up as a whole.*

**Table F.1 – Fire performance risk factors**

| Positive                                                                                                                                                                                                                                                                                                                                                                                                 | Neutral                                                                                                          | Negative                                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| <b>F.3 Facings/cladding panels</b>                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                  |                                                                                                 |
| Low HRR                                                                                                                                                                                                                                                                                                                                                                                                  | —                                                                                                                | High HRR                                                                                        |
| <p><i>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.</i></p> |                                                                                                                  |                                                                                                 |
| Mechanically fixed                                                                                                                                                                                                                                                                                                                                                                                       | —                                                                                                                | Adhesive fixed                                                                                  |
| <p>Solid metal panels with high melting point (&gt;800 °C)<br/>(Typically, steel)</p> <p><i>NOTE Some paint finishes can result in a Class B or lower rating.</i></p>                                                                                                                                                                                                                                    | <p>Solid metal panels with low melting point (&lt;800 °C)<br/>(Typically, aluminium, zinc and copper)</p>        | <p>Metal faced panels with a combustible backing<br/>(Typically, aluminium on plywood)</p>      |
| Category 1 ACM or other MCM<br>(At least Class A2)                                                                                                                                                                                                                                                                                                                                                       | Category 2 ACM or other MCM<br>(Typically, a combustion modified polyethylene core, also referred to as FR type) | Category 3 ACM or other MCM<br>(Typically, an unmodified polyethylene core)                     |
| <p>Other rigid non-combustible facings<br/>(Typically:</p> <ul style="list-style-type: none"> <li>• brick;</li> <li>• ceramic;</li> <li>• stone;</li> <li>• clay tile;</li> <li>• concrete;</li> <li>• stone wool cladding boards; and</li> <li>• cement fibre boards)</li> </ul> <p>Masonry or concrete at least 75 mm thick*</p>                                                                       | <p>Brick slip with organic mortar</p> <p>Brick slip with inorganic mortar*</p>                                   | <p>Brick slip and other similar facing/cladding panels supported by thermoplastic materials</p> |

**Table F.1 – Fire performance risk factors**

| Positive                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Neutral                                                                                                                                                                                                                                                                                                                                                                                                               | Negative                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Glazing and glazed curtain walling<br/>(See <b>F.11</b> for infill panels)</p> <p><i>NOTE 1 Glass type might not be Class A2 or better, but still considered positive.</i></p> <p><i>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.</i></p> <p><i>NOTE 3 Further consideration of laminated glass is given in Annex M.</i></p> | —                                                                                                                                                                                                                                                                                                                                                                                                                     | —                                                                                                                                                                                                                                                                                                                                                                                           |
| <p>Glass rainscreen panels, where either:</p> <ul style="list-style-type: none"> <li>at least Class A2; or</li> <li>if incorporating organic resins, binders, etc., a similar combination has been subject to BR 135 classification</li> </ul>                                                                                                                                                                                                                            | Glass rainscreen panels, with organic resins, binders, etc.                                                                                                                                                                                                                                                                                                                                                           | —                                                                                                                                                                                                                                                                                                                                                                                           |
| <p>HPL, combustion modified (no lower than Class B), when used in combination with non-combustible insulation</p> <p><i>NOTE Class B products are sometimes also referred to as an “FR” HPL.</i></p>                                                                                                                                                                                                                                                                      | <p>HPL (Class C or lower), when used in combination with non-combustible insulation*</p> <p><i>NOTE 1 Class C or lower products are sometimes also referred to as a “standard” HPL.</i></p> <p>HPL, combustion modified (no lower than Class B), when used in combination with combustion modified polymeric foam insulation</p> <p><i>NOTE 2 Class B products are sometimes also referred to as an “FR” HPL.</i></p> | <p>HPL, combustion modified (no lower than Class B), when used in combination with polymeric insulation*</p> <p><i>NOTE 1 Class B products are sometimes also referred to as an “FR” HPL.</i></p> <p>HPL (Class C or lower), when used in combination with polymeric foam insulation</p> <p><i>NOTE 2 Class C or lower products are sometimes also referred to as a “standard” HPL.</i></p> |
| —                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <p>Timber, direct on non-combustible substrate*</p> <p>Timber, in combination with non-combustible insulation</p>                                                                                                                                                                                                                                                                                                     | 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)                                                                                                                                                                                                                                                                                                               |

**Table F.1 – Fire performance risk factors**

| Positive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Neutral                                                             | Negative                                                                                                                                                                                                                                                                                                                                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>F.4 Panel construction</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                     |                                                                                                                                                                                                                                                                                                                                                      |
| No gaps between panels                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Limited size of gaps between panels<br>(Typically <10 mm)           | Gaps between panels of 10 mm to 20 mm*<br>Gaps between panels of >20 mm                                                                                                                                                                                                                                                                              |
| <p><i>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 M.</i></p> <p><i>NOTE 2 Gaps might result from loss of integrity of sealant during fire exposure.</i></p> |                                                                     |                                                                                                                                                                                                                                                                                                                                                      |
| <b>F.5 Cavities</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                     |                                                                                                                                                                                                                                                                                                                                                      |
| 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                                                                                                                                                                                                                                                                                            |
| <p>Cavities closed by barriers/fire stopping located in line with all of the following:</p> <ul style="list-style-type: none"> <li>• compartment floors;</li> <li>• compartment walls;</li> <li>• around openings, e.g. windows, doors; and</li> <li>• ventilation ducts, grilles and other openings for services</li> </ul> <p><i>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.</i></p>                                           | Cavity barriers present with no more than minor workmanship defects | <p>Cavities closed at least at compartment floors and walls but not:</p> <ul style="list-style-type: none"> <li>• around windows and other openings*; or</li> <li>• at ventilation ducts, grilles or other openings for services*</li> </ul> <p>No cavity barriers present, or cavity barriers ineffective through poor installation/maintenance</p> |

**Table F.1 – Fire performance risk factors**

| Positive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Neutral                                                                                                                                                                                                                                                                                                                                                                                                                                              | Negative                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><i>NOTE 1 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:</i></p> <ul style="list-style-type: none"> <li><i>steel at least 0.5 mm thick;</i></li> <li><i>timber at least 38 mm thick;</i></li> <li><i>polythene-sleeved mineral wool, or mineral wool slab, installed under compression in the cavity; or</i></li> <li><i>calcium silicate, cement-based or gypsum-based boards at least 12 mm thick.</i></li> </ul> <p><i>Fire stopping that is present to close gaps in compartmentation provides a higher standard of fire resistance than a cavity barrier/stop.</i></p> <p><i>NOTE 2 It is common for building regulations guidance to call for cavity barriers at the edges of cavities. This is often interpreted as meaning cavity barriers are needed (1) at ground/floor level, (2) at the top of any wall (including at roof level), (3) where cavities reach the corners of buildings and (4) at the interfaces between different external wall constructions. In relation to (1), the ground or floor provides the function of a cavity barrier. In relation to (2) cavity barriers need to be provided where a cavity meets a roof, but are not needed if the cavity terminates against the underside of construction providing at least 30 minutes fire resistance (e.g. a compartment floor). In relation to (3) unless the corner of a building coincides with a compartment line, the presence of a cavity barrier does not provide any benefit in terms of risk of fire spread where a cavity changes direction but is still associated with the same compartment. In relation to (4) the need or otherwise for cavity barriers needs to be considered on a case by case basis; changes in wall construction do not, in and of themselves, give rise to the edge of a cavity but if the possibility of fire spread in one of the adjacent wall systems gives rise to the possibility of significant fire spread in the other, it might be necessary to install cavity barriers at the interface between the adjacent wall systems.</i></p> <p><i>NOTE 3 Some national guidance refers to these forms of cavity barrier construction only in relation to stud partitions and around openings. This PAS considers these forms of construction can be acceptable in external wall construction.</i></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>F.6 Insulation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| No insulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | —                                                                                                                                                                                                                                                                                                                                                                                                                                                    | —                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Class A1/A2, Class B                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Class C                                                                                                                                                                                                                                                                                                                                                                                                                                              | Class D, Class E, Class F                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <p><i>NOTE This is a broad indicator only. It is likely that detailed analysis in accordance with Clause 13 would be needed to fully utilize the values within the context of the particular wall build-up.</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Mineral/glass insulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>Thermoset polymeric foams that form a stable char on fire exposure, e.g. phenolic foams and some PIR foams</p> <p><i>NOTE Consideration of the thickness of such insulation cannot be taken into account here, but is highly relevant in detailed analysis in accordance with Clause 13 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.</i></p> | <p>Thermoplastics (e.g. EPS/XPS) or thermoset polymeric foams that do not form a stable char on fire exposure (e.g. PUR)</p> <p><i>NOTE Consideration of the thickness of such insulation cannot be taken into account here, but is highly relevant in detailed analysis in accordance with Clause 13 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.</i></p> |

