



PAS 9980:2026, Fire risk appraisal of external wall construction and cladding of existing Blocks of Flats – Code of practice

THIS PAGE DOES NOT FORM PART OF PAS 9980:2026

PAS 9980:2026 supersedes PAS 9980:2022, which is now withdrawn. The new edition reflects learning and industry feedback gathered since the original PAS 9980:2022 was published and provides clearer, more structured guidance on appraising the fire risk associated with external wall construction in existing multistorey residential buildings. The changes in PAS 9980:2026 are not meant to significantly impact the assessment of risk. The publication of this revised edition does not in itself invalidate reports prepared under PAS 9980:2022. Responsibility for determining whether a report should be reviewed or updated rests with the dutyholder, informed by professional advice and the circumstances of the building.

What is PAS 9980?

PAS 9980:2026 provides a methodology for conducting a fire risk appraisal of external walls (FRAEW). It is designed to:

- support competent professionals in identifying fire risk factors;
- recommend proportionate remediation and/or mitigation measures; and
- promote consistency in fire risk appraisals of external walls.

Given the complexity and range of different external wall systems that exist, PAS 9980:2026 does not contain “off the peg” solutions for specific wall types and materials but enables a consistent approach to evaluating the risk when considering the external walls of actual buildings.

A proportionate approach is about identifying and addressing fire risks posed by external wall construction in a manner that is proportionate to the risk. This should ensure residents are safe in their homes whilst preventing unnecessary works that can be disruptive and costly.

Key changes in PAS 9980:2026

The 2026 edition of PAS 9980:

- reflects the latest best practice and regulatory developments;
- incorporates industry and stakeholder feedback; and
- aligns with BS 9792 and other relevant standards.

It includes clearer guidance on:

- determining whether an FRAEW is required;
- communicating findings to non-specialist audiences; and
- definitions of risk outcomes.

Intended audience

PAS 9980:2026 is intended for competent fire engineers, building professionals and fire risk assessors. It is a highly technical document and is not designed for use by non-specialists. However, PAS 9980:2026 encourages assessors to communicate findings in a way that is accessible to all interested parties, including residents and leaseholders.

MHCLG has developed [supporting guidance](#) to help residents, freeholders and those who may commission FRAEWs understand the purpose of an FRAEW and how it relates to PAS 9980.

Limitations of PAS 9980:2026

PAS 9980:2026 is not a compliance tool. It operates alongside, and does not replace, legal duties under the Regulatory Reform (Fire Safety) Order 2005 (FSO), Building Regulations or housing legislation. Dutyholders are still expected to comply with statutory requirements independently of this methodology. Under the FSO, any multi-occupied residential building with two or more sets of domestic premises is required to have a fire risk assessment (FRA) that includes consideration of the external walls. Where it is identified that the external wall could materially influence overall fire risk, an FRAEW undertaken in accordance with PAS 9980 might be recommended. An FRAEW focuses on the fire risk associated with the external wall construction and is not to be considered in isolation from the wider FRA. Together, the FRA and the FRAEW provide a holistic assessment of fire safety risks across the building.

PAS 9980 does not set, regulate or certify competence requirements. While the PAS includes commentary on competence, ethics and professional conduct of assessors, it does **not** define competency frameworks or determine who may carry out an appraisal.

Competence sits outside the scope of the PAS and can be assured through existing professional pathways. MHCLG's supporting guidance includes information for those seeking to understand how to commission an FRAEW. It outlines which professionals may be suitable, the specialist expertise required, and the practical steps for verifying an assessor's competence before appointing them.

PAS 9980:2026

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



Ministry of Housing,
Communities &
Local Government

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© The British Standards Institution 2026
Published by BSI Standards Limited 2026

ISBN 978 0 539 30829 7

ICS 13.220.20; 91.040.30; 91.060.10

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Publication history

First published January 2022
Second edition September 2026

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Foreword

This PAS was sponsored by the Ministry of Housing, Communities and Local Government (MHCLG). Its development was facilitated by BSI Standards Limited and it was published under licence from The British Standards Institution. It came into effect on 30 September 2026.

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

- Neal Butterworth of Design Fire Consultants
- Bart Kavanagh of Expert Architect Studio
- Mostyn Bullock of 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
- DCCH Experts LLP
- Design Fire Consultants
- End Our Cladding Scandal
- Expert Architect Studio
- Fire Industry Association
- Fire Protection Association
- Institution of Fire Engineers
- Ministry of Housing, Communities and Local Government
- National Fire Chiefs Council
- Northern Ireland Housing Executive
- Royal Institution of Chartered Surveyors
- Scottish Government
- Society of Façade Engineering
- Tenos
- 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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This PAS is not to be regarded as a British Standard. It will be withdrawn in the event of its being superseded by a British Standard.

The PAS process enables a standard to be rapidly developed in order to fulfil an immediate need in industry. A PAS can be considered for further development as a British Standard, or constitute part of the UK input into the development of a European or International Standard.

Supersession

This PAS supersedes PAS 9980:2022, which is withdrawn.

Relationship with other publications

This PAS supplements the recommendations given in BS 9792 and is consistent with the methodology set out therein, although the two documents can be used independently and a knowledge of BS 9792 is not a prerequisite for using PAS 9980.

This PAS is written with the intention of being an independent document. Some of its contents cover similar principles to those of other documents, e.g. Approved Document B (ADB)¹⁾ (used in relation to building work) and the Single Building Assessment [2] (used in relation to the safety of external walls in Scotland) but this does not constitute adoption of the guidance in those documents, nor is this PAS to be seen as replacing those documents. Technical guidance in the devolved administrations, including equivalents to the examples above, 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 conducting a fire risk appraisal of external walls (FRAEW), 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 document now addresses buildings that both do and do not need an FRAEW, providing a methodology to establish whether the building or its external wall construction are inherently low risk in terms of external fire spread. Triaging of when buildings do or do not require an FRAEW is anticipated to be within the capability of a broad range of building professionals, property managers and/or fire risk assessors.
- b) The methodology for conducting FRAEWs has been more clearly set out using process diagrams.
- c) PAS 9980:2022 used three bands of risk outcome; high, medium and low. Within the medium risk band, the risk might fall into the higher end of the band and not be tolerable, or the lower end of the band, in which case it was medium (tolerable). This revised edition uses four bands of risk outcome: high, medium, tolerable and low. "High" and "low" remain the same; "medium" relates to what was previously the upper portion of medium; and "tolerable" relates to what was previously "medium (tolerable)".
- d) The process for conducting an FRAEW in Clause 6 has been expanded to make clearer that it is an iterative process which can be curtailed or expanded depending on the building and the findings of the FRAEW as it progresses.
- e) The recommendations for FRAEW reports in Clause 15 are more detailed and prescriptive than was previously the case.

¹⁾ The abbreviation "ADB" is used for all editions of Approved Document B. Some explicit references are made to the 2019 edition [1], which is current (incorporating various amendments) at the time of publication of this PAS. Where no bibliographic reference number is cited, the reference can be taken as being relevant to any edition.

- f) Some of the images from Annex A (now Annex L) and Annex B (now Annex C) have been removed for copyright reasons. The original images can still be viewed in the 2022 edition of this PAS.
- g) A new Annex B provides information on the types of review of FRAEW reports that might be commissioned, including what they practically involve and what value they are expected to bring to end users.
- h) The list of notable fires involving external wall construction and cladding has been deleted from Annex B (now Annex C). The annex has, however, been expanded to give an explanation of how external wall fire spread interacts with:
 - 1) the stay put strategy in place in most blocks of flats; and
 - 2) the wider need to address the safety of everyone, including people with specific evacuation requirements.
- i) PAS 9980:2022 relied on the best knowledge available at the time concerning fires involving balconies; however, this was limited to knowledge that had been obtained from real incidents. This revised edition relies on research that was commissioned by the Building Safety Regulator in support of its ongoing work to update ADB. The guidance remains similar, but has been split between fire performance and façade configuration risk tables (Annex E and Annex F) to address both the construction and layout of balconies.
- j) Annex O (now Annex K) contains an additional case study dealing with a building that has been remediated and for which detailed records of the remediation have been retained and provided for the FRAEW.
- k) 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 ADB; 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 to set out the context and thinking behind the original development of this PAS, but they are now considered superfluous to the conducting of FRAEWs, although 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.

The publication of this revised edition does not in itself invalidate reports prepared under PAS 9980:2022. Responsibility for determining whether a report is to be reviewed or updated rests with the dutyholder, informed by professional advice and the circumstances of the building.

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 PAS 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 includes:

- 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.

Copyright is claimed in the following figures. The copyright holders are as follows:

- Figure C.3: Scottish Fire and Rescue Service, Westburn Drive, Cambuslang, G72 7NA;
- Figure C.4: London Borough of Hammersmith and Fulham, Town Hall, King Street, Hammersmith, London, W6 9JU; and
- Figure L.1, Figure L.3, Figure L.4, Figure L.5 and Figure L.6: DCCH Experts LLP, George Suite, 40–42 London Road, St Albans, AL1 1NG.

The scope of this edition of PAS 9980 remains limited, as described in Clause 1, primarily to multistorey blocks of flats, although it also covers some other residential buildings such as 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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Hazard warnings

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

Use of this document

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

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

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

This PAS includes case studies based on commonly found types of external wall construction and its configuration on existing multistorey, multi-occupied residential buildings. However, these are intended only 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 document. The word “may” is used in the text to express permissibility, e.g. a course of action that is permitted but is not a provision of the document. 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 document. 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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The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

Compliance with a PAS cannot confer immunity from legal obligations.

In particular, attention is drawn to the Regulatory Reform (Fire Safety) Order 2005 [3] (hereafter referred to as the Fire Safety Order), and to guidance available from the Ministry of Housing, Communities and Local Government, and the devolved administrations.

0 Introduction

0.1 Background

There are blocks of flats in the UK where the external walls have not been designed and/or built adequately to resist fire spread. However, a blanket approach of removing and replacing cladding is disproportionate compared to the associated risk. Therefore, the external walls need to be appraised to determine whether the risk of fire spread is sufficiently low or whether risk reduction is necessary (a “fire risk appraisal of external walls” or “FRAEW”).

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 the risk of fire spread via the external walls of the building.

It is recognized that FRAEWs are likely to require specialist advice, and that they are not necessarily within the competence of all fire risk assessors conducting FRAs for blocks of flats (e.g. an FRA carried out in accordance with BS 9792). Equally, in many cases, it will be obvious to a competent fire risk assessor that certain buildings are manifestly low risk and/or the risk to life from fire spread over external walls is not such as to warrant an FRAEW by a specialist. In these cases, the fire risk assessor is likely to address the fire risk associated with the external wall construction under the Fire Safety Order [3] as part of the FRA.

Similarly, the necessary skills for FRAEWs are not possessed by all fire engineers. Persons conducting an FRAEW are advised to consider whether they have the necessary competence for the circumstances in question.

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;
- b) the competencies required to conduct an FRAEW; and
- c) how to conduct an FRAEW tailored to the particular risk posed by fire spread over external walls, and in particular how to identify whether:
 - 1) any increased risk of fire spread is still low enough to be tolerated; and
 - 2) there are any risk-proportionate actions that could be taken to reduce the risk of fire spread.

0.2 Risk-based approach

An FRAEW is a risk-based approach that considers the probability of fire spread via external wall constructions resulting in harm to building occupants.

A risk-based approach can be informed by prescriptive requirements and guidance that applied when a building was designed and constructed, but it is not limited by matters of compliance with prescriptive requirements or guidance.

Similarly, given the varying degrees of readily available knowledge and performance data, the methodology in this PAS seeks to apply a degree of quantitative, as well as qualitative, judgement and it follows that any FRAEW will inevitably be, to a large degree, based on professional judgement.

While this PAS includes criteria for appraising 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.

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 to:

- a) provide competent, conscientious building professionals with a structured 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) assist persons conducting FRAEWs to communicate clearly the process and methodology applied, the resulting findings and the outcome, including any recommendations;
- c) 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) 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 seeking conformity of new construction to the standards for new buildings;
- e) assist those receiving an FRAEW, and their other advisers, to understand the meaning of the risk outcome, how the risk outcome was derived, where the FRAEW fits in the context of the building's FRA, and the limitations that apply to the FRAEW;
- f) enable common relevant terminology to be adopted by persons conducting FRAEWs;
- g) promote consistency in FRAEWs;
- h) provide a pragmatic and risk-proportionate approach in FRAEWs;
- i) establish a satisfactory basis for documentation of FRAEWs;
- j) identify the competencies that are required by persons conducting FRAEWs;
- k) enable consistent training in conducting an FRAEW and thus facilitate more entrants into the discipline of conducting FRAEWs; and
- l) satisfy professional indemnity insurers that there is a standard that underpins consistency in conducting FRAEWs.

This PAS is not and does not purport to be a substitute methodology for conducting wider FRAs in accordance with, for example, BS 9792. FRAEWs are concerned only with the impact of fire spreading across the external façades of buildings; as such, they form a subset of the suite of issues that need to be assessed as part of a suitable and sufficient FRA.

0.4 Structure of this PAS

The first three clauses in this PAS follow a set structure that applies to all PAS standards. Clause 1 sets out the scope of the PAS, including information on those buildings to which the methodology in the PAS is applicable. Clause 2 is a set location for normative references, of which none are given in this edition of the PAS. Terms, definitions and abbreviated terms are given in Clause 3.

From Clause 4 onwards, each clause begins with an informative commentary, in italic type, giving background and context for the recommendations that then follow.

General issues for consideration before undertaking an FRAEW are set out in Clause 4. In particular, PAS 9980 recognizes that an FRAEW is not required for all buildings or all wall constructions, and Clause 4 sets out circumstances for which an FRAEW is not required.

There are many different competencies required to gather information, conduct an FRAEW and document the outcomes. The spectrum of competencies that might be required (depending on the circumstances) is discussed in Clause 5.

The principles and process of FRAEWs are described in Clause 6, including an overarching decision-making process for arriving at risk outcomes, including:

- purpose of an FRAEW;
- structured approach;
- proportionality;
- risk ratings and risk outcomes;
- risk factors;
- weighting; and
- uncertainty.

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.

Clause 10 addresses how materials, systems and configurations of external walls perform in fire, and Clause 11 addresses factors relating to the configuration of external wall systems. Clause 12 deals with the impact of a building's fire strategy on risk.

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

Clause 14 sets out the content of reports prepared in accordance with this PAS that do not contain an FRAEW, while Clause 15 deals with FRAEW reports.

A series of annexes follows on from the main clauses, giving further informative text that supports the commentary and recommendations.

Finally, there is a Bibliography that lists all the informative references given throughout the PAS.

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1 Scope

This PAS gives recommendations and guidance on:

- a) how to determine whether or not a building requires a fire risk appraisal of external walls (FRAEW); and
- b) how to undertake an FRAEW.

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

- 1) appraising the risk to occupants from a fire spreading over or within the external walls of a 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 a building, remediation or other mitigation measures to address the risk are necessary.

This PAS is applicable where a fire 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 BS 9792, but they can be carried out independently of the BS 9792 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 [4] 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 applies predominantly to multistorey blocks of flats of any height, but can also be applied to other types of residential 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. This includes, for example:

- 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 dwelling constructed or adapted 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 normally expected to require an FRAEW:

- individual dwellinghouses;
- 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. 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; however, it necessarily addresses issues that might help or hinder firefighters' ability to protect relevant persons in the event of a fire.

This PAS (including the methodology it contains) 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 analysing 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

There are no normative references in this document.²⁾

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

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1 aluminium composite material (ACM)

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

NOTE ACM is a particularly significant form of metal composite material (MCM), in terms of fire risk, due to aluminium's low melting point. The categories of MCM apply to ACM.

3.1.2 automatic opening vent (AOV)

natural smoke and heat exhaust ventilator with a defined aerodynamic free area of ventilation (A_v), or smoke control damper, activated automatically from a detector or fire alarm system, for the purpose of permitting smoke and heat to be ventilated from a building or allowing inlet air into a building

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

[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

NOTE Cavity barriers can exist in either full fill or open state form.

[SOURCE: BS 4422:2024, 3.32, modified – note added]

3.1.5 cladding

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

NOTE 1 Cladding is normally attached to the primary structure of a building, or to a secondary support system that in turn is supported off the primary structure, to form non-structural, non-loadbearing external surfaces. These surfaces can comprise a range of facing materials/cladding panels, including metal composite panels or non-loadbearing masonry, along with insulating materials, rendered insulation systems [external thermal insulation composite system (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 (3.1.35)

NOTE Different jurisdictions have different definitions for combustible in their legislation and statutory guidance.

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

NOTE This is known as a separating floor in some jurisdictions.

[SOURCE: BS 4422:2024, 3.40, modified – note added]

3.1.9 compartment wall

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

NOTE This is known as a separating wall in some jurisdictions.

[SOURCE: BS 4422:2024, 3.41, modified – note added]

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 competence

application of skills, knowledge, experience and behaviour to achieve a defined outcome

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” is used for convenience within this PAS. 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. For example, in England and Wales, the responsible person, to which the Fire Safety Order [3] 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 evacuation alert control and indicating equipment

[SOURCE: BS 4422:2024, 3.76]

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 (3.1.56).*

[SOURCE: BS 4422:2024, 3.121, modified – cross-references updated to reflect numbering in PAS 9980]

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 heat release rate (HRR)

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

[SOURCE: BS 4422:2024, 3.178]

3.1.27 high pressure laminate

sheet material formed using paper, fabric or other similar material mixed with resin, which is bound together under high heat and pressure

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 that do not provide this function for a building as a result of the manner in which they have been installed (e.g. discrete sections of insulation that 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) non-combustible material or product; or
- b) a material or homogenous product of density 300 kg/m³ or more, which, when tested in accordance with BS 476-11, does not flame nor cause any rise in temperature on the furnace thermocouple of more than 20 °C; or
- c) a material of density less than 300 kg/m³, which, when tested in accordance with BS 476-11, does not flame for more than 10 s nor cause any rise in temperature of more than 35 °C on the centre (specimen) thermocouple or of more than 25 °C on the furnace thermocouple; 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. The term has been phased out in some jurisdictions.

3.1.33 metal composite material (MCM)

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

NOTE This PAS refers to the following three categories of metal MCM. These categories apply equally to ACM and zinc composite material (ZCM), both of which are significant due to being common forms of MCM and due to aluminium and zinc having low melting points.

- 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.

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 non-combustible

either:

- a) a material classified as Class A1 in accordance with BS EN 13501-1:2018; or
- b) a product classified as non-combustible in accordance with 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 conforming to BS EN 771-3; or
- f) products composed entirely of one or more materials that can be deemed to be Class A1 without the need for testing

NOTE 1 The latter are materials that do not contain more than 1.0% by weight or volume (whichever is the lower) of homogeneously distributed organic material, as defined in Commission Decision 96/603/EC [5].

NOTE 2 This term is included here given its use in relation to materials used in, and standards applicable to, existing buildings. The term has been phased out in some jurisdictions.

3.1.36 people with specific evacuation requirements

people with characteristics that might require specific arrangements to support them to respond to a fire or to a fire alarm, and to evacuate when necessary

NOTE This includes people who are identified in the assessment as being especially at risk, as referred to in the Regulatory Reform (Fire Safety) Order 2005 (as amended) [3].

[SOURCE: BS 9792:2026, 3.1.54, modified – bibliographic reference updated to reflect numbering in PAS 9980]

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 product

item that is formed of one or more materials

NOTE 1 For example, painted aluminium or timber, ACM, and manufactured boards that have a complex internal structure or densities which differ across their thickness, are all non-homogenous products. Some products are homogenous.

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

3.1.39 professional judgement

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

3.1.40 re-entrant corner

intersection of two elevations that points inwards towards the footprint of a building

NOTE For example, BS 8414-1 and BS 8414-2 test specimens feature re-entrant corners.

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 risk factor

feature of an external wall, a building and/or its fire strategy which has been determined as having a positive, neutral or negative impact on the risk rating

NOTE This PAS identifies three forms of risk factor. Fire performance factors relate to the hazard posed by the external walls; whether and the extent to which they are likely to support fire and smoke spread. Façade configuration factors relate to the likelihood of the hazard spreading across the external walls and affecting parts of the building exposed to these. Fire strategy factors concern the relationship between external fire spread and the fire strategy, including people being exposed to the effects of an external fire, the availability of alarm and means of escape, and the ability of the fire and rescue service to respond to an external wall fire.

3.1.43 risk outcome

acceptability or otherwise of the risk rating, taking into account the time, effort and/or cost that might be involved in reducing the risk

NOTE Risk outcome is determined based on the risk rating (see 3.1.44) and the proportionality of taking action to reduce the risk further.

3.1.44 risk rating

product of the hazard associated with an external wall fire and the likelihood that such a fire will cause harm

NOTE 1 The hazard aspect of the risk rating is covered by the fire performance risk factors and the façade configuration factors insofar as they relate to fire spreading, while the likelihood of harm is covered by the façade configuration factors insofar as they relate to the fire strategy factors.

NOTE 2 Risk rating is established absent any consideration of the time, effort and/or cost that might be involved in reducing risks, whether by implementing mitigation or remediation.

3.1.45 sandwich panel

two thin metal skins bonded to an insulating core material

3.1.46 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]

3.1.47 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]

3.1.48 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 a fire to bypass fire barriers between floors.

3.1.49 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]

3.1.50 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 a steel framing system (SFS).

3.1.51 surface

outside part or uppermost layer

NOTE 1 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.

NOTE 2 This definition is particularly important in the context of reaction to fire tests [see definitions for material (3.1.31) and product (3.1.38)].

3.1.52 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]

3.1.53 thermoplastic material

polymeric material that can be melted and recast almost indefinitely

3.1.54 thermoset material

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

3.1.55 waking watch

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

3.1.56 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]

3.1.57 zinc composite material (ZCM)

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

***NOTE** ZCM is a particularly significant form of MCM, in terms of fire risk, due to zinc's low melting point. The categories of MCM apply to ZCM.*

3.2 Abbreviated terms

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

ACM aluminium composite material

ADB Building Regulations (various dates) – Approved Document B: Fire safety

NOTE The abbreviation “ADB” is used for all editions of Approved Document B. Some explicit references are made to the 2019 edition [1], which is current (incorporating various amendments) at the time of publication of this PAS. Where no bibliographic reference number is cited, the reference can be taken as being relevant to any edition.

AOV automatic opening vent

CLT cross-laminated timber

CP cement particle

CRMP community risk management plan

CWFT Classification Without Further Testing

DPC damp-proof course

EPDM ethylene propylene diene monomer

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

MCM metal composite material

OSB oriented strand board

PIR polyisocyanurate

PUR polyurethane

SIP structural insulated panel

SFS steel framing system

uPVC unplasticized polyvinyl chloride

XPS extruded polystyrene

ZCM zinc composite material

4 General issues for consideration before undertaking an FRAEW

COMMENTARY ON CLAUSE 4

Appraisers cannot know the condition of every part of a building, as it is unreasonable to expect a building to be entirely dismantled to enable inspection. Accordingly, appraisers need to work with information that provides some degree of knowledge and confidence regarding the condition of a building. Gaps in knowledge and confidence need to be treated with caution, meaning that appraisers need to make reasonable worst-case assumptions for these (e.g. where nothing is known regarding the condition of cavity barriers, it is prudent to assume that they are either missing or defective). Sometimes, even a reasonable worst-case assumption does not result in an unacceptable risk being identified, depending on what other knowledge an appraiser might possess in relation to a building.

This clause is concerned with two situations where an FRAEW is not necessary.

- a) *Buildings that, due to their size and layout, are not significantly vulnerable to external fire spread irrespective of the external wall construction. In these buildings, external wall fire spread has little impact on the fire strategy (notwithstanding that these buildings might still require an FRA), either because there are no fire compartment lines for fire to cross (dwellinghouses), or because the total extent of potential fire spread is so small as to be within the range of fire spread that might occur absent any contribution from the external wall. The following types of buildings fall into this category, and as such are not expected to require an FRAEW.*
 - 1) *Detached individual dwellinghouses. These are stand-alone buildings that contain a single family unit and generally contain no or very little compartmentation. Therefore, fire spread via the external walls is unlikely to impact risk significantly.*
 - 2) *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 limited even if combustible materials have been used in the external wall construction. This is because fire spreads horizontally 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 in dwellinghouses (being capable of alerting all occupants to a fire and the need to evacuate at the very early stages of a fire), means the risk associated with this mechanism of spread is low.*
 - 3) *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 that it will be well within the reach of the fire and rescue service.*
 - 4) *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.*

b) *Buildings where the hazard associated with all of the external wall construction is established as being inherently low. In such cases, there is no merit in appraising the configuration of external wall systems or their relationship to people in and around the building, as none of these forms of external wall construction pose a significant fire risk. The following forms of external wall construction fall into this category (regardless of how extensively they are used on a building), and as such buildings that have only one or more of these forms of external wall construction are not expected to require an FRAEW.*

- 1) *Solid masonry construction at least 150 mm thick, where any insulation or other combustible materials are applied only as internal linings to rooms, not to the external face of the masonry.*
- 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, if present, are applied only as internal linings to rooms, not to the external face of the masonry.*
- 3) *External walls and attachments 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 at <https://eur-lex.europa.eu/>. The excepted components (which do not need to be European classification A2-s1, d0 or A1) are:*
 - *cavity trays when used between two leaves of masonry;*
 - *any part of a roof;*
 - *door frames and doors;*
 - *electrical installations;*
 - *fibreoptic 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 imperforate substrate under it.*

In addition, in order to be deemed sufficiently low risk not to need an FRAEW, cavity barriers are likely to need to be provided where any cavities within the external wall construction either:

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

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 is expected to be provided if the following are present:

- *steel at least 0.5 mm thick;*

- polythene sleeved mineral wool, or mineral wool slab, installed under compression in the cavity; or
 - calcium silicate, cement-based or gypsum-based boards at least 12 mm thick.
- 4) External wall construction closely matching that which has been successfully tested to BS 8414-1 or BS 8414-2, and classified to BR 135 [6] based on the test data. Where the extended application rules in BS 9414 have been met as part of classification to BR 135, then the wall construction would still be considered inherently low risk. Where an assessment to BR 135 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 is 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 needs to be recorded.