**Table F.1 – Fire performance risk factors**

| Positive                                                                                                                                                                                                                                                                                         | Neutral                                                                                                                                                                 | Negative                                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>F.7 Substrate</b>                                                                                                                                                                                                                                                                             |                                                                                                                                                                         |                                                                                                                                                                   |
| Masonry, >75 mm thick*<br>Masonry, <75 mm thick<br>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<br>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<br>No sheathing board present                                        |
| <b>F.8 Sheathing boards</b>                                                                                                                                                                                                                                                                      |                                                                                                                                                                         |                                                                                                                                                                   |
| Class A1/A2<br>Cement, calcium silicate or magnesium oxide-based Class B                                                                                                                                                                                                                         | Other Class B<br>Class C                                                                                                                                                | Class D, Class E, Class F<br>OSB, hardboard or similar                                                                                                            |
| <b>F.9 Insulated core panels</b>                                                                                                                                                                                                                                                                 |                                                                                                                                                                         |                                                                                                                                                                   |
| Combustible insulation, but panels either: <ul style="list-style-type: none"> <li>classified to BR 135 [15]; or</li> <li>met success criteria in alternative large-scale fire testing (e.g. LPS 1181, Part 1 [21] and LPS 1208 [22])</li> </ul> Non-combustible insulation encapsulated in metal | Readily combustible insulation, but fully encapsulated in steel                                                                                                         | Readily combustible insulation, but not fully encapsulated<br>Readily combustible insulation, but only encapsulated in aluminium or other low melting point metal |

**Table F.1 – Fire performance risk factors**

| Positive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Neutral                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Negative                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>F.10 ETICS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Thin organic render or inorganic render on Class A1/A2 insulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <p>Inorganic render on thermoset polymeric foams that form a stable char on fire exposure, e.g. phenolic foams and some PIR foams</p> <p>Thick inorganic render on thermoplastic polymeric foams (e.g. EPS/XPS)</p> <p>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</p>                                                                                                                                                                                                                    | Any other render system                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <p><i>NOTE The fire performance of ETICS is a specialist area requiring persons conducting an FRAEW to have relevant expertise. ETICS with specifically formulated renders can achieve classification to BR 135 [15] even with polymeric foam insulation. However, detailed analysis in accordance with Clause 13 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.</i></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>F.11 Infill/spandrel panels</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <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 detailed analysis in accordance with Clause 13 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 detailed analysis in accordance with Clause 13 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> |

**Table F.1 – Fire performance risk factors**

| Positive                                                                                                                                                                                                                                                                                                                                                                                                  | Neutral | Negative |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|----------|
| <b>F.12 Internal finishes</b>                                                                                                                                                                                                                                                                                                                                                                             |         |          |
| —                                                                                                                                                                                                                                                                                                                                                                                                         | —       | —        |
| <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 G (informative)**

### **Façade configuration risk factors**

Table G.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 G.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 G.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.

It is important to consider the relative importance of the façade configuration risk factors. For example:

- a) building height might not be important if combustible construction is limited to the lower storeys only;
- b) if construction cannot be ignited (e.g. because there are no openings between the inside of the building and the construction and there are no external ignition sources), factors such as height and extent of coverage become less important; and
- c) proximity to ground is less important where there are no credible external ignition sources.

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

**Table G.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.                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                       |
| <b>G.1 Maximum vertical distance from firefighting access</b>                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                       |
| <p>&lt;11 m</p> <p>Below 11 m, the fire and rescue service is expected to be able to gain closer access to the façade via the use of ladders etc (provided that there is access around the building).</p>                                                                                                                                                                            | <p>&lt;18 m</p> <p>Below 18 m, the fire and rescue service is expected to be able to direct water onto the façade from ground level, provided that there is ground level access.</p>                                                                                                                                                                                                                                                               | <p>18 m to 30 m*</p> <p>&gt;30 m</p>                                                                                                                                                                                                                                                                  |
| <p><i>NOTE These relate to commonly used trigger heights, but it is important that these are considered, along with all other pertinent factors in the round. The thresholds above necessarily aid in contextualizing risk, but persons conducting an FRAEW need to be mindful that, in practice, risk increases gradually in line with the increasing height of a building.</i></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                       |
| <b>G.2 Proximity to external ignition sources</b>                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                       |
| <p>Combustible construction is more than 5 m from an external ignition source</p> <p><i>NOTE At this distance, 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.</i></p>                                                                     | <p>Combustible construction is 2 m to 5 m from an external ignition source</p> <p>Low hazard construction at any distance from the ignition source</p> <p><i>NOTE At this distance, 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.</i></p> | <p>Combustible construction is within 2 m of an external ignition source</p> <p><i>NOTE At this distance, 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.</i></p> |

**Table G.1 – Façade configuration risk factors**

| Positive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Neutral                                                                                                                                                                                                                                | Negative                                                                                                                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>G.3 Extent of cladding</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                        |                                                                                                                                                                                         |
| 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<br>Entire façade covered but the fire performance is such that the external walls are not expected to propagate fire spread (i.e. fire performance is positive) | Entire façade covered and the fire performance is such that the external walls are expected to propagate fire spread (i.e. fire performance is not positive)                            |
| <p><i>NOTE In the case of a 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 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 H).</i></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 |
| <b>G.4 Cavities</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                        |                                                                                                                                                                                         |
| No cavity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | —                                                                                                                                                                                                                                      | —                                                                                                                                                                                       |
| Cavity not continuous, due to façade being only partially clad or broken by building features<br>(Examples include: <ul style="list-style-type: none"> <li>projecting floor slabs that divide part of the wall and isolate sections of cavity from each other; and</li> <li>walls that project out or are set back, such as to limit the vertical extent of cavities)</li> </ul> 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 many floor levels<br>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 G.1 – Façade configuration risk factors**

| Positive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Neutral                                                                 | Negative                                                                                                                                                                                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>G.5 Infill/spandrel panels</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                         |                                                                                                                                                                                            |
| <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><i>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.</i></p> <p><i>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.</i></p> |                                                                         |                                                                                                                                                                                            |

**Table G.1 – Façade configuration risk factors**

| Positive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Neutral | Negative |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|----------|
| <b>G.6 Setbacks</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |         |          |
| <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</p> <p>(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 safety 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> | —       | —        |

**Table G.1 – Façade configuration risk factors**

| Positive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Neutral                                                                                                                                                                                                                                                                                         | Negative                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>G.7 Overhangs and projections</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                               |
| 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<br><i>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.</i> |
| <p><i>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.</i></p> <p><i>NOTE 2 This does not refer to balconies as projections (see G.11).</i></p> <p><i>NOTE 3 The potential beneficial contribution of projections in terms of dividing cavities is referred to earlier in this table.</i></p> |                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                               |
| <b>G.8 Re-entrant corners</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                               |
| —                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Re-entrant corners are present but do not span more than two storeys<br>Re-entrant corners are present but all of the external wall construction which occurs at these re-entrant corners is not expected to contribute to external fire spread (i.e. the fire performance outcome is positive) | Re-entrant corners are present and the external wall construction is such that external fire spread is to be expected (i.e. the fire performance outcome for at least one of the external wall constructions is not positive)                                                                                                                                                 |
| <b>G.9 Dual aspect flats</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                               |
| —                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | —                                                                                                                                                                                                                                                                                               | Dual aspect flats are present in the building and the arrangement of these flats is such that there is a risk of a single fire in the building involving two elevations of the building simultaneously                                                                                                                                                                        |