NOTE 1 The presence of any combustible attachments precludes reliance on testing to BS 8414-1 or BS 8414-2 and classification to BR 135 [6] or the purpose of this clause.

If all the external walls on a building comprise one of the types in b)1) to b)4), 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 needs to be prepared in accordance with Clause 14 that records the factual basis upon which it can be concluded that the building or its external walls are inherently low risk. In respect of items b)3) and b)4), it might be necessary to conduct inspection or to review inspection photographs taken by others, in order to confirm that cavity barriers are properly provided and/or that the construction closely matches what has been tested to BS 8414-1 or BS 8414-2 and classified to BR 135 [6].

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) are generally expected to be factual, setting out the manner in which a building meets one of the above scenarios.

If only some of the walls on a building comprise one of the types in b)1) to b)4), 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.

- 1) 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 minimal investigation or analysis is necessary to better understand the risk.
- 2) 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 good practice to inform the local fire and rescue service of the 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.

NOTE 3 It is unlikely to be appropriate to provide all FRAEWs, in their entirety, to fire and rescue services given the volume of information these contain. Whether or not the FRAEW contains significant findings (i.e. a risk outcome other than “low”) is a relevant consideration in this regard. Attention is drawn to the legal duties in some parts of the UK relating to provision of information on external walls to fire and rescue services.

- 3) An FRAEW is not 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.
- 4) 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.

- 5) *This PAS does not apply to the design of new buildings or to the snagging of newly constructed buildings prior to occupation. Accordingly, it is not intended to constitute an alternative solution to meeting the requirements for fire performance of external walls of new buildings.*
- 6) *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 verify that:

- a) the building requires an FRAEW, which should be established in accordance with **4.2** and using the process shown in Figure 1; and
- b) the external walls of the building require an FRAEW, which should be established in accordance with **4.3** and using the process shown in Figure 1.

4.2 Where a building is one of the following types, it should be deemed to be inherently low risk such that an FRAEW is not required:

- a) detached individual dwellinghouses;
- b) terraced or semi-detached dwellinghouses;
- c) blocks of flats having no more than two storeys above ground (i.e. ground floor and first floor only); and
- d) blocks of flats having no more than three storeys above ground (i.e. ground floor, first floor and second floor only) unless there is an obvious hazard associated with the external walls.

4.3 Where a building's walls are made up exclusively of one of the following, the building should be deemed to be inherently low risk such that an FRAEW is not required:

- a) solid masonry construction at least 150 mm thick where any insulation or other combustible materials are applied only as internal linings to rooms;
- b) 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;
- c) external walls and attachments that are, save for some exceptions (see Note 1), entirely formed of materials that are of European classification A2-s1, d0 or A1 and where cavity barriers are provided either:
 - 1) in line with compartment walls and floors; or
 - 2) at the edges of all cavities, including around openings such as windows, doors and penetrations; and

NOTE 1 *The exceptions to c) are set out in the commentary.*

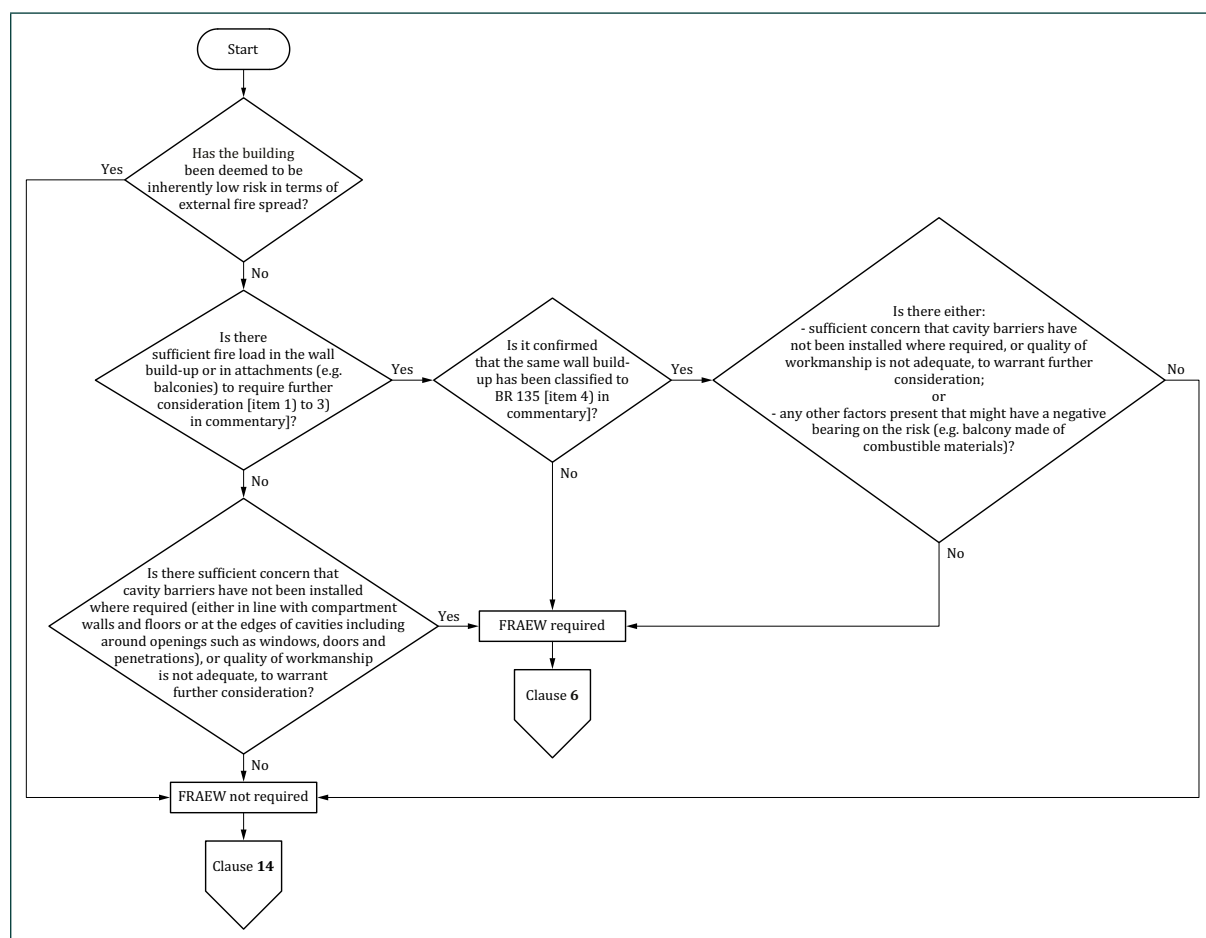
- d) external wall construction without combustible attachments, closely matching that which has been successfully tested to BS 8414-1 or BS 8414-2, and classified to BR 135 [6] based on the test data.

NOTE 2 *For construction to closely match that which has been tested, both the form and adequacy of the as-built construction need to reflect that of the test specimen. BS 8414-1 and BS 8414-2 test specimens have prescribed dimensions and features that necessarily differ from the geometry of real buildings, but details such as products, materials, their dimensions and manner of installation, are all expected to match. Further guidance is available in BS 9414, but it is expected that inspection will be necessary as part of this.*

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

- a) the purpose of the FRAEW is to inform the building's FRA;
- b) 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;
- c) the objective of assessing the fire risk is to address the safety of all occupants; and
- d) they have the necessary competence (see Clause 5).

Figure 1 – Process for determining whether an FRAEW is required



4.5 Where it is established, in accordance with 4.1, 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 identifies 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.

4.6 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 is risk-based and reliant on professional judgement;

- 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 directly 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.

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

4.8 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 conduct 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 undertaking work in accordance with this PAS are competent so as 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 appraisal. In addition to the recommendations and guidance given in this clause, Annex A provides more detailed information regarding the skillsets expected of those undertaking or contributing to FRAEWs, while Annex B provides guidance on the types of review that might be carried out on FRAEWs and on the relationship between reviewer and author.

Because the risk of fire spread via external wall constructions is potentially contentious, with multiple, sometimes conflicting, stakeholder objectives, ethical behaviour is also paramount. Persons conducting an FRAEW need to avoid influence on their decision making by such pressures, and need to be satisfied that the FRAEW is sufficiently reliable and evidence-based 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 might ultimately be tested in a court of law.

The recommendations in this PAS reflect the position taken in Issue 2 of the Setting the bar report [7]. Since PAS 9980 was originally published in 2022, 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.

While it is recognized that professional body memberships and professional qualifications do not guarantee ethical behaviour and competency, they do provide confidence regarding competence. 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.

While many aspects of an FRAEW, e.g. gathering of factual information, do not require specialist skills, a determination of risk in accordance with this PAS requires an understanding of the fire behaviour and fire performance of materials, components and systems forming the external walls of blocks of flats, and an understanding of fire hazards and the potential consequences on compartmentation, means of escape, smoke control systems, and fire detection and fire alarm provisions (to the extent relevant). Therefore, a person conducting an FRAEW needs knowledge of the fire strategy and regulatory framework underpinning the fire safety design of such buildings. However, it does not follow that all fire engineers have the necessary competence to undertake FRAEWs.

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 persons who are commissioning work in accordance with this PAS (i.e. the clients of persons conducting FRAEWs), as well as to persons conducting FRAEWs.

Guidance on relevant skills, knowledge and experience for the different roles of persons involved in conducting an FRAEW, based on the National Qualifications Framework,³⁾ is given in Annex A. It is not expected that everyone involved in preparing an FRAEW will possess all of the skills, knowledge and experience listed in Annex A; these are set out on a per-role basis. In some instances, it might be necessary to involve additional professionals; this might, for example, be as a consequence of the complexity of the external wall construction, concerns regarding particular forms of construction and cladding, or where more detailed technical analysis is required.

In addition to the range of competence that appraisers might need, there is a range of ways in which the work might need to be checked. Peer review is good practice, whether 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. The type of peer review that is appropriate for any given FRAEW depends 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 B.

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

- a) adequate and relevant competence to undertake their work in accordance with this PAS; and
- b) sufficient competence in relation to fire safety of external walls to be able to complete an FRAEW 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 qualification³⁾ in a science, engineering or construction-related subject.*

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

5.1.3 Persons conducting an FRAEW should be able to provide evidence of competence to the client with respect to appraising 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.

³⁾ Further information is given at <https://www.gov.uk/what-different-qualification-levels-mean/list-of-qualification-levels>.

5.1.4 Persons undertaking information gathering should possess relevant competence in surveying, building engineering or fire engineering to enable an appropriate review of documents. They should be competent to interpret drawings, reports, fire strategies and FRAs and to identify, in sufficient detail, those aspects of the nature of the building and its construction that are relevant to conducting the work in accordance with this PAS.

5.1.5 Persons undertaking intrusive inspection as part of information gathering should possess relevant competence in surveying or façade engineering to enable an appropriate inspection of the building to be completed. They should be competent to determine the methods of construction and to identify, in sufficient detail, those aspects of the nature of the construction that are relevant to conducting the work in accordance with this PAS.

5.1.6 Persons conducting FRAEWs in accordance with the methodology set out in Clause 6 should have sufficient knowledge of:

- a) the fire performance of external wall materials and cladding systems;
- b) fire strategy development and fire safety design; and
- c) how to apply a risk-based approach, e.g. through conducting FRAs of buildings.

5.1.7 It is not suggested 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.

5.1.8 Persons undertaking a more detailed appraisal 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 analysis, 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. This might involve achieving registration through a suitable professional body that takes steps to ensure that the person has sufficient knowledge of the principles of fire safety engineering. Additional guidance is given in Annex A.*

5.1.9 Persons following the methodology in this PAS should make clear to clients at the outset that an outcome of an FRAEW might be a recommendation to undertake a more detailed technical analysis of the type described in Clause 13, and whether or not they have the necessary competence to conduct such an analysis. They should understand the limits of their own competence and advise clients when there is a need to involve others.

***NOTE** Appraisers reaching the limits of their competence might compensate by being overly conservative; this is distinct from uncertainty arising from lack of information/evidence, as discussed in Clause 6.*

5.1.10 Persons following the methodology in this PAS should maintain their competence, including undertaking self-assessment and personal development activities in relation to the fire risk posed by external wall construction and cladding. As a result, these persons should be able to 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 these are configured on buildings.

5.1.11 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.

***NOTE** Guidance on peer review is provided in Annex B.*

5.2 Technical knowledge

COMMENTARY ON 5.2

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 set out in detail in Annex C and is part of possessing the necessary competency to conduct an FRAEW (see 5.1).

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, and apply knowledge of, the various mechanisms of fire spread giving rise to fires involving external wall construction and cladding.

5.2.3 Persons conducting an FRAEW should understand, and apply knowledge 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, and apply knowledge of, the measures that are required within external walls to inhibit or delay fire spreading from compartment to compartment, whether horizontally or vertically.

5.2.5 Persons conducting an FRAEW should recognize and take account of the following benchmark criteria:

- 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 speed 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 from 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 appraised is the ongoing legislative control applicable to occupied buildings. An FRAEW forms part of the package of measures that need to be taken by dutyholders in respect of this legislation, but it is not a substitute for an FRA, rather a subset of it.

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 important but is not to be used to determine what is acceptable or not in terms of risk.

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 [3]. This allows goals to be set without being prescriptive and, 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.

Therefore, persons conducting an FRAEW need to understand the principles of proportionality (see Commentary on Clause 6).

When considering the time, cost and effort involved in implementing an FRAEW's recommendations, appraisers are expected to have a broad understanding of the order of magnitude of these costs and whether they are likely to be one-off or present a need for ongoing regular expenditure (e.g. maintenance of active systems). Accordingly, appraisers are expected to be able to advise on potential risk-proportionate actions, but the final decision is likely to require dutyholders to seek advice from design professionals, contractors and quantity surveyors (e.g. providing detailed cost information or feasibility studies).

5.3.1 Persons conducting an FRAEW should understand the relationship between the FRAEW and the building's FRA, including that:

- a) an FRAEW is intended to feed into an FRA; and
- b) an outcome of an FRAEW could require that an FRA be reviewed and revised.

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

5.3.2 Persons conducting an FRAEW should understand the principles of proportionality and apply these to the setting of recommendations in an FRAEW.

NOTE As part of the principles of proportionality, it is good practice for appraisers to advise on potential future opportunities to reduce risk. For example, an FRAEW might conclude that the risk outcome is currently tolerable, but the appraiser might be aware that the external walls will need to undergo planned preventative maintenance in the next 5 to 10 years; in this case, it would be prudent to advise that consideration be given to ways in which the risk can be reduced further when this opportunity arises.

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 practicability and cost (both long- and short-term cost), according to the circumstances, effectiveness and maintainability. This should include any interim measures recommended.

6 Principles and process for an FRAEW

COMMENTARY ON CLAUSE 6

Clause 6 sets out the principles and process for an FRAEW. The process 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. As such, it is an iterative process whereby the appraiser initially reviews 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). Notwithstanding this, experienced appraisers might be able to identify confidently the entire programme of work needed at the outset of a commission.

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.

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 risk appraisal [see i) to iv) below], making conservative assumptions to mitigate uncertainty as necessary (i.e. where there are unknowns, assume a reasonable worst-case position).*

NOTE 1 *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 as soon as possible that immediate steps need to be taken to reduce the risk (e.g. identifying that Category 3 ACM is still present on a high rise block of flats).*

- 3) Where the appraisal in step 2) does not allow (due to uncertainty or conservatism) the risk outcome to be confirmed as “tolerable” or “low”, conduct further appraisal activity to reduce uncertainty and the associated conservatism, subject to proportionality. Once completed, refine the appraisal using the new information.*

NOTE 2 *As an example, the Commentary on Clause 4 discusses the possibility of cavity barriers being assumed to be missing or defective where there is no information regarding their condition, yet the risk outcome is confirmed as “low”. Conversely, the wall construction might be such that even perfectly installed cavity barriers would result in an unacceptable risk (such as the Category 3 ACM example in Note 1 above). Unless one of these two scenarios exists, it is likely to be proportionate to conduct inspections to better understand their actual condition.*

- 4) Repeat step 3) until the risk outcome is “low” or it is determined that further appraisal activity would not be proportionate.*
- 5) Determine the relevant action to take according to the risk outcome, as set out in Clause 7.*
- 6) In the event of a “tolerable” outcome where further appraisal activity is not proportionate, identify any proportionate risk reduction measures. It might be that no proportionate risk reduction measures are available, in which case the risk outcome will remain “tolerable”.*

The risk appraisal comprises some or all of the following.

- i) The risk-based methodology begins with hazard identification, i.e. appraising the fire performance of each of the external wall constructions (see Clause 10). If the risk outcome 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 FRAEW addresses 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 FRAEW addresses 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 D.*
- iv) *At each of the above stages, the person conducting the FRAEW is expected to take a conservative approach to any uncertainty in terms of information/evidence available. 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 fire performance is achieved. Where uncertainty is rooted in the competence of the person(s) conducting the FRAEW, then it might be necessary to involve others (see 5.1.9).*

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, although 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 at the extreme end of either “low” 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.

Establishing what is proportionate requires consideration of the concept of “as low as reasonably practicable” or ALARP. In the context of external wall fire safety, a computation needs to be made that considers the potential consequence of a fire affecting the external walls, against the cost of taking steps to reduce those potential consequences. Such steps might include mitigation (doing something other than work on the external walls in order to mitigate the risk associated with the external construction), partial remediation or full remediation/replacement of the external wall construction. In reality, many decisions about proportionality are not obvious and have no simple formula. However, the point can be illustrated by the following two extreme examples (noting that these are only examples and lack granular detail).

- *Entirely recladding a 15 m tall building to remove combustible insulation in the external walls, despite it being demonstrated that the insulation is fully encapsulated and will not substantially contribute to a fire (i.e. the fire performance is low risk), would be grossly disproportionate.*
- *Entirely recladding a 60 m tall building to remove an extensive cladding system of untreated timber rainscreen over combustible insulation with inadequate cavity barriers would be proportionate.*

In the context of this PAS, good practice applicable to most situations can be found within the risk factors, in particular the guidance on these provided in Annex E, Annex F, Annex G, Annex H and Annex I.

There might also be some cases (e.g. a novel form of construction) where the risk factors do not adequately address the situation. In such cases, factors need to be followed as far as they can be, and then consideration given to whether there is any more that can be done to reduce the risk. The more advanced tools discussed in Annex J concern first principles.

d) Risk ratings and risk outcomes

The ultimate aims of the FRAEW are 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 deemed to be unacceptable.

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 either low or low enough to be tolerated, and/or whether proportionate risk reduction action needs to be taken. To this end, PAS 9980 expresses the risk rating in terms of low to high risk, and defines four risk outcomes: “low”, “tolerable”, “medium” and “high”.

Fundamental to this is that the specific circumstances of the building being appraised need to be considered holistically when determining the risk rating. As such, the risk outcome might be sufficiently low to be tolerated even where compliance with the BR 135 [6] 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.

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”.

The following list gives examples of scenarios that might fall into each of the risk outcomes. Clear examples are provided in simple terms for “low” and “high” risk outcomes; however, for the “tolerable” and “medium” risk outcomes, the outcome is very sensitive to specific circumstances.

1) Examples of scenarios that might result in a “low” risk outcome are:

- *external wall construction where it is concluded that the benchmark criteria are met; the wall construction is such that it would not accelerate spread of a fully flashed-over fire from one storey to the next in less than 15 min, and would not propagate fire beyond that second storey until the second storey is itself involved. Where these criteria are met for all external wall constructions, it ceases to be necessary to appraise façade configuration or fire strategy factors;*
- *external wall construction where it is concluded that external wall constructions are present which support fire spread, but that these cover areas of the building that are so limited that it is nonetheless the case that the external walls would not accelerate spread of a fully flashed-over fire from one storey to the next in less than 15 min, and would not propagate fire beyond that second storey until the second storey is itself involved;*
- *external wall construction where it is concluded that some external fire spread would occur, e.g. involving a second storey in less than 15 min, but that wider involvement of the façade would not occur, and where there are ample arrangements inside of the building to provide warning and means of escape in the event of fire (e.g. student accommodation operating simultaneous evacuation);*
- *external wall construction that has poor fire performance over the top storey only (such as a penthouse), where the remaining floors below are all covered in low-risk external wall construction (see case study 1 in Annex K, K.2 for full details);*

- *solid aluminium rainscreen over phenolic insulation formulated for good fire performance with adequate cavity barriers on an eight-storey block of student accommodation (see case study 2 in Annex K, K.3 for full details); and*
- *external wall construction which comprises materials that are Class A2 or better, and for which evidence of adequate cavity barrier construction has been retained for review by the appraiser (see case study 6 in Annex K, K.7 for full details).*

2) *Examples of scenarios that might result in a “high” risk outcome are:*

- *Category 3 ACM rainscreen cladding covering a substantial proportion of the external walls of a block of flats 18 m or more in height;*
- *Class D high pressure laminate (HPL) panel rainscreen over polyurethane (PUR) insulation with adequate cavity barriers, on a seven-storey block of flats (see case study 4 in Annex K, K.5 for full details); and*
- *rendered ETICS with expanded polystyrene insulation, thin organic render and defective fire barriers over an 18m+ height block of flats (see case study 5 in Annex K, K.6 for full details).*

3) *Examples of scenarios that might result in a “medium” risk outcome are:*

- *solid aluminium rainscreen over phenolic insulation formulated for good fire performance with adequate cavity barriers, but where AOVs serving the means of escape open onto the external wall construction, on an eight-storey block of student accommodation (see “what if” scenario for case study 2 in Annex K, K.3 for full details); and*
- *zinc rainscreen over polyisocyanurate (PIR) insulation without cavity barriers, on a four-storey block of flats (see “what if” scenario for case study 3 in Annex K, K.4 for full details).*

4) *Examples of scenarios that might result in a “tolerable” risk outcome are:*

- *two storeys linked by external wall construction that has poor fire performance, where other floors are all covered by low-risk external wall construction (see “what if” scenario for case study 1 in Annex K, K.2 for full details);*
- *solid aluminium rainscreen over PIR or phenolic insulation not formulated for good fire performance, but with adequate cavity barriers, on an eight-storey block of student accommodation (see “what if” scenario for case study 2 in Annex K, K.3 for full details); and*
- *zinc rainscreen over PIR insulation with cavity barriers that are generally but not always adequate, on a four-storey block of flats (see case study 3 in Annex K, K.4 for full details).*

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 the avoidance of doubt, while it could reasonably be concluded that an external wall construction that achieves compliance with the BR 135 [6] 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.

A range of considerations is set out in the examples given in Annex E (relating to fire performance risk factors), Annex F (relating to façade configuration risk factors) and Annex G (relating to fire strategy risk factors arising from consideration of the fire strategy/fire hazards, including the limitations of fire and rescue service intervention; see also Annex D).

f) Benchmarking

For each group, the likely influence of each of these risk factors needs to be taken into account when appraising their contribution in terms of achieving the success criteria determined from the benchmark for external fire spread (see 5.2 and Annex C).

Typically, an external wall comprising materials that have average fire performance, 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 strategy would have a dominance of neutral risk factors and lead to a “tolerable” or “low” risk outcome.

- 1) In the case of 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 in line with benchmark 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 are adequate large-scale test data available).

- 2) In the case of risk factors relating to the configuration of the façades and the extent and location of the 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 in line with benchmark expectations, and, as a result, they can be deemed neutral in this respect.
- 3) In the case of 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 they 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 in line with benchmark 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 based on professional judgement by competent persons, given the state of knowledge of, and ability to predict, how certain materials behave in fire.

g) 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 appraisal of risk factors ought to evaluate 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 E, Annex F and Annex G, 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.*

h) Uncertainty

With any FRAEW, it is inevitable that there are limitations in what can be achieved (i.e. uncertainty). These limitations 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, while it might be possible to reduce uncertainty, doing so might not be practicable or proportionate. Eliminating uncertainty entirely is not possible and the pursuit of certainty can be both costly and time-consuming. Therefore, in many cases, it is necessary to accept that reducing uncertainty is not practicable or proportionate, 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. Conversely, over-reliance on conservatism can lead to an unduly onerous outcome in terms of remedial work recommendations.

Similarly, clients, enforcing authorities and other stakeholders need to accept that uncertainty cannot be eliminated and, as such, to avoid imposing conditions and restrictions on the terms within which an FRAEW is conducted. 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.

Presumptions that, because of experience of poor common practice across the sector, buildings cannot be accepted as having been built satisfactorily unless survey information suggests otherwise, can 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 appraisal 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 [6], based on BS 8414 test data, but with walls that meet the pass criteria in BR 135 [6] for this build-up being known to be particularly susceptible to changes in the parameters of their construction.*

i) Case studies

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

These are intended solely 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 appraised in the particular circumstances of the building under consideration 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 Persons conducting an FRAEW should adopt a risk-based approach. 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.