**Table G.1 – Façade configuration risk factors**

| Positive                                                                                                                                                                                                                                                                                                                                                                                 | Neutral                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Negative                                                                                                                                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>G.10 Proximity to windows and other openings to the accommodation</b>                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                    |
| <p>Remote from windows and openings, such that fire and smoke spread into the building, causing secondary fires, is not possible</p> <p>(Typically, this occurs when a façade has no openings for windows and other unprotected openings; see <b>G.9.</b>)</p>                                                                                                                           | <p>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</p> <p>Horizontally adjacent to windows and openings, and vertically in line with such openings, but the fire performance is such that the external walls are not expected to propagate fire spread (i.e. fire performance is positive)</p> | <p>Horizontally adjacent to windows and openings, and vertically in line with such openings with fire performance that is not positive, such that fire and smoke spread into the buildings, causing secondary fires, as a result of direct flame impingement, is highly likely</p> |
| <b>G.11 Presence of vents or other openings for services in the façade</b>                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                    |
| <p>Where vents pass through a cavity, either:</p> <ul style="list-style-type: none"> <li>they are either protected by cavity barriers (including ADB “deemed to satisfy” alternatives); or</li> <li>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)</li> </ul> | <p>Where vents pass through a cavity, either:</p> <ul style="list-style-type: none"> <li>the cavity does not include combustible materials; or</li> <li>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</li> </ul>                                                                                                                                                                                                      | <p>Any other circumstances where vents pass through a cavity</p>                                                                                                                                                                                                                   |
| <p>Vents pass through solid construction that is either:</p> <ul style="list-style-type: none"> <li>non-combustible; or</li> <li>fire resisting;</li> </ul> <p>such that a fire involving the vent would not be able to ignite combustible materials making up the external wall construction (if present)</p>                                                                           | <p>Vents pass through solid construction that is Class B or Class C</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                | <p>Vents pass through solid construction that is Class D, Class E or Class F</p>                                                                                                                                                                                                   |

**Table G.1 – Façade configuration risk factors**

| Positive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Neutral                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Negative                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>G.12 Proximity of combustible elements of a façade to escape route windows and other openings</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <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* (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 (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 (Typically, where there are two or more escape routes which can be used by occupants who all have access to multiple routes)</p> <p>Horizontally adjacent to windows and openings, and vertically in line with such openings, but the fire performance is such that the external walls are not expected to propagate fire spread (i.e. fire performance is positive)</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 (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><i>NOTE 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> |
| <b>G.13 Attachments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <p>[Covers:</p> <ul style="list-style-type: none"> <li>• a balcony attached to an external wall;</li> <li>• a device for reducing heat gain within a building deflecting sunlight, which is attached to an external wall (brise soleil);</li> <li>• a solar panel attached to an external wall;</li> <li>• any other attachment which could present a fire risk]</li> </ul> <p><i>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.</i></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

**Table G.1 – Façade configuration risk factors**

| Positive                                                                                                                                                                                                                                                              | Neutral                                                                                                                | Negative                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Non-combustible open balconies<br/>(Where these extend along a façade, they have the potential both to:</p> <ul style="list-style-type: none"> <li>• interrupt a cavity; and</li> <li>• deflect flames away from the building and away from the façade)</li> </ul> | <p>Timber (or other combustible) balconies of limited extent<br/>Timber decking with steel plate or concrete below</p> | <p>Timber balconies of large extent<br/>Timber (or other combustible) balconies, with aggravating features<br/>(For example:</p> <ul style="list-style-type: none"> <li>• without protection from the underside; and</li> <li>• adjacent to timber or other combustible wall panelling)</li> </ul> <p>Combustible features such as brise soleil incorporating combustible material<br/>Photovoltaic (PV) installations, especially if incorporating combustible elements<br/><i>NOTE PV installations present an ignition hazard as well as a potential fire load.</i></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:*

- *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.*

*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 N.*

**Table G.1 – Façade configuration risk factors**

| Positive                                                                             | Neutral | Negative                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------------------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>G.14 Proximity of combustible elements of a façade to a neighbouring building</b> |         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| —                                                                                    | —       | <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 H (informative)**

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

Table H.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 H.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 copy of the fire strategy has been obtained as part of the information gathering process, the person conducting the FRAEW is expected to review its contents and pay particular attention to any deliberate departures from statutory guidance. Unless proven otherwise, the fire strategy is expected to take precedence over generic guidance. This is particularly relevant to buildings which are close to trigger dimensions such as building height.

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

**Table H.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.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>H.1 Occupancy</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <p>Accommodation in which there will be shorter evacuation times</p> <p><i>NOTE 1 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><i>NOTE 2 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><i>NOTE 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"> <li>sheltered/retirement;</li> <li>extra care; and</li> <li>supported</li> </ul> <p><i>NOTE 1 These housing types are indicative; terminology applying to specialized housing varies. See also BS 9991 and NFCC publication Fire safety in specialised housing [23].</i></p> <p>Other accommodation in which there will be long evacuation times</p> <p><i>NOTE 2 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> |
| <i>NOTE This relates to the predominant occupant type within the building, recognizing that the occupancy might be mixed.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>H.2 Evacuation strategy</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <p>Immediate, total evacuation (or with simultaneous evacuation and a suitable investigation time)</p> <p>Phased evacuation (see Note)</p> <p><i>NOTE 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><i>NOTE 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 H.1 – Risk factors arising from fire strategy/fire hazards (including limitations of fire and rescue service intervention)**

| Positive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Neutral                                                                                                                                                                                                                                                                                                                          | Negative                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><i>NOTE The evacuation strategy might have been temporarily modified at the time when an FRAEW is carried out. If this has been done to mitigate against shortcomings in the building then this needs to be recorded in the FRAEW. Depending on the circumstances, it might be prudent for the FRAEW to consider both (a) the temporary (current) strategy and the reasons for it being implemented, and (b) the return to the normal evacuation strategy once the shortcomings have been addressed. Alternatively, the FRAEW might need to be updated when normal operation resumes.</i></p> |                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>H.3 Escape route design</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <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><i>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.</i></p>                                                                                                                                  | <p>Single staircase, with lobby approach</p> <p>Extended travel distances ≤15 m (with supporting smoke control)</p> <p><i>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.</i></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 &gt;15 m (with or without supporting smoke control)</p> <p><i>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.</i></p> <p>Open balcony approach to flats</p> <p><i>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.</i></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><i>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.</i></p> |
| <p><i>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.</i></p>                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

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

| Positive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Neutral                                                                      | Negative                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>H.4 Compartmentation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| —                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 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<br><i>NOTE 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> |
| <b>H.5 Smoke control</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| —                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | —                                                                            | 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                                                                                                               |
| <p><i>NOTE 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></p> |                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

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

| Positive                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Neutral                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Negative |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>H.6 Fire detection and fire alarm system</b>                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |
| <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"> <li>• common area coverage, also with detectors at least inside flat entrance halls (local warning within flat from domestic smoke/heat alarms); or</li> <li>• common areas and throughout flats*; or</li> <li>• monitored by staff on a 24 h basis or by an alarm receiving centre (ARC)*</li> </ul> | <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><i>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.</i></p> <p>Evacuation alert system for use by the fire and rescue service</p> <p><i>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.</i></p> | —        |