6.2 Persons conducting an 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 a fire could 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 (i.e. to avoid unnecessary intrusive surveys and detailed analysis), the structured approach may be iterative, beginning by relying on the information that is immediately available and then conducting more work in each iteration to increase certainty as necessary (i.e. where risk cannot be confirmed as being low with the information that is immediately available). For the avoidance of doubt, this iterative approach is not intended to drive appraisers to reach a “low” risk outcome in situations where the risk outcome is not low; instead, its purpose is to avoid disproportionate investigations and work, and to avoid defaulting to “medium” or “high” risk outcomes due to conservatism associated with uncertainty.*

Figure 2 – Overall FRAEW process

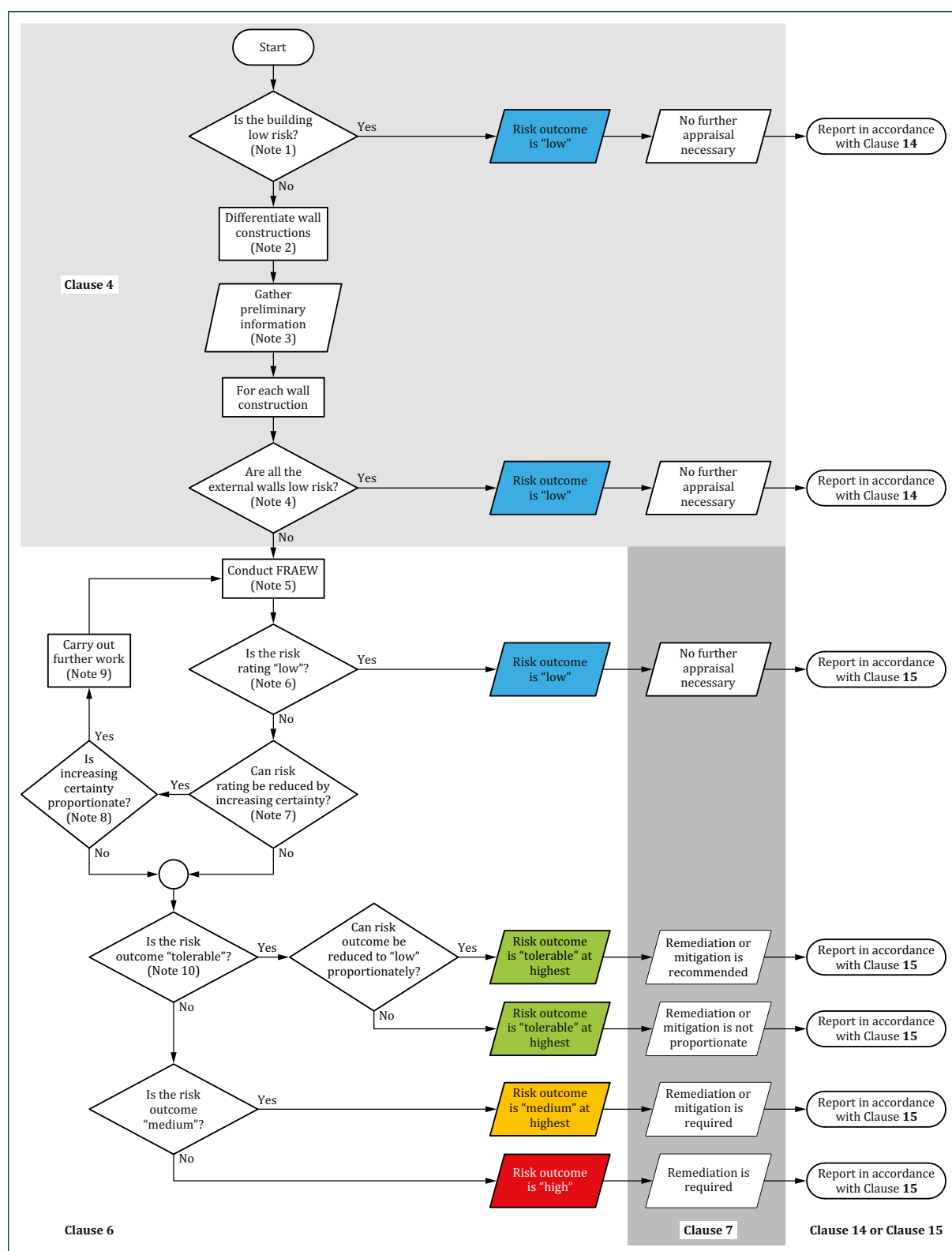


Figure 2 – Overall FRAEW process (continued)

NOTE 1 The parameters for determining whether a 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 H. The fire performance and façade configuration of each external wall construction need to be appraised 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 is 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 the risk is likely to be highly sensitive to as-built construction details). This preliminary information can also inform the planning of inspections so that they can be carried out as efficiently and effectively as possible.

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

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 the actual risk rating is lower than that currently appraised, and that the appraised 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.

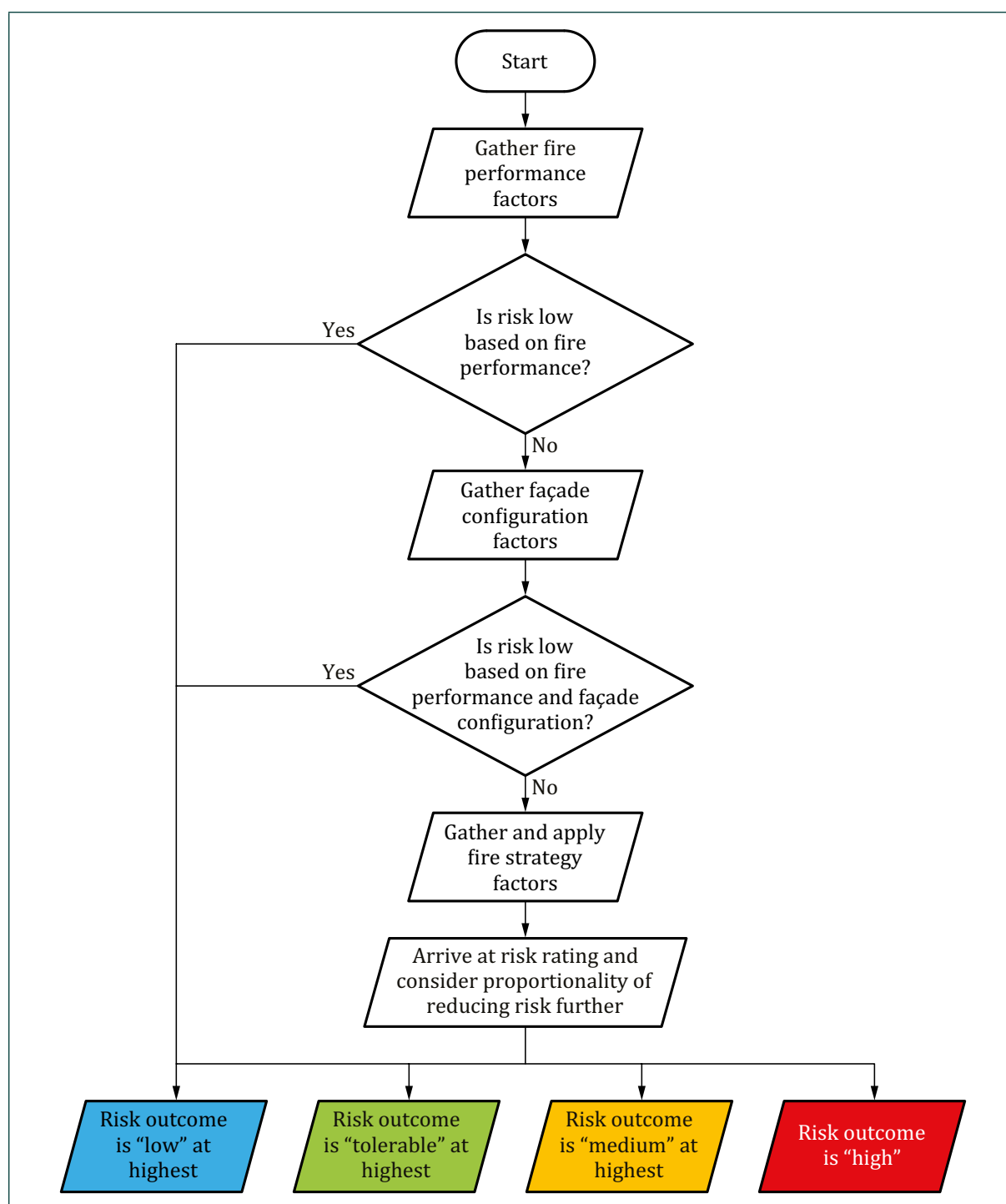
NOTE 9 Further work that might need to be carried out (subject to proportionality; see Note 8) includes:

- 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 I and Annex L).

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 FRAEW



6.3 Persons conducting an FRAEW should take into account the principle of proportionality (see 5.3) when formulating the specific investigations and analysis to conduct the FRAEW, and when forming an opinion on the risk and the appropriate risk reduction and/or mitigation measures, including considerations of benefit gained, practicability and cost.

***NOTE** The requirements of the Fire Safety Order [3] are based on measures that are “reasonably practicable”, i.e. that the cost, time and effort in reducing risk are not grossly disproportionate to the risk itself.*

6.4 Persons conducting FRAEWs on multiple buildings should not assume that the construction and risk are the same, even if the buildings are all part of the same development or have been constructed by a single entity. Any inferences that are drawn should be based on evidence of consistent construction, not merely an assumption that two buildings which appear similar have the same underlying construction.

***NOTE** Further information on information gathering and inspection is given in Clause 8 and Clause 9.*

6.5 Buildings that are determined to be low risk, following an 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.*

6.6 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 appraisal of the fire risk posed by the external wall construction and cladding on the building (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 E.*

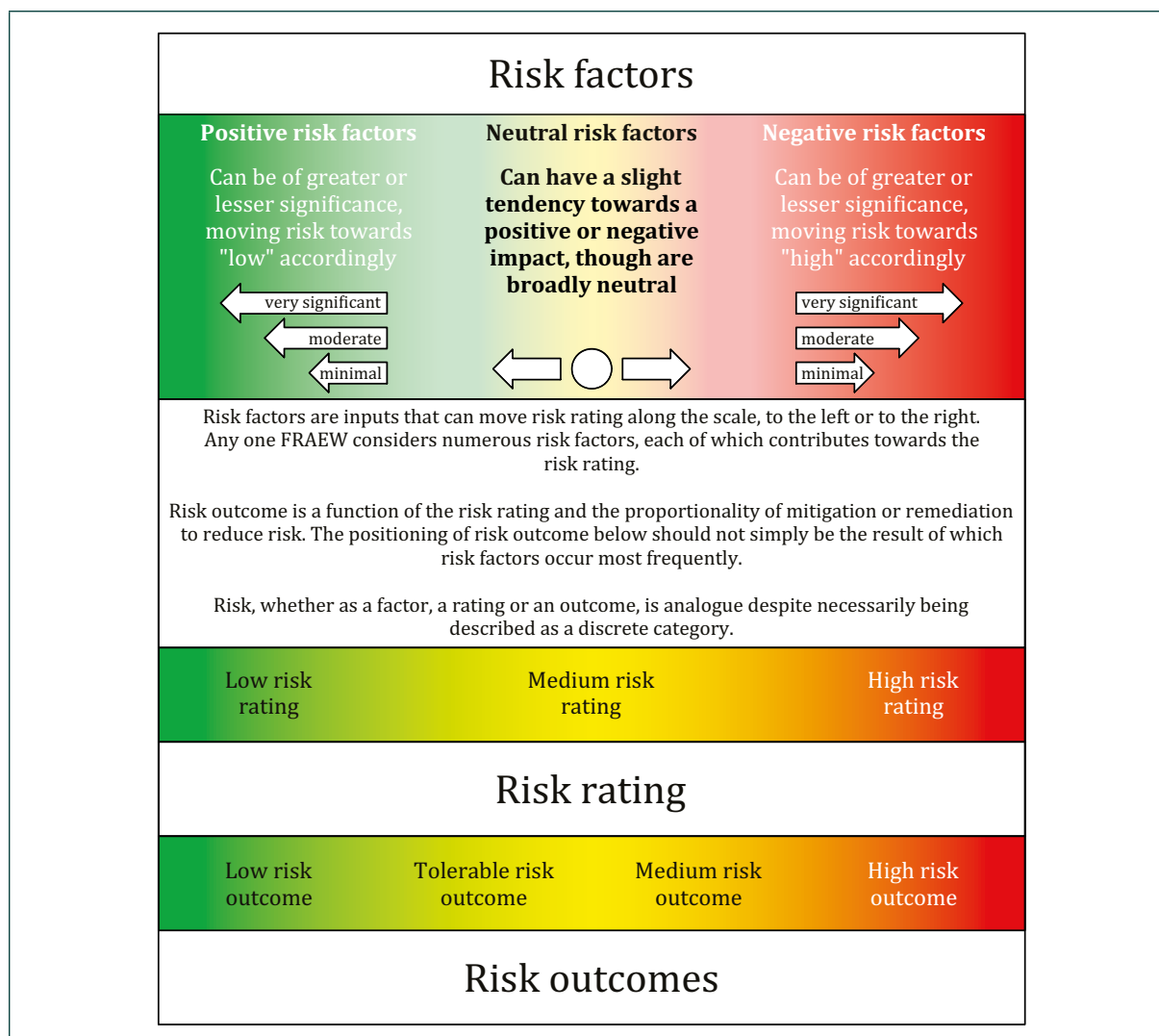
- b) Where necessary, the façade configuration of each external wall construction should be individually appraised, taking into account the fire performance previously established (see Clause 11). Where the façade configuration needs to be appraised, all relevant risk factors should be determined as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

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

- c) Where necessary, 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 G.*

- 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.

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

6.7 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.

NOTE Annex E, Annex F and Annex G contain example risk factors, while Annex K provides some case study examples of how to apply weightings. The risk factor tables are expected to be applicable to the majority of buildings and external wall constructions, but they are not to be treated as absolute or definitive; appraisers are expected to 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. Where appraisers choose to deviate from the risk factor tables, whether by varying their contents or taking an entirely different approach, this needs to be justified.

6.8 In determining the level of risk, persons conducting an 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 D, and some specific risk factors to be taken into account are discussed in Annex G.

6.9 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 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 remediation or mitigation is required; or
- c) a "tolerable" risk outcome, where risk outcome cannot be confirmed as "low", but the consequences for the safety of occupants are 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).

6.10 In any risk assessment, there is unavoidable uncertainty, and therefore appraisers should take into account that risk exists within a range rather than being absolute. Appraisers should satisfy themselves that the risk rating selected is appropriate in spite of uncertainty.

6.11 The FRAEW should result in a "high" or "medium" risk outcome where:

- 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** Guidance on benchmark expectations for external fire spread and how this interacts with the common approach to fire safety in blocks of flats is given in Annex C.*

6.12 The FRAEW should result in a "low" or "tolerable" risk outcome where:

- 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) fire and rescue services are likely to be able to intervene effectively to enable occupants to reach safety in time.

***NOTE** Guidance on benchmark expectations for external fire spread and how this interacts with the common approach to fire safety in blocks of flats is given in Annex C.*

6.13 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.

7 Outcomes and actions from an FRAEW

COMMENTARY ON CLAUSE 7

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 outcome 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 advising 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”, it is not necessary to undertake remediation; however, consideration needs to be given to proportionate means by which the risk outcome can be reduced to “low”. 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. Similarly, 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 periodic 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 is 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 building. Whilst it is generally not desirable or practicable to move away from a stay put strategy, the installation of a fire detection and fire alarm system and a change to a permanent, immediate and simultaneous evacuation strategy could be appropriate in some cases where both:

- the limitations of such a change have been appropriately assessed as not having a likelihood of counteracting the desired risk reduction; and
- other options for reducing the risk that would retain the stay put strategy have been considered and discounted.

Annex H provides guidance on the various approaches that might be taken in mitigating risk.

Where an FRAEW concludes that the risk outcome is “high”, remediation is likely to be the only viable option for reducing risk outcome to “tolerable” or “low”. 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 corresponding range of approaches to and urgency of remediation.

7.1 Where the person conducting the FRAEW becomes concerned that the risk is so high that there is an immediate risk to life, they should notify the dutyholder as soon as possible, giving details of mitigation 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.

***NOTE** For the avoidance of doubt, this clause is concerned with scenarios where it is established that, in the event of a fire, people will be at imminent and/or immediate risk to life. In such circumstances, appraisers are expected to act immediately to inform relevant stakeholders, prior to continuing the remainder of the FRAEW process.*

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 and outcome.

***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 outcome 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. This action plan should address the need for prompt action in 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 this 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, the person conducting the FRAEW should set some degree of periodic review of the FRAEW, taking into account any reasonably foreseeable circumstances under which the external walls might change in a way that impacts fire performance, e.g. 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 gathering of information 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, inspections of cavity barriers are not necessary. Conversely, external wall constructions that are highly reliant on proper detailing and high-quality workmanship [such as expanded polystyrene (EPS) render systems incorporating fire barriers] 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.

If 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) which 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 each external wall construction 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;*
- d) the building's fire strategy;⁴⁾ and*
- e) the building's FRA.*

Further guidance on information gathering is given in Annex M.

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.

⁴⁾ 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 need to 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.

Persons conducting an FRAEW 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 required to gather all necessary information 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 appraisal, 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 appraisal 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. If an FRAEW of the building already exists, it should be critically reviewed.

NOTE *Subject to the complexity of the building and its FRA, it can be desirable for the appraiser to liaise with the fire risk assessor to develop a shared understanding of the issues affecting the building being appraised.*

8.2 Where necessary, 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.

8.3 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).

8.4 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 as part of information gathering.

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.*

8.5 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.

8.6 Where presented with reports of investigations carried out by others who have been commissioned separately to, and not as part of, the FRAEW, 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

Original design information 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.

Therefore, site survey and inspection is often 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:

- a) *removal of components to reveal the wall build-up and determine which materials and products have been installed; this also allows the identity of the specific products, and their respective manufacturers, to be established;*
- b) *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*
- c) *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 appraisal 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.*

The number and extent of site surveys and investigations needed to appraise 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 appraised. 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 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 conducting the investigation. This is likely to be useful when communicating with clients, residents and others as to the scope of the investigation.

Persons conducting site surveys and investigations need to have sufficient 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, although this might be limited in extent.

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

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

9.1 Site 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 site surveys and investigations carried out by others prior to an FRAEW being commissioned are made available, the person conducting the FRAEW should use their own site 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 surveys and inspections should accurately record their findings in a form suitable for inclusion in a report. The report should be written such that persons reading it are able easily 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

This clause is concerned with estimating the potential hazards arising from the external wall construction and any attachments, relative to the benchmark criteria set out in 5.2 and Annex C.

The person conducting the FRAEW needs to understand how any combustible materials, whether in isolation or in combination, will cause the system 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 H). They then need to determine the overall fire performance as a function of the relative importance of the components (see Annex E) that influence fire performance.

Ultimately, the aim is to rank the fire performance, even if only broadly, on a relative scale from the excellent level of fire performance from a double skin masonry wall to the generally unacceptable level of fire performance of Category 3 ACM.

To do this, 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 in the as-built configuration;*
- *combustibility;*
- *heat released (calorific potential);*
- *rate of heat release;*

- propensity to produce smoke; and
- propensity to produce burning droplets.

The ranking of fire performance needs to take into account, to the extent available, 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.

Further information on fire performance factors is given in Annex E.

In practice, there are likely to be cases where the quantity of combustible material within the external wall construction, on the façades or in any attachments, is so small that it can be discounted (see for example Clause 4). In these cases, it might be that the external wall construction being appraised 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.

For example, 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.

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 build-up.

Even in a building in which the external walls and attachments are potentially low hazard by virtue of the above, further appraisal 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.

Annex L 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 [6]. Annex I provides specific guidance on how to use data from BS 8414 tests and BR 135 [6] classification in the context of this PAS.

Annex O provides information on common components in different types of cladding systems in relation to 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 Annex O.

Annex P provides further information relating to fire performance 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/>) and the intermediate scale cladding research commissioned by MHCLG (<https://www.gov.uk/government/publications/fire-performance-of-cladding-materials-research>).

10.1 When the person conducting an FRAEW has identified that combustible material is present, they should establish the significance of that material on the likely speed 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 external wall build-up and any attachments, and its behaviour in fire.

10.2 The FRAEW should establish, to the extent possible and necessary, all available indicators of the fire performance of the materials, components and systems forming the external walls and/or attachments of the building undergoing appraisal. Where available, information that enables the performance of external walls and attachments 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 and any attachments in context.

NOTE Establishing the fire performance factors for each external wall construction and any attachments is likely to involve use of the risk tables in Annex E, the principles in Annex H, Annex O and Annex P, and/or empirical evidence.

10.3 The influence of each relevant 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.

10.4 Where two different external wall 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), 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 consider 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 an outcome of the configuration of wall types and attachments across the façades. For the 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 faster 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 could 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 could 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 appraisal of the risk rating. This is set out in Annex F. 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 F, 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 faster, 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 D).

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 to an undue speed of fire spread, as well as to consequences in terms of the likelihood of secondary fires elsewhere in the building.

NOTE Establishing the façade configuration factors for each external wall construction is likely to involve use of the risk tables in Annex F and the principles in Annex H.

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.

11.3 Where two different external wall 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. Such factors relate to elements of the fire safety design of the building, including:

- *evacuation strategy, which in most blocks of flats is a 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 BS 9792) 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 that 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 taken into account, albeit the extent to which management 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 necessarily impact on the overall level of risk and whether or not it can be tolerated. FRAEWs need to address 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 with 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 that the building's FRA would have checked the records of testing and maintenance of such systems. Where there is reason to doubt the reliability of a system, this needs to be incorporated into the overall consideration of risk (see Annex H for further information).

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 given in Annex G. This includes those relating to fire and rescue service intervention (see also Annex D).

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 table in Annex G and applying the principles in Annex H.

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 appraisal

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 E, Annex F and Annex G. This method is broad ranging and relatively simplistic in its approach, but is intended to serve the purpose of eliminating from further consideration, as far as possible, those buildings where it can be readily demonstrated that the risk is low or tolerable.

In some instances, it might be necessary and appropriate to 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 are likely to 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 J provides additional information on tools for more detailed analysis and Annex I provides additional information on using BS 8414 test data, BS 9414 assessment and BR 135 [6] 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 E, Annex F and Annex G. This is discussed in Clause 5. Persons conducting a more detailed analysis need to have the competence to be able to conduct such an analysis, 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 outcome is “low” or “tolerable”, the person conducting the FRAEW should determine whether a more detailed analysis would enable the risk outcome to be refined.

NOTE 1 *This might enable the risk outcome to be considered as “low”, or, even if not low, as heightened compared with benchmark expectations, but, nevertheless, “tolerable”. Equally, it might confirm that the risk is “high” and add weight to the recommendation to remediate the walls by removal and replacement of cladding.*

NOTE 2 *Some information on the principles and considerations that need to be made in a detailed analysis is given in Annex J.*

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 *Some information on the principles and considerations that need to be made in a detailed analysis is given in Annex J.*

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 pro forma 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 its external wall construction, and confirming that this accords with one of the situations set out in the Commentary on Clause 4 where the risk is inherently low, 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 [3].*

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 do so for 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) information that might assist dutyholders in complying with relevant statutory duties.

NOTE *Such information can be provided in summary form in accordance with those duties that are applicable to the relevant jurisdiction (for example, the Fire Safety (England) Regulations 2022 [8]).*

15 Scope and format of reports that contain FRAEWs

COMMENTARY ON CLAUSE 15

Reports need not follow a prescribed format, and this PAS does not contain a pro forma 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 any site survey and inspection (if carried out), 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.*

The report is expected to provide readers with an evidence-based rationale for, and therefore confidence in, the conclusions reached.

15.1 The report should make clear that:

- a) 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 1 *Being a document that informs the FRA, it is expected that the report will be made available to the fire risk assessor and to the dutyholder. It might also be prudent to conduct a handover meeting with the fire risk assessor to assist them with understanding the FRAEW and its implications for the FRA.*

- b) it is not aimed at confirming compliance with building regulations, either at the time of construction, or currently;

NOTE 2 *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. However, the FRAEW is ultimately risk-based, as set out in 0.2.*

- c) it addresses life safety and not property protection, specifically in relation to the appraisal of the fire safety of the external walls of the building;
- d) it does not address the risk of spread of fire arising from space separation between buildings (i.e. heat transfer via radiant heat) or the performance of external walls in terms of fire resistance, or maintaining structural stability in the event of fire;
- e) being a risk-based appraisal reliant on professional judgement, the FRAEW cannot guarantee that a particular outcome will occur in the event of a fire;

- f) 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; and
- g) the FRAEW is to be reviewed:
 - 1) if significant changes/repairs have been made to the external wall; and/or
 - 2) if the external wall reaches the end of its expected service life or appears materially aged/worn; and/or
 - 3) in the event of a fire incident, if the fire involved the external wall construction; and/or
 - 4) 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 that a periodic 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.

15.2 The report should include a statement of the competence of the FRAEW report signatories to undertake an FRAEW for 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 typically used by professional organizations to demonstrate a level of membership.*

15.3 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 FRAEW 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) a list of the documents that have been reviewed by the appraiser in preparing the FRAEW;
- h) the basic form of construction of the building (e.g. concrete frame, timber frame, modular);
- i) a description of the wall types and their location/extent of coverage across the building;
- j) details as to how the as-built condition of each wall type has been established (e.g. drawings, photographs, findings of any intrusive inspections, operation and maintenance manuals); and
- k) details of the constraints and limitations that had an impact on conducting the FRAEW and arriving at a risk rating. Relevant limitations and sources of uncertainty should be set out, for example, in relation to:
 - 1) the extent of sampling carried out;
 - 2) 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;
 - 3) the extent of the content and detail within the report; and

- 4) 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, including whether any documents were specifically sought by the appraiser but either could not be obtained or were not provided to the appraiser.

NOTE 1 Appraisers are not expected to list every conceivable document that might have been of assistance in preparing an FRAEW. However, appraisers might identify documents that would be of particular assistance and either search for or request copies of these. Where such documents either cannot be found or are not provided, this would be a limitation of the FRAEW.