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

| Positive                                                                                                                                                                                                                                                                                                                                                                                                                               | Neutral                                                                                                                                                                                                                                                                                              | Negative                                                                                                                                                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>H.7 Fire suppression</b>                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                             |
| Sprinkler system throughout building, conforming to BS EN 12845*<br>Domestic sprinkler/watermist system in each flat: <ul style="list-style-type: none"> <li>conforming to BS 9251 (sprinklers);</li> <li>conforming to BS 8458 (watermist)</li> </ul>                                                                                                                                                                                 | Local protection within flats, e.g. cooker hood protection or other partial protection system<br>No sprinklers, but their absence is in accordance with guidance relevant to the design and construction of the building in question                                                                 | —                                                                                                                                                                                                                           |
| <i>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.</i>                                                                                                    |                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                             |
| <b>H.8 Firefighting facilities</b>                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                             |
| Good access for firefighting vehicles<br><i>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.</i>                                                                     | Adequate access for firefighting vehicles<br><i>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.</i> | Poor access for firefighting vehicles<br><i>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.</i> |
| <i>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.</i>                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                             |
| <i>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.</i>                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                             |
| <i>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).</i> |                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                             |

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

| Positive              | Neutral                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Negative                                      |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| <b>H.9 Fire mains</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                               |
| —                     | <p>Suitable fire main present</p> <p><i>NOTE 1 While fire 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><i>NOTE 2 “Suitable” refers to a main meeting current standards. It is recognized that there will be a variety of standards of fire main present depending upon the age of the building, including dry fire mains in very tall buildings that would currently be required to be fitted with wet fire mains. Dry fire mains in these situations could be considered as potentially negative unless pressure tests can demonstrate that their performance is satisfactory.</i></p> | Absence of fire mains in buildings above 18 m |

*NOTE 1 Fire 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.*

*NOTE 2 There is no requirement for fire 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.*

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

| Positive                                  | Neutral                                                                                                                                                                                                                                                                               | Negative                                             |
|-------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|
| <b>H.10 Lifts for use by firefighters</b> |                                                                                                                                                                                                                                                                                       |                                                      |
| —                                         | <p>Suitable firefighting lift present</p> <p><i>NOTE 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 |

*NOTE 1 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.*

*NOTE 2 There is no requirement for firefighting lifts to be fitted in new buildings below 18 m in height.*

*NOTE 3 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.*

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

| Positive                          | Neutral                                          | Negative                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------------------------|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>H.11 Specific fire hazards</b> |                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| —                                 | Vehicle parking on roadways adjacent to building | Vehicle parking under overhangs<br>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<br><br>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<br><br>Permanent refuse storage in close proximity to the external walls. |

*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 O.*

*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.*

## **Annex I (informative)**

### **Case studies with working examples illustrating the use of the methodology**

#### **I.1 General**

The following case studies are based on the real-life experiences of the authors, but are ultimately fictitious and are solely intended to illustrate the application of the framework and rationale in Clause 6 and Clause 7. 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.

#### **I.2 Case study 1: Six-storey building with Category 2 ACM cladding panels and polymeric foam insulation on penthouse flats**

##### **I.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 [16].

Nevertheless, given a general concern regarding ACM, the owner commissioned an FRAEW to supplement the building's FRA.

##### **I.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 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 (i.e. it could not be said that all of the external walls were inherently low risk).

### **I.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 initially 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 person conducting the FRAEW 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 for the walls other than the brickwork walls, was “high”. The brickwork system was deemed to be an inherently low risk wall construction.

### **I.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, the external wall construction that was of concern was limited in extent to the height of one storey at the top 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.

### **I.2.5 Risk factors arising from fire strategy/fire hazards (and limitations of fire and rescue service intervention)**

Given a low risk rating was achieved as a result of considering both the fire performance and façade configuration factors, it would not normally have been necessary to consider fire

strategy factors; a person completing the FRAEW could simply have proceeded to prepare a report. However, given the “what-if” scenarios below, we have set these out.

There were a number 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 service, 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.

### **I.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
- it was highly unlikely that a fire involving the offices would be capable of causing ignition of the external walls of the flats, given their setback position; 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.

### **I.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?**

The absence of a setback would likely mean that there exists a possibility of fire involving the offices leading to ignition of the external walls of the flats, so the façade configuration factors alone would be insufficient to conclude a “low” risk outcome. It would therefore become necessary to consider fire strategy factors.

The lack of a setback 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, given consideration of the fire strategy factors, 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.

Provided that cavity barrier protection was found to be adequately provided, the fact that only two levels are involved would be likely to result in the risk being considered to be tolerable but not low. Provided all flats still had access to two independent staircases and were unlikely to be cut off from either as a result of fire/smoke spread, it might still be possible to view the overall rating of the risk as “low”. Were this not to be the case, then it might be prudent to install an interlinked fire detection and alarm system (so that smoke affecting any part of the means of escape raises the alarm in all flats).

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.

Provided it was possible to access the external walls of the flats without the need for scaffold then, given the very limited amount of work that would be involved in providing vertical barriers in line with compartment walls, it would be prudent to install these in order to reach a low risk rating.

### **I.3 Case study 2: Eight-storey block of flats with an aluminium rainscreen cladding system incorporating polymeric foam insulation**

#### **I.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.

#### **I.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. Absent any inspection information, a person conducting an FRAEW would need to assume a reasonable worst case scenario that workmanship within the system was poor, which would lead to a “high” fire performance risk outcome owing to the possibility of both rapid and extensive fire spread. The façade configuration risk factors will not provide mitigation (see below) and while the fire strategy risk factors would provide some mitigation, the risk outcome would remain “medium” and not be “tolerable”.

### **I.3.3 Findings from investigations**

Given the lack of specificity regarding the insulation and the possibility of poor workmanship, 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 brickwork was 100 mm thick and had a full fill of mineral fibre insulation in the cavity behind it; and
- there was no continuous cavity between the brick walls and the rainscreen cladding system; the soffit was concrete.

### **I.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 person conducting the FRAEW, 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 "tolerable" risk band given a minor risk of fire spread exceeding benchmark expectations.

However, to fully conclude this, the person conducting the FRAEW 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. However, before deciding whether to proceed with this additional investigation, the person conducting the FRAEW proceeded to consider the remaining risk factors.

### **I.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 (and in fact were not) 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”.

### **I.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 service, 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.

### **I.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.

### **I.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 **I.3.4**), to the “low” risk band unless this coincided with the system becoming very similar to a system classified to BR 135 [15].

- 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 in the “tolerable” 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 if doing was disproportionate. Further analysis in accordance with Clause **13** 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 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 “medium” band. The cost of installing a fire detection and alarm system might need to be compared with the level and cost of inspection needed to achieve confidence regarding workmanship.

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. This and the issue of cost would be matters that would need to be highlighted so that they could be considered more broadly by the client 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.

## **I.4 Case study 3: Four-storey block of flats with a zinc cladding system incorporating polymeric foam insulation**

### **I.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.

### **I.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, absent such confirmation the possibility of combustible insulation (and other reasonable worst case assumptions such as missing/poor cavity barriers) would need to be made, creating a need for inspection.

### **I.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.

#### **I.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;
- a small proportion of cavity barriers were in poor condition; 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.

#### **I.4.5 Façade configuration risk factors**

The appraisal noted significant positive risk factors in relation to the configuration of the façade, 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 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 “tolerable” risk band.

#### **I.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 was “tolerable”.

#### **I.4.7 Outcome of the analysis of the risk and possible remedial action**

Based on the “tolerable” 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 everywhere;
- 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.

The primary options available to reduce the risk further would be to move to a simultaneous evacuation policy (involving installation of a building-wide fire detection and alarm system) or remedial works to the external walls, neither of which would be proportionate in the circumstances. Accordingly, no remedial action was considered necessary.

#### **I.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 in 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, in conjunction with replacement of a zinc with a material offering greater protection, 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?**

These materials can lead to extremely rapid external fire spread and therefore present a significant hazard. Accordingly, it would be expected that the FRAEW would conclude

the rainscreen in this case would need to be replaced; given the works needed to achieve this (likely scaffolding the entire building) consideration would need to be given to conducting additional work to further reduce risk provided it is proportionate to do so (e.g. checking and, as necessary, remediating all cavity barriers given these will be exposed in any event).

## **I.5 Case study 4: Seven-storey block of flats with high pressure laminate (HPL) panels and polymeric foam insulation**

### **I.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 age, and included suitable smoke control to protect the single staircase route.