NOTE 2 Some of the contents of the report necessarily duplicates information that is given in the executive summary (see 15.11).

15.4 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 6.6 in particular), including the following.

- 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 at 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.
- c) Where necessary, relevant aspects of the fire safety design of the building (evacuation strategy, means of escape, 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.

15.5 It is not expected that the weight attached to the factors set out in 15.4 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.

15.6 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 5.2.5, 6.11 and 6.12. Where uncertainty is one of the reasons why the risk outcome has been determined as being “medium” or “high”, the report should explain why it was not possible or proportionate to conduct further appraisal work to address this uncertainty.

NOTE Where the risk outcome has been determined as being “tolerable” rather than “low”, the report needs to explain whether or not there are proportionate steps that could be taken now or in the future to reduce risk further.

15.7 The report should set out the necessity for, urgency of, and nature of any interim measures.

15.8 Where risk reduction is necessary, the report should either:

- a) where possible, state the reduction measures (mitigation and/or remediation) that need to be implemented; or
- b) state any risk reduction options (mitigation and/or remediation) that can be evaluated by the relevant stakeholders for proportionality, and suggest the actions required to select the most risk-proportionate option.

NOTE 1 Appraisers cannot be expected to identify every conceivable option in respect of interim measures, mitigation and remediation options; they are however expected to set out reasonably identifiable options for consideration by the client.

NOTE 2 In relation to mitigation and remediation options, the FRAEW and FRA necessarily inform the remedial works design but cannot direct it. Therefore, while not within the scope of the FRAEW, where there are multiple risk reduction options, it is expected that they will be appraised by the relevant stakeholders and designers. The FRAEW therefore needs to make clear recommendations that consider proportionality.

15.9 Variations from any part of the process set out in this PAS should be documented in the report, together with a clear justification for doing so.

NOTE This includes deviations from the guidance on risk factors provided in Annex E, Annex F and Annex G.

15.10 Where the FRAEW reviews, updates or replaces a previous FRAEW and reaches significantly different conclusions, the report should provide a clear explanation as to the root causes of the differences.

NOTE 1 Root causes of changes might include, for example, changes to the building's external walls or simply the risk appetite of the appraisers. Annex B sets out principles that can be applied when various forms of review are to be undertaken.

NOTE 2 Significantly different FRAEW conclusions are a significant change for the FRA, so it is expected that they will be communicated to the fire risk assessor.

15.11 The report should include an executive summary that is readily understandable by non-experts, including residents. The executive summary 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) information that might assist dutyholders in complying with relevant statutory duties.

NOTE 1 Such information can be provided in summary form in accordance with those duties that are applicable to the relevant jurisdiction (for example, the Fire Safety (England) Regulations 2022 [8]).

NOTE 2 Some of the contents of the executive summary necessarily duplicates information that is given in the main report (see 15.3).

15.12 Persons authorizing or otherwise signing the report should satisfy themselves that the report is a piece of work that they would be willing to provide as their own work.

Annex A (informative)

Expected skillsets of a person conducting tasks in accordance with this PAS

Table A.1 sets out the skillsets typically expected of persons undertaking different tasks or levels of appraisal when applying the methodology in this PAS. It also provides non-exhaustive examples of the types of professional recognition that might provide evidence that a person possesses the expected skillset, although professional recognition alone cannot guarantee this.

The indicative expected skillsets in Table A.1 are based on the National Qualifications Framework.⁵⁾

Table A.1 – Expected competences of a person conducting tasks in accordance with this PAS

Task	Typical professional recognition	Expected competence
Establishing whether a building is inherently low risk (see 4.2)	No professional recognition necessary	Not applicable. Establishing whether a building is one of the four 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 the external walls of a building are inherently low risk where this does not require inspection (see 4.3 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	Knows the limitations of their competence and can draw in additional support as required. 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. Able to communicate accurately and reliably. Takes personal responsibility for their work.
Establishing whether all the external walls of a building are inherently low risk where this does require inspection (see 4.3 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	Knows the limitations of their competence and can draw in additional support as required. 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. Able to conduct on-site inspection and gather accurate factual information regarding the as-built construction of the building. Able to identify types of construction products as set out at Annex O. Able to communicate accurately and reliably. Takes personal responsibility for their work.

⁵⁾ Further details of this framework are available from <https://www.gov.uk/what-different-qualification-levels-mean/list-of-qualification-levels>.

Table A.1 – Expected competences of a person conducting tasks in accordance with this PAS (*continued*)

Task	Typical professional recognition	Expected competence
Information gathering (see Clause 8)	Surveyor or other building professional, such as an architect or façade engineer	Knows the limitations of their competence and can draw in additional support as required. 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. 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 appropriate repairs to be made. 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 that are inconsequential, and thus concluding that such walls do not need to be considered further in an FRAEW. Able to communicate the results of their inspection accurately and reliably. Takes personal responsibility for their work.
Site survey and inspection (see Clause 9)	Surveyor or other building professional, such as an architect or façade engineer	Knows the limitations of their competence and can draw in additional support as required. Able to conduct on-site inspection and gather accurate factual information regarding the as-built construction of the building. Able to identify types of construction products as set out at Annex O. Able to communicate the results of their inspection accurately and reliably.

Table A.1 – Expected competences of a person conducting tasks in accordance with this PAS (*continued*)

Task	Typical professional recognition	Expected competence
FRAEW based on risk factor tables (see Annex E, Annex F and Annex G)	Full member of a relevant professional body, such as a surveyor, architect, façade engineer or fire engineer	Knows the limitations of their competence and can draw in additional support as required. Has 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. 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. Able to evaluate the appropriateness of different approaches to solving problems related to the fire performance of the relevant external wall construction. Able to communicate the results of their appraisal accurately and reliably, and with structured and coherent arguments. Takes personal responsibility for their work.

Table A.1 – Expected competences of a person conducting tasks in accordance with this PAS (*continued*)

Task	Typical professional recognition	Expected competence
FRAEW making use of advanced tools and/or fire safety engineering in a more detailed analysis (see Clause 13 and Annex J)	Chartered engineer	Knows the limitations of their competence and can draw in additional support as required. 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 the fire safety engineering discipline as it relates to the fire performance of the relevant external wall construction. Able to deploy accurately established techniques of analysis and enquiry within the fire safety engineering discipline. 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. 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. Appreciates the uncertainty, ambiguity and limits of knowledge relating to the fire performance of the relevant external wall construction. 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. Able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences. Able to exercise initiative and accept personal responsibility.

Annex B (informative)

Review of reports

There are five overarching purposes for which reports are normally reviewed. Whether a review needs to address one or more of these purposes depends on the specific circumstances, scale and complexity of the appraisal.

- a) **Compliance:** A peer review to confirm any purported compliance with PAS 9980. Compliance is primarily focused on the methodology and outcomes.
- b) **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 that 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 professional judgement and/or detailed analysis where the thinking of the author has not been properly expressed.
- c) **Accuracy:** A peer review to check that the appraisal and its outcomes are accurate, based on the information available and any assumptions made. It might be that, to a lay reader, the author has presented a logical argument [see item b) above], but there might be some fundamental technical error that undermines the findings of the report.
- d) **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 the report is more likely to result in a reliable and comprehensible report. Whether this is the case depends on the competence of all involved.
- e) **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 a) to e). 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 here.

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

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

Annex C (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 for the fire to develop rapidly and spread extensively, especially if the façades incorporate external wall construction and cladding that is combustible.

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 C.1 depicts fire spread that is restricted in its extent and development in line with this scenario. By contrast, Figure C.2 depicts a situation in which the external wall construction and cladding give rise to rapid fire spread and development. In the latter case, the extent of secondary fires can be far greater, affecting many floor levels simultaneously. This is indicative of external wall construction that is not considered to resist adequately the spread of fire. It is, of course, possible in both cases for fires to be started on lower levels by burning droplets and debris falling from the fire above.

A notable feature of external walls, and especially modern cladding systems such as a rainscreen cladding system, is the presence of cavities. These present the particular danger of concealed and extensive fire spread. As well as contributing to the speed of fire development, this mechanism for fire spread can, if not properly mitigated by cavity barriers, circumvent key features in a 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 later in this annex. 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 able to release a significant quantity of heat when it burns. Such a situation can give rise to extremely rapid fire spread.

However, Figure C.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 limiting in extent any cavities present, 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.

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

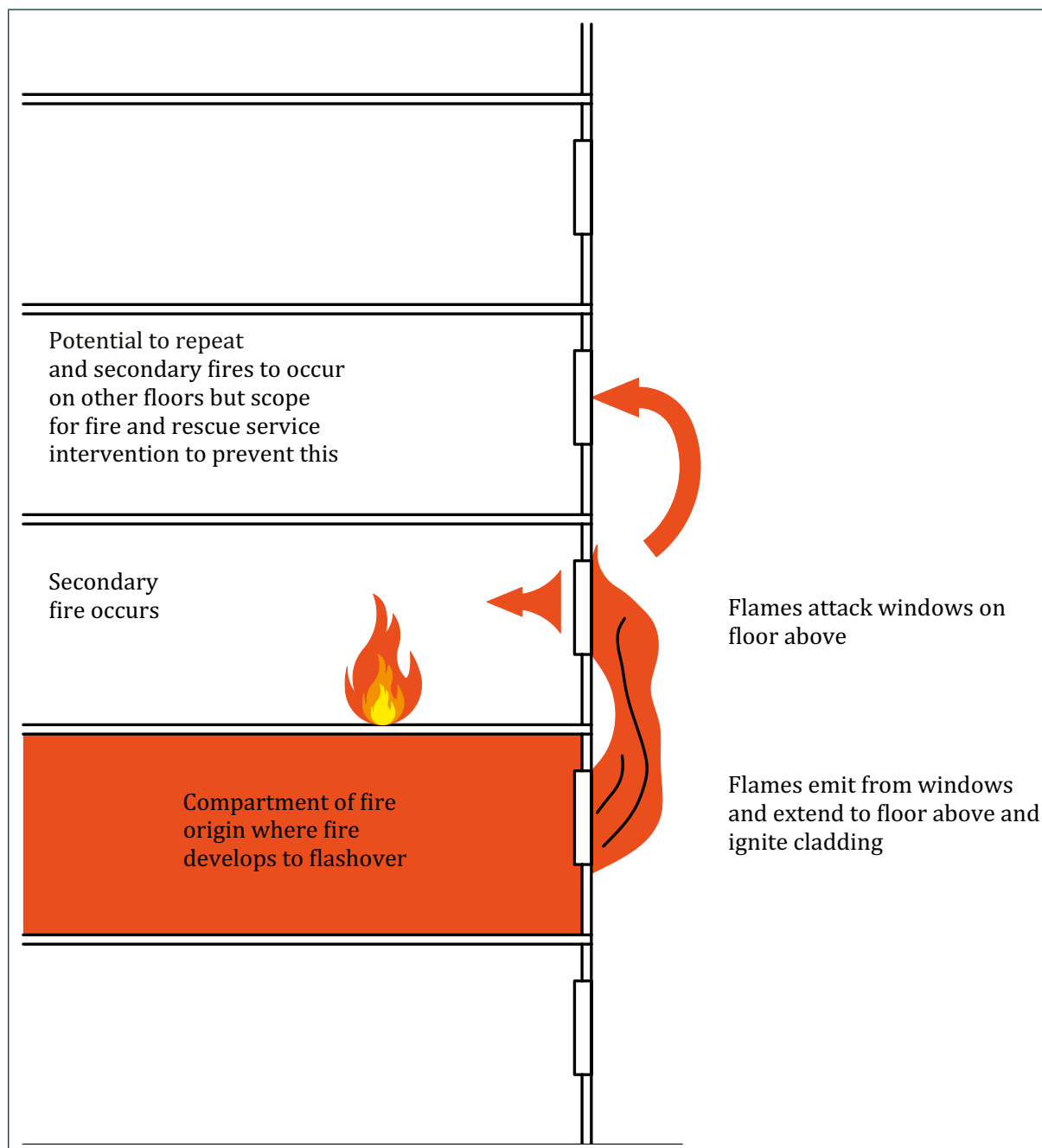
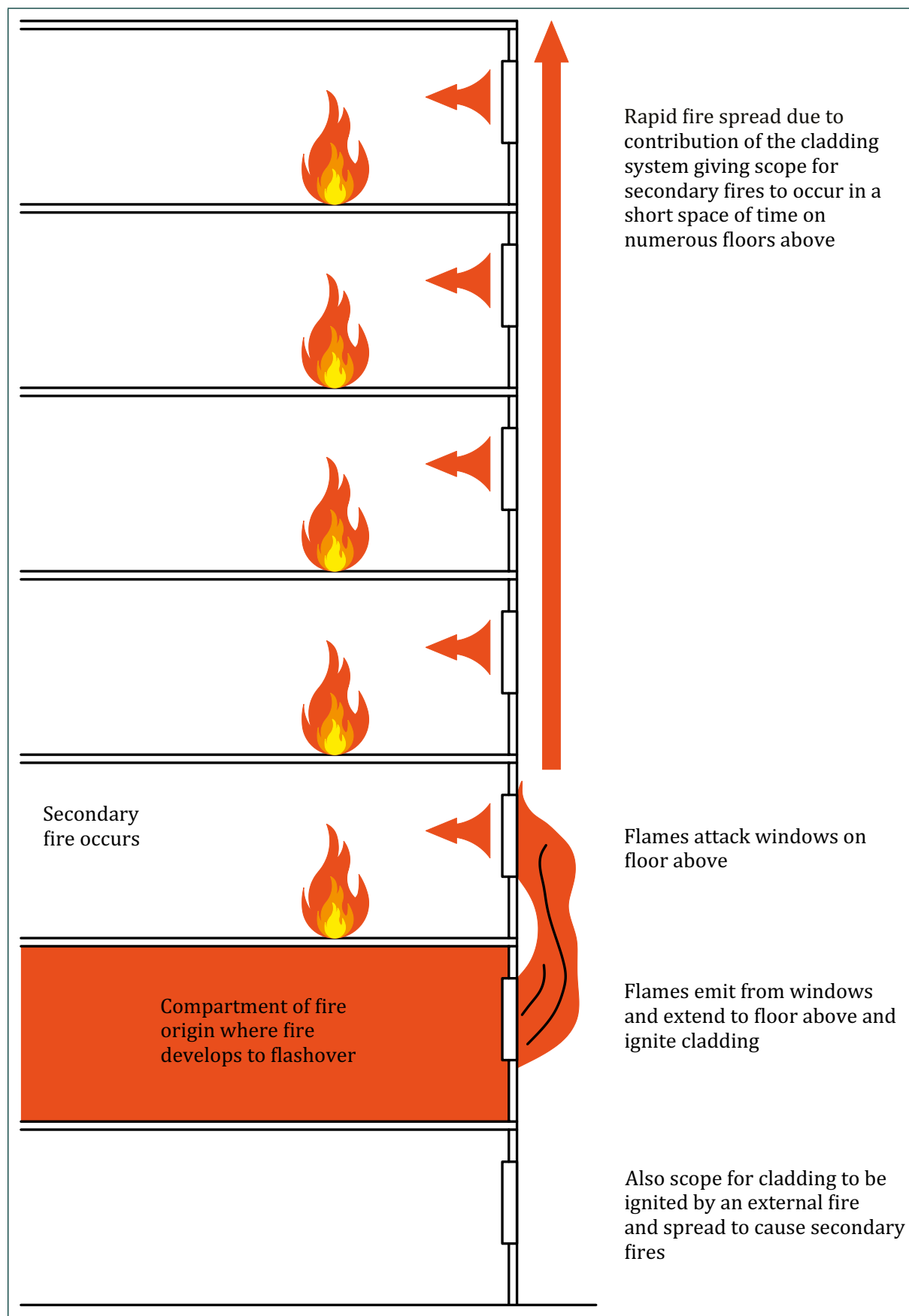