### **I.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 person conducting the FRAEW was aware that combinations of HPL and combustible insulation can, subject to their specific performance and the presence or otherwise of cavity barriers, support rapid and extensive fire spread. On this basis, based on the information immediately available to them, they informed the client that it would be highly likely that the outcome of the FRAEW 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 person conducting the FRAEW 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 analysis in accordance with Clause 13 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 person conducting the FRAEW did not have the necessary competence to conduct such a detailed analysis, 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 detailed analysis with all necessary information.

### **I.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.

### **I.5.4 Outcome of the analysis of the risk and possible remedial action**

On this basis, the person conducting the FRAEW was of the opinion that the actual build-up was so far removed from any form that they knew had been tested that further detailed analysis in accordance with Clause 13 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 person conducting the FRAEW advised the client to notify the local fire and rescue service of the risk.

## **I.6 Case study 5: 15-storey block of flats with ETICS comprising rendered EPS**

### **I.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 age, 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.

### **I.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 (i.e. it could not be said that all of the external walls were inherently low risk).

### **I.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 [21] and LPS 1208 [22], 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 person conducting the FRAEW 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 person conducting the FRAEW considered that there might be the need for more detailed analysis in accordance with Clause 13 of the cladding system.

#### **I.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 detailed analysis in accordance with Clause 13 of the cladding system by a fire engineer with specialist knowledge was one possible outcome from this.

#### **I.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.

#### **I.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 expectations for a building of its age and height. As such, it would be expected most firefighting operations would be carried out internally.

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.

#### **I.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 necessary 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 detailed analysis in accordance with Clause 13 of the ETICS by a fire engineer with specialist knowledge in that form of cladding system. The person conducting the FRAEW also advised the client to notify the local fire and rescue service of the risk.

#### **I.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, the sprinkler system would be overwhelmed by multiple flats becoming involved in fire, leading to more heads operating than the system was designed to accommodate. Prompt evacuation of all occupants of the block might still 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 for the fire and rescue service, conforming to BS 8629, might be seen as beneficial in this regard, but such a 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 person conducting the FRAEW 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, capable of causing secondary fires in flats. This would require detailed analysis in accordance with Clause 13 of the ETICS by a fire engineer with specialist knowledge in that form of cladding system.

## **1.7 Case study 6: Ten-storey block of flats which has undergone remediation**

### **1.7.1 Background**

An FRAEW of this ten-storey building, measuring some 27 m above ground to its top storey, was requested by the owner of a block which had undergone remediation.

It was a building with 40 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 age, and included suitable smoke control to protect the single staircase route.

The block had previously featured Category 3 ACM rainscreen cladding with combustible insulation, but this had been replaced as a result of works carried out in accordance with previous government guidance (prior to the first edition of this PAS).

### **I.7.2 External wall construction**

At the time the FRAEW was requested the external walls comprised solid aluminium rainscreen over a cavity and mineral wool insulation. Behind the mineral wool insulation there was sheathing board fixed to SFS construction and plasterboard internally. The sheathing board was Class B-s1,d0 to BS EN 13501-1 and there was no insulation within the SFS construction.

There were extensive records of the remedial work which had previously been carried out, including contemporaneous photographs of the installation of cavity barriers and a file of correspondence which included queries raised with the project fire engineer for the remedial works.

### **I.7.3 Findings from investigations**

Given the level of detail available regarding both the design and construction of the remedial works, no inspection was considered necessary. The presence of a Class B sheathing board meant that the external walls could not be deemed to be inherently low risk.

An FRAEW therefore proceeded on the basis of the information provided.

### **I.7.4 Fire performance risk factors**

The only major component within the external wall construction which was not Class A2-s1,d0 or better was the sheathing board. However, as a Class B board covered in mineral wool externally, there was no realistic prospect of it ever contributing significantly to a fire.

The fire performance of the external wall construction was therefore concluded to be “low” risk.

### **I.7.5 Outcome of the analysis of the risk and possible remedial action**

Given the “low” risk outcome reached in relation to the external walls, the FRAEW was concluded without needing to consider the façade configuration or fire strategy risk factors. Any issues concerning the remaining fire safety issues in the building could be considered as part of the building’s fire risk assessment.

### **I.7.6 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 sheathing board was Class A2-s1,d0?**

This would lead to a conclusion, in accordance with Clause 4, that all of the external wall construction is inherently low risk. There would, therefore, be a need for a report complying with Clause 14 to document this, but not a full FRAEW complying with Clause 15 as well.

## **Annex J (informative)**

### **Hazard contextualization**

#### **J.1 General**

This annex provides guidance on identifying and contextualizing the hazards associated with different external wall systems.

#### **J.2 Methodology**

##### **J.2.1 Differentiation of wall constructions**

The respective elevations of the building can be differentiated into separate wall constructions 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.

In some cases, the systems can be differentiated into clearly different system types (for example where an elevation is clearly split into two construction types such as a brick cavity wall and a separate rainscreen system), but in others there might be two typologies within one system (for example rainscreen infill panels within a brick cavity wall).

In all cases, the interaction between different, adjacent systems needs to be taken into account.

##### **J.2.2 Hazard identification**

Different wall system typologies have different potential hazards. Therefore, for each wall construction system, potential fire and smoke spread hazards and the strategy for resisting fire and smoke spread need to be identified.

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 **J.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 **J.3.2**): There are no cavities and the hazard of fire spread via materials and surfaces is adequately low.
- 4) Compartmentation continuation (see **J.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 **J.3.4**): The combustibility of materials is such that they would not be a medium for fire spread.
- 6) Subdivision (see **J.3.5**): Combustible materials and/or cavities are subdivided by construction that adequately resists fire spread.

### **J.2.3 Assessment**

The critical success criteria for each wall construction system (as a function of the hazard mitigation strategy) are identified and assessed for 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.

### **J.2.4 Documentation**

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

## **J.3 Assessment considerations**

### **J.3.1 Encapsulation**

#### **J.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 edge protection: protection of cavity edges (i.e. top, bottom and sides) and cavity openings (e.g. windows, doors, vents).

#### **J.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.

### **J.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.

### **J.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 J.1).

**Table J.1 – Typical indicators of level of encapsulation**

| <b>Level of encapsulation</b> | <b>Equivalence</b>                                                                                                                        | <b>Direct risk assessment</b>                                                                     |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| 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.

### **J.3.1.5 Competence**

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

- fire performance: understanding the difference between fire resistance and reaction to fire (ignition and combustibility);
- 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
- surveying: being able to assess whether encapsulating components have been installed and maintained correctly.

### **J.3.1.6 Uncertainty**

Areas of uncertainty for existing constructions are likely to include:

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

### **J.3.1.7 Deficiencies**

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

- 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.

### **J.3.2 Restricting fire spread in the absence of a cavity**

#### **J.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.

#### **J.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 J.2.

**Table J.2 – Relevance of reaction to fire classes in the absence of a cavity**

| <b>Reaction to fire class</b>                                                                                               | <b>Characteristic behaviour</b>                                                                                                                                                                               | <b>Acceptability</b>                                                                                                                    |
|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| a) Class A1 and Class A2                                                                                                    | 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                                                                                |
| b) Class B where all constituent materials each achieve Class B without fire retardants                                     |                                                                                                                                                                                                               |                                                                                                                                         |
| c) Class C charring thermosetting insulations                                                                               |                                                                                                                                                                                                               |                                                                                                                                         |
| 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                           |

**Table J.2 – Relevance of reaction to fire classes in the absence of a cavity**

| Reaction to fire class | Characteristic behaviour                                                                                                                                                                                                                                                                 | Acceptability                                                                                                                                                                 |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                        |                                                                                                                                                                                                                                                                                          | 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                         |

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 J.3.

**Table J.3 – Relevance of heat of combustion by mass in the absence of a cavity**

| Heat of combustion <sup>A)</sup> | 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           |

<sup>A)</sup> There is deliberate overlap in the heat of combustion values between categories to avoid a "binary" risk classification process.

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 J.4.

**Table J.4 – Relevance of heat of combustion by area in the absence of a cavity**

| Heat of combustion <sup>A)</sup>                                                                                                               | Characteristic behaviour                                                                                              | Acceptability                                                                                         |
|------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| <4 MJ/m <sup>2</sup>                                                                                                                           | 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 <sup>2</sup> to 10 MJ/m <sup>2</sup>                                                                                                    | 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 <sup>2</sup>                                                                                                                           | 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                                                        |
| <sup>A)</sup> There is deliberate overlap in the heat of combustion values between categories to avoid a “binary” risk classification process. |                                                                                                                       |                                                                                                       |

### J.3.2.3 Competence

The skills, knowledge and experience required to assess adequacy of restricting fire spread are:

- 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
- surveying: being able to identify the products and materials used in the external wall construction.

### J.3.2.4 Uncertainty

Areas of uncertainty for existing constructions are likely to include fire spread characteristics of materials and products.

## J.3.3 Compartmentation continuation

### J.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).

### **J.3.3.2 Assessing adequacy**

Assessment of adequacy of compartmentation continuation requires assessment as summarized in Table J.5.

**Table J.5 – Compartmentation continuation assessment**

| <b>Element of construction</b> | <b>Equivalence</b>                                                                                                                          | <b>Direct risk assessment</b>                                                                                                                                                                                            |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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. |

### **J.3.3.3 Competence**

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

- fire resistance: whether subdividing elements achieve an adequate fire resistance standard when installed in conjunction with the cladding in question;
- cladding: whether the cladding presents any significant risk for fire spread around subdividing components; and
- surveying: being able to assess whether the encapsulating components have been installed and maintained correctly.

### **J.3.3.4 Uncertainty**

Areas of uncertainty for existing constructions are likely to include fire resistance of components such as fire barriers.

### **J.3.3.5 Deficiencies**

Typical deficiencies that might need to be considered include fire barrier adequacy and workmanship of installation.

## **J.3.4 Limiting combustibility**

### **J.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”.

#### **J.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.

#### **J.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.

#### **J.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.

#### **J.3.4.5 Deficiencies**

Typical deficiencies that might need to be considered include cavity barrier adequacy and workmanship of installation.

### **J.3.5 Subdivision**

#### **J.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.

#### **J.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.

#### **J.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) thermomechanical material/product response: changes in mechanical response of materials/products with respect to time and temperature.

#### **J.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.

#### **J.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.

### **J.4 Mitigation of risk**

#### **J.4.1 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 person conducting the FRAEW 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 J.6.

**Table J.6 – 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 |

## J.4.2 Practical application of principles

### J.4.2.1 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.

### J.4.2.2 Consequence reduction

#### J.4.2.2.1 General

Consequence mitigation measures are listed in Table J.7 and discussed further in J.4.2.2.2 to J.4.2.2.10.

**Table J.7 – 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                |

#### J.4.2.2.2 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.

#### **J.4.2.2.3 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.

#### **J.4.2.2.4 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.

#### **J.4.2.2.5 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.

#### **J.4.2.2.6 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.

#### **J.4.2.2.7 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.

#### **J.4.2.2.8 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).

#### **J.4.2.2.9 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 fire 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.

#### **J.4.2.2.10 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 fire loads), and the potential consequences of fire spread in the event that the external wall construction is ignited.

## **Annex K (informative)**

### **Use of BS 8414 and BR 135**

#### **K.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 8414 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.

- a) 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.
- b) 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.
- c) Margin of safety: The greater the margin of safety, the lower the uncertainty in use of data.
- d) Critical success factors: The key components of a wall construction depend on the strategy for adequacy (see **J.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.

#### **K.2 Interpreting BR 135 classifications**

##### **K.2.1 Performance criteria**

Performance criteria, both explicit and implicit, are described in **A.3**.

##### **K.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).

### **K.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.

Persons conducting an FRAEW need 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.

### **K.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.

Persons conducting an FRAEW need 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.

### **K.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 thermomechanical 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.

### K.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 thermomechanical properties of the cladding panels; and
- e) combustibility of materials behind the cladding panels including in any cavity.

Table K.1 shows some combinations of critical success factors that are likely to result in adequate resistance to fire spread.

**Table K.1 – Typical examples of critical success factors**

| <b>Factor</b>                                                    | <b>Compartmentation continuation</b>                                            | <b>Subdivision (combustible insulation)</b>                              | <b>Subdivision (limited combustibility insulation)</b>    |
|------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------------|
| Fire resistance of cavity barriers                               | Critical:<br>Same as internal compartmentation                                  | Critical:<br>At least 30EI (see <b>A.4</b> ) or demonstrated by BS 8414  | Not critical                                              |
| Fire resistance of substrate                                     | Not important                                                                   | Critical:<br>At least 30EI (see <b>A.4</b> ) or demonstrated by BS 8414  | Low sensitivity                                           |
| Combustibility of cladding panels                                | Critical:<br>Limited combustibility or Class A2 or better                       | Critical:<br>Class B or better or demonstrated by BS 8414                | Critical:<br>Class B or better or demonstrated by BS 8414 |
| Thermodynamic and thermomechanical properties of cladding panels | Critical:<br>Needs to retain functionality in respect of inhibiting fire spread | Critical:<br>Enough to have confidence regarding adequacy of subdivision | Low sensitivity                                           |
| Combustibility of cavity materials                               | Not important                                                                   | Limited sensitivity                                                      | Critical:<br>Limited combustibility or Class A2 or better |

## **Annex L (informative)**

### **Aspects of information gathering**

#### **L.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 8).

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 [24] records key information relating to the design and construction of buildings.

## **L.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 9 and Annex M.

When identifying products, persons conducting an FRAEW need to be aware that families of products might appear very similar from visual inspection but have very different fire performances.

## **L.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.

Persons conducting an FRAEW 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 9.

#### **L.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, persons conducting an FRAEW normally need 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 a detailed analysis, as described in Clause 13.

## **Annex M (informative)**

### **Site survey and inspection considerations**

#### **M.1 Methods of construction and workmanship**

##### **M.1.1 General**

Site surveys and inspections are aimed at gaining accurate information about the materials, products and geometry of the external wall construction and cladding. This information can be used to inform a professional judgement about how the walls might behave in a fire.

However, in addition to the performance of the individual components and materials making up a cladding system, several other factors can affect its response to fire. These include workmanship, tolerances, and junctions between different types of construction.

##### **M.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 external cladding panels, and the installation of cavity barriers.

Gaps between external cladding panels allow ventilation of the cavity of a rainscreen cladding system. Ventilation is essential for the proper functioning of this type of cladding system, but it can also provide support to a fire. Where the fire performance of a system is dependent on the ventilating air not exceeding a certain volume, the size of the gaps between cladding panels becomes critical. In these circumstances, it is essential that the gaps between panels in the system as installed are the same as those with which it was designed and, where applicable, tested.

Cavity barriers play an essential role in preventing the unseen spread of fire within an external wall system. The investigation of numerous buildings in the wake of the fire at Grenfell Tower, however, 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 intumescent 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. Persons conducting an FRAEW are expected to have a good understanding of industry best practice, and to acquaint themselves with the manufacturer's recommendations and/or instructions in relation to any proprietary cavity barrier components found within a system under investigation.

##### **M.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 can result in the occurrence of unintended cavities between the structure of the building and the external cladding system. It can also result in variations in the dimensions of cavities, and/or gaps between components of the system, that fall outside the range required for effective performance of the system.

In insulated render systems, for example, fixing insulation on dabs of adhesive to accommodate irregularities in the structure can result in the formation of unintended cavities behind the insulation. In rainscreen cladding systems, accommodating irregularities in the structure can result either in variations in the width of the ventilated cavity and the volume

and flow of air within it, or in the formation of unintended cavities between the sheathing board and the structure.