Figure C.2 – Potential scenario resulting in rapid external fire spread and significant risk of multiple secondary fires



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.

The basis of controls within the guidance applied to fire safety of external walls is to restrict 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. 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 C.1 and Figure C.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.

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 to allow for safe escape and/or the intervention of the fire and rescue service; measures 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 it takes for a fire to grow to flashover and 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.

Understanding how these mechanisms and benchmarks relate to the fire risk posed by external wall construction therefore necessarily requires understanding how these relate to fire strategies for blocks of flats. Whether in a generic or building-specific sense, appraisers need to understand the relationship between the need to provide means of escape, and the need to delay fire and smoke spread.

In most blocks of flats in England, the stay put strategy is in use. This strategy has been widely misinterpreted as being one where residents are expected to remain in their homes indefinitely in the event of a fire. The policy was first codified in CP3 Chapter IV Part 1:1962, which stated:

"The assumption should no longer be made that buildings must be evacuated if a fire occurs and high residential buildings should, therefore, be designed so that the occupants of floors above a dwelling which is on fire may, if they choose, remain safely on their own floor. It may be necessary to evacuate the floor on which the fire occurs, and in some circumstances those floors which are in the immediate vicinity of the fire, but the occupants of these floors should be free to reach safety in any other part of the building via the staircase."

The 1971 edition of CP3 Chapter IV Part 1 provided similar text:

"It is no longer assumed that when a fire occurs in a block it is necessary to evacuate the whole block, whole floors or even dwellings adjacent to the fire. In an emergency, however, the occupants of dwellings would generally first try to escape from a fire by the most obvious route in order to reach safety before being cut off by smoke and hot gases. Where escape routes are adequately protected, safety may be reached within the building, or in the open air clear of the building, by the occupants' own unaided efforts and without reliance on rescue by the fire service."

Understanding the principles and rationale of the stay put strategy is fundamental to understanding the design philosophy underpinning the design and construction of existing blocks of flats, as well as the extent to which fire precautions are necessary when the building is in occupation so that a "tolerable" or "low" risk outcome can be achieved. As part of this understanding, it is necessary to consider how external fire spread might impact people with specific evacuation requirements, and how both issues arising from an FRAEW and issues arising from an FRA need to be considered together in order to address their safety.

As set out in the quoted text from the two editions of CP3 Chapter IV Part 1, the stay put strategy does not mean an expectation that people remain in their flats indefinitely. Achieving a safe building therefore does not require fire spread to be prevented indefinitely. Such an objective is, in any event, unrealistic and unreasonable, as set out in further detail in the text that follows.

A significant component of the stay put strategy is that means of escape need to remain available for use throughout the duration of an incident. This is so that people can choose to remain safely in their flat if a fire occurs, on the basis that if they change their mind or smoke or fire begins to affect their flat, causing actuation of the smoke alarm in their flat, they can move safely into the means of escape. It is for this reason that the façade configuration factors consider adjacency of external wall materials to openings onto escape routes separately to their adjacency to openings onto accommodation spaces.

People might have a wide range of characteristics that could potentially impact on their approach to evacuation; further information is given in BS 9792:2025, Annex D. All of these need to be addressed by the dutyholder; the majority of measures fall within the scope of the FRA, but the FRAEW is necessarily relevant.

- 1) As set out earlier in this annex, it is not reasonable to seek to prevent external fire spread entirely; research reported in Fire Research Note 436 [9] and Fire Research Note 8 [10] established that the flames from a fully developed fire produce flaming out of windows are capable of igniting the contents of rooms near windows immediately above in approximately 15 min. The time for fire to spread from one floor of a building, via windows, absent any contribution from external walls, to the floor immediately above is therefore the time taken for a fire to become fully developed (i.e. the entire room becoming on fire, termed flashover) plus approximately 15 min. Further fire spread from floor to floor up the building is limited by the time taken for fire to grow from ignition to full involvement, plus 15 min, on each floor. In most cases, the fire and rescue service intervene before a fire escapes the compartment of fire origin. As set out earlier in this annex, the benchmark criterion for external fire spread (related to meeting building regulations objectives) is that the external walls do not contribute to fire spreading any faster than as set out here.
- 2) While it is not reasonable to seek to prevent external fire spread entirely, the occurrence of external fire spread is compatible with the stay put strategy because it is expected that anyone whose flat becomes affected by fire or smoke would be alerted by the smoke detectors in their flat and be able to move from their flat into the means of escape via their entrance door. The means of escape is intended to be a place of relative safety, providing passage to a place of ultimate safety, and this ought to remain the case throughout a fire incident.
- 3) A properly completed FRAEW therefore weighs the relative importance of protecting accommodation spaces and means of escape from the hazards associated with external fire spread (by appraising the fire performance and, where necessary, façade configuration and fire strategy risk factors).

Many people with specific evacuation requirements are able to move into the means of escape and make use of it, albeit that different people move at different speeds across each floor and down staircases. Where a person either cannot leave their flat into the means of escape at all, or cannot use the stairs to evacuate, then the dutyholder needs to determine, as part of the FRA, what steps they need to take to address the associated risk. This might involve the provision of a residential personal emergency evacuation plan (RPEEP).

FRAEWs are not intended to be carried out as frequently as FRAs. The reasons why an FRAEW might be reviewed or updated are set out in 15.1g), but these events are not expected to occur as frequently as changes to the internal parts of a building, or indeed changes to the building occupancy.

Any resident can go overnight from having no disabilities to having some form of temporary or permanent impairment; the FRA is therefore the appropriate means for dutyholders to maintain awareness of the needs of all residents, and to take suitable measures accordingly.

In summary, it is not reasonable or indeed possible to seek to prevent external fire spread entirely. It is also not reasonable to attempt to use an FRAEW to forego the need to address properly the needs of people with specific evacuation requirements.

The main focus of recent attention has been on the type of rainscreen cladding system installed 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 [6].

BR 135 [6] 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 C.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 C.3 – Fire at Garnock Court, Irvine



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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 C.4).

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



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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 images at <https://www.bbc.co.uk/news/uk-england-london-48706110>) has highlighted that this can be highly significant in terms of the fire risk posed by external wall construction and cladding.

A further fire that caused public concern and served to highlight, yet again, the dangers of combustible cladding, occurred in November 2019 at the Cube in Bolton (see image at <https://manchesterfire.gov.uk/media/2100/image-7.jpg?mode=crop&width=500&height=375>). This student accommodation building had an HPL cladding system, which was implicated in the extensive fire spread that occurred.

The fire at Grenfell Tower, followed by these other recent fires involving external fire spread, led many to conclude that insufficient attention has been paid to this matter in modern building construction. It is against this background that existing buildings are being scrutinized to determine whether or not they are “safe”.

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.

Seventy-two lives were lost as a result of the Grenfell Tower fire, and in the examples of external fire spread cited above, there were injuries. 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 BRE report *External fire spread – Part 1: Background research* [11]. The fully developed fire that broke out of the windows caused only localized damage to the façade in the immediate vicinity of the windows, beyond which there was only surface charring and sooting of the rendered mineral wool ETICS, applied as a new cladding system to a 1960s building.

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

This can be seen from the very small number of incidences in which it has been necessary for the fire and rescue service to intervene to evacuate or rescue people beyond the flat of fire origin. Typically, in purpose-built blocks of flats, compartmentation and means of escape provisions have been effective, and neither internal nor external mechanisms of fire spread have led to fires requiring large numbers of people beyond the flat of fire origin to be evacuated or rescued. For example, in a specific analysis of data from 2019–2020, of more than 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.⁶⁾

In reality, the only way external fire spread can be prevented in its entirety is to build a building of entirely non-combustible materials and not have any windows or other openings in the external envelope. As stated earlier in this annex, in any multistorey building that 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.

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

- i) 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
- ii) occupants in places to which fire has spread are not unduly harmed, or prevented from escaping, by the time any such secondary fires occur; and/or
- iii) secondary fires do not compromise the communal means of escape before occupants needing to use the escape routes have left the building; and/or

⁶⁾ Home Office data.

iv) fire and rescue service intervention is likely to be effective in:

- avoiding undue secondary fires; or
- taking steps to ensure that occupants at risk are not prevented from escaping; or
- rescuing occupants.

Annex D (informative)

Fire and rescue service intervention

D.1 General

While fire and rescue service attendance at any incident is to be expected, there are many factors that impact 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 FRAEW, as over-reliance on the fire and rescue service can lead to an ill-informed and incorrect appraisal of the overall risk.

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

D.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). There are 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 therefore 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 is influenced by multiple factors.

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

- a) the nature of the premises;
- b) the access, both internally and externally;
- c) availability of local fire and rescue service resources, taking into account the time of day;
- d) availability of water supplies;
- e) the nature and location of the fire;
- f) the priorities of the fire and rescue service on arrival;
- g) occupant characteristics;
- h) environmental conditions;
- i) other factors affected by the time of day; and
- j) 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 and undertaking rescues, 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 G), it is important that the person conducting the FRAEW does not place an over-reliance on fire and rescue service intervention when appraising the risk.

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

D.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.

- a) 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.
- b) 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.
- c) The inherent design of external walls is 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).
- d) Fire and rescue service equipment and practices are continually evolving.

When considering the effectiveness of external firefighting, persons conducting an FRAEW need to be mindful of these 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.

D.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 D.3), it has been assumed that fire and rescue service intervention takes 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.

- a) It is unlikely that access is possible to all faces of the building.
- b) 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.
- c) 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.
- d) Effective application of firefighting water onto external walls is unlikely to be easily achieved from inside the building.
- e) Dismantling of external wall elements to access cavities, extinguish fire, or form fire breaks, is unlikely to be easily achieved from inside the building.
- f) 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 E (informative)

Fire performance risk factors

Table E.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.

The following principles apply to the contents of Table E.1.

- a) No single row in Table E.1 gives a definitive answer on risk.
- b) Whether an entry is considered positive, negative or neutral is purely indicative of the potential influence it might have. A description of the influences is given in item f)1) of the Commentary on Clause 6.
- c) 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 O provides guidance on the relative importance of system components for different types of external wall systems, while Annex P provides commentary