#### **M.1.4 Junctions**

Many buildings are designed with several different external wall types in different locations and the fire performance of each individual wall type might, when appraised individually, be deemed to be satisfactory. However, junctions between different wall types, or changes of direction within a single wall type, can cause a lack of continuity of some components, including cavity barriers across junctions or at changes of direction, resulting in extensive unintended cavities.

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.

#### **M.2 Invasive investigation and sampling**

Site surveys and investigations necessarily involve the removal of external components of the system, such as cladding panels, trims and decorative features, to expose the internal components. Some internal components might also need to be removed so that the composition and condition of the substrate to which the system is attached can be examined.

This can result in substantial destructive works and it is important that persons conducting an FRAEW, or those who undertake this part of an FRAEW on their behalf, plan these works carefully. Such planning is expected both to maximize the benefit gained from such work and to minimize the risk of damaging the features to be inspected and/or causing other negative consequences, which might include:

- damaging water-resisting elements of the wall, thereby impairing its watertightness;
- impairing the continuity of thermal insulation, thereby reducing the environmental performance of the wall;
- damaging cavity barrier installations, thereby impairing the fire performance of the wall;
- weakening the structural integrity of the cladding system and its supports;
- causing inconvenience to residents; and
- impairing the appearance of the external wall because of an inability to procure exact replacements for components that have been damaged, or to colour-match repairs.

Careful selection of sample locations can minimize damage and other negative consequences, but the greater the number of sample locations, the greater the risk of such consequences. Appropriate timing of investigations, rather than limiting their scope, might be an acceptable means of reducing inconvenience to residents.

Determination of the number of sample locations requires an understanding that it is neither realistic nor appropriate, in the case of an existing building, to expect site surveys and inspections to be able to identify all instances of deficiencies in external wall construction and cladding. An FRAEW is not a general forensic investigation into the construction of an external wall, and it is neither reasonable nor necessary to open up the entire extent of the external wall to carry out a robust FRAEW. This is consistent with the FRA process, in which sampling is also inherent. The size of the sample is a key consideration in both the FRA and the FRAEW processes and will be determined by the factual and legal matrix in each individual matter.

Plans and elevation drawings can be marked to show the location of critical features such as compartment walls and compartment floors, as well as the locations of different cladding or substrate types. Each location to be opened up can include multiple features of interest so that the amount of work required is minimized. For example, a single area of opening up at a

junction between a compartment wall and floor not only exposes insulation and cladding components, but also shows whether cavity/fire barriers have been installed at both the compartment wall and the compartment floor.

The availability of suitable access equipment, such as mobile elevating work platforms, scaffolding towers, cleaning cradles or abseiling points, needs to be taken into account when selecting areas to be inspected. Low level areas can be easier to access, but cladding at this level is typically designed to be more robust to provide greater resistance to impact and vandalism. It might not, therefore, be representative of cladding installation at higher levels.

A limited inspection of the exposed construction and components is usually sufficient to determine whether the materials, components and proprietary products specified in the design documents, or shown on the as-built drawings, have been used or substituted by others. It also enables verification that the dimensions of the components, cavities and other features are in accordance with those indicated on the drawings.

A limited inspection is also likely to be sufficient allow the quality of the workmanship of the various trades involved in the installation to be assessed.

On larger buildings, where the installation is likely to be inconsistent from area to area, opening up in several locations, remote from one another, is likely to be required to enable any variations in standards of workmanship to 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 the different wall build-ups.

## **Annex N (informative)**

### **Generic fire properties of external wall materials, systems and configurations**

#### **N.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).

#### **N.2 Common components across all system types**

Table N.1 to Table N.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 N.1 – Fire properties of common elements – Structural elements**

| <b>Element</b>                                      | <b>Property</b>                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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.                                       |

**Table N.1 – Fire properties of common elements – Structural elements**

| Element                                                                           | Property                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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 N.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. All plasterboard is fire-resisting to some extent, 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>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

**Table N.2 – Fire properties of common elements – Plasterboard and sheathing boards**

| Element               | Property                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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 N.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"> <li>• Stone wool</li> <li>• Ceramic fibre</li> <li>• Glass fibre</li> <li>• Foamed glass</li> <li>• Exfoliated vermiculite</li> </ul> | <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> |

**Table N.3 – Fire properties of common elements – Insulation**

| Element                                                                                                                                                                                                                                                                                             | Property                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rigid (thermoset) foam insulations <ul style="list-style-type: none"> <li>• Polyurethane (PUR)</li> <li>• Polyisocyanurate (PIR)</li> <li>• Phenolic</li> </ul>                                                                                                                                     | <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 person conducting the FRAEW 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> |
| Thermoplastic insulation <ul style="list-style-type: none"> <li>• EPS foam</li> <li>• XPS foam</li> <li>• “Multifoil insulation” (e.g. layers of reflective foil and thermoplastic fibre wadding or bubble-wrap type material)</li> <li>• Importance of cavities being formed on heating</li> </ul> | <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 N.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 fire 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. 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"> <li>• steel 0.5 mm thick;</li> <li>• timber 38 mm thick;</li> <li>• mineral wool provided it is in slab form or sleeved in polythene; and</li> <li>• calcium silicate, cement-based or gypsum-based (plaster) board at least 12 mm thick.</li> </ul> <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 N.4 – Fire properties of common elements – Cavities**

| 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 (see BS 9414) 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. Technical Guidance Document 19 [25], issued by the Association for Specialist Fire Protection (ASFP), sets out a method for testing the fire resistance of open state cavity barriers.</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"> <li>• vertical cavity barriers might not be suitable for use as horizontal cavity barriers;</li> <li>• 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.</li> </ul> |

**Table N.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"> <li>• 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</li> <li>• insulating glass, which acts as a barrier both to heat and to thermal radiation, usually by turning opaque on heating.</li> </ul> <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>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

**Table N.5 – Fire properties of common elements – Glazing**

| Element                | Property                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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"> <li>• metal skins with an insulating core;</li> <li>• metal skins with an insulating and timber (typically plywood) core;</li> <li>• metal external face with insulating core and timber (typically plywood) internal face;</li> <li>• HPL skins with an insulating core; and</li> <li>• solid HPL.</li> </ul> <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"> <li>• 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.</li> <li>• 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.</li> </ul> |

**Table N.6 – Fire properties of common elements – Other generic components**

| Element                                                                                                                         | Property                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Breather membrane</li> <li>• Vapour membrane</li> <li>• EPDM</li> <li>• DPC</li> </ul> | <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> |

**Table N.6 – Fire properties of common elements – Other generic components**

| Element                 | Property                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 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>                                                                                                                                                                                                                                                                                                                                                        |

**Table N.6 – Fire properties of common elements – Other generic components**

| Element                                                   | Property                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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"> <li>• the general external wall construction (are the panels integrated with or stood off from the system?);</li> <li>• whether the external wall construction is likely to be fire-resisting;</li> <li>• windows onto accommodation;</li> <li>• windows onto means of escape; and</li> <li>• any other routes that might allow fire and smoke spread into the building.</li> </ul> |
| 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 N.6 – Fire properties of common elements – Other generic components**

| 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"> <li>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);</li> <li>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</li> <li>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.</li> </ul> <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 fire load which can support a significant fire. 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>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

### N.3 Common system types

Table N.7 to Table N.9 describe the fire properties of common types of external wall system. Further considerations relating to specific system types are given in Table N.10.

**Table N.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"> <li>Is the masonry/concrete loadbearing or simply providing a façade?</li> <li>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"> <li>brick slip (tiles) fixed to a substrate; or</li> <li>factory produced (typically panellized) brickwork?</li> </ol> <p>If either item 1) or item 2) above, then treat as other form of cladding depending upon underlying construction (most likely rainscreen).</p> </li> <li>What is the underlying construction? For example: <ol style="list-style-type: none"> <li>second leaf of masonry/concrete forming a cavity;</li> <li>timber frame;</li> <li>steel structure and frame;</li> <li>concrete structure and SFS;</li> <li>concrete structure and concrete panels; or</li> <li>insulated build-up (this is typically used where historic façades are retained over more modern construction, and can come in a variety of forms).</li> </ol> </li> </ol>                                                                          |
| 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"> <li>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.</li> <li>The masonry/concrete is likely to be of limited combustibility or better.</li> </ul> <p>Given the above, this form of construction is invariably accepted as:</p> <ul style="list-style-type: none"> <li>not requiring cavity barriers generally, except that cavity closers are needed so that there is no free flow of air through the cavity; and</li> <li>being able to accommodate combustible materials within the cavity irrespective of building height.</li> </ul> <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 N.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 N.4):</p> <ul style="list-style-type: none"> <li>• ventilated and drained; or</li> <li>• pressure equalized.</li> </ul> <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 N.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 N.9 – Fire properties of common system types – Rainscreen facing materials<sup>A)</sup>**

| 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"> <li>• 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.</li> <li>• 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.</li> </ul> |
| 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 N.9 – Fire properties of common system types – Rainscreen facing materials<sup>A)</sup>**

| 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"> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> </ul> <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 persons conducting an FRAEW 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>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

**Table N.9 – Fire properties of common system types – Rainscreen facing materials<sup>A)</sup>**

| Element                                           | Property                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Plastics                                          | <p>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, persons conducting an FRAEW need to establish their fire performance in some way, noting in particular that fire performance can degrade as the plastic degrades over time.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 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, persons conducting an FRAEW 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, persons conducting an FRAEW need to check that it is relevant to the cassette, and not just to the material in flat panel form.</p> |

**Table N.9 – Fire properties of common system types – Rainscreen facing materials<sup>A)</sup>**

| Element                 | Property                                                                                                                                                                                                         |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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 N.6). |

<sup>A)</sup> 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.

**Table N.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"> <li>Mineral wool-based systems are likely to be low-risk.</li> <li>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.</li> <li>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.</li> </ul> <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 N.2 and Table N.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 overlaid by a rainscreen, or might be exposed to the exterior, effectively as a rainscreen in their own right.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

**Table N.10 – Further considerations for specific system types**

| System type          | Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Curtain wall systems | <p>There are two principal forms of curtain wall system.</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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 compartmentation, this limits the extent/speed at which fire can spread across the system.</li> </ul> <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"> <li>• 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.</li> <li>• 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.</li> <li>• 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).</li> </ul> <p>The other components of curtain wall systems are covered in Table N.5.</p> |

## **Annex O (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 [26] 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 dutyholders 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 [27]). 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 [21]) 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 5.2 and Annex D, 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 [26], 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 [28] 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, Government published research [19] carried out by BRE 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 P (informative)**

### **Tools for more detailed analysis**

#### **P.1 General**

The methodology in this PAS is risk-based and requires persons conducting an FRAEW to determine the risk of fire spread via external wall constructions from “low” to “high” as a function of fire performance (a metric of the potential hazard), façade configuration (a metric of the probability of fire spread) and the fire strategy factor (a metric of the potential consequences).

For each of these factors, this PAS provides information on features that influence the overall risk on a scale from positive to negative (see Annex F, Annex G and Annex H).

In some circumstances, it might be appropriate to use more detailed tools or methods to determine the fire performance, façade configuration and fire strategy factors. This annex introduces example tools for more detailed analysis.

#### **P.2 Overarching principles**

It is not necessary nor practical to prevent fire spread via the outside of a building. In fact, the risk associated with fire spread via external wall constructions can be deemed to be low, provided that:

- a) the probability of fire spread between compartments (or flats) via the external wall construction is low;
- b) the rate of fire spread between compartments (or flats) is sufficiently low that:
  - 1) the probability of multiple secondary fires occurring simultaneously is also low; and
  - 2) there is sufficient time for the fire and rescue service to manage the incident (both in terms of managing evacuation and preventing or controlling further fire spread);
- c) fire spread over the walls of the building does not unduly compromise means of escape or fire and rescue service access;
- d) fire spread would not result in elements of structure failing to retain stability for a reasonable period (not within the scope of this PAS); and
- e) fire spread over the walls of the building is sufficiently limited as to limit the probability of fire spread to any adjacent buildings (not within the scope of this PAS).

#### **P.3 Fire performance**

##### **P.3.1 Principles**

The fire performance is a measure of the potential:

- a) rate of fire or smoke spread;
- b) extent of fire or smoke spread; and
- c) heat of spread.

Any tool used for more detailed analysis needs to provide additional information or certainty on each of these factors.

##### **P.3.2 Tools**

Because of the inextricably linked interactions between the various components, the fire performance of external wall systems can be extremely complex, and it is unlikely that anything other than crude approximations of rate and extent of fire spread can be conducted for anything other than the most simple of systems. As such, it is most likely that any analytical tools would be comparative (for example comparing key features of the external wall in question to a known performance of a similar external wall system).

Regardless, any tool needs to treat the thermodynamic and thermomechanical performance of external wall systems as an assembly. In so doing, issues that might need to be considered include the following.

- a) Scope and limitations of standardized test methods: The information that can be taken from standard tests results is limited to the purpose and scope of the test. As such, it is necessary to have detailed a understanding of the test methods and outputs and classifications (see Annex A and Annex K).
- b) Ad-hoc fire tests: Ad-hoc fire tests can provide useful information to increase understanding of fire performance.
- c) Principles of ignition, combustion and heat transfer: More detailed assessments are likely to require a fundamental understanding of the principles of ignition, combustion and heat transfer of materials, products and systems. This includes understanding the interactions (e.g. radiative feedback and heat sinks) between different components within a system.
- d) Material degradation: Material degradation such as loss of strength and stiffness, delamination, spalling, pyrolysis can have a significant impact on overall performance.
- e) Modes of failure: Systems and products can fail to resist fire spread in different ways. It is important to understand the thermodynamic and thermomechanical performance to be able to identify and assess all potential modes of failure.

### **P.3.3 Fire testing**

While it is not generally expected that FRAEWs will requiring testing to be undertaken, there will be instances where it is the only means by which risk can be quantified (for example, if a particularly novel material or system is encountered for which there is no existing fire performance data). Further information on testing is provided at Annex A, while the specific interpretation of data from BS 8414 tests and BR 135 [15] classification is addressed in Annex K.

## **P.4 Façade configuration**

### **P.4.1 Principles**

The façade configuration is a measure of:

- a) the probability of the external wall construction being ignited; and
- b) the potential for spread via the external walls to result in fire spread from one part of a building to another.

Any tool used for more detailed analysis needs to provide additional information or certainty on each of these factors.

### **P.4.2 Tools**

Tools for assessment might include any of the following.

- a) Sprinkler effectiveness: There are calculation tools that can be used to inform the likely effectiveness of sprinklers (e.g. calculating the fire size at which sprinklers would activate based on the room geometry and sprinkler head configuration). Such tools can inform whether sprinklers would reduce the probability of ignition.
- b) External flame assessments: There are multiple tools that can be used to approximate flame extensions from compartment fires and external fires. These tools could be used to inform whether an external wall construction is likely to be ignited as a function of its proximity to windows or external fuel sources, or whether fire spread over one wall construction is likely to result in fire spread to another wall construction.

## **P.5 Fire strategy factors**

### **P.5.1 Principles**

The fire strategy factor is a measure of the consequence that fire spread via an external wall construction could have on means of escape routes, fire and rescue service access routes or fire fighting operations.

Any tool used for more detailed analysis needs to provide additional information on whether fire spread via an external wall construction is likely to result in means of escape routes or fire and rescue service access routes being compromised prematurely, or whether such fire spread would hinder fire and rescue service intervention or incident command.

### **P.5.2 Tools**

Tools for assessment might include the following.

- a) Means of escape assessments: A tool might be able to assess the time required for occupants to evacuate the building as a function of the evacuation strategy, means of warning and fire and rescue service intervention.
- b) Fire and rescue service access assessments: A tool might be able to assess the time required for the fire and rescue service to arrive, set up and access the building or its perimeter.

## **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.

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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*

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<sup>8)</sup> Withdrawn pending development of a British Standard. Available for download at <https://www.bsigroup.com/en-GB/standards/pas-79-22020>.

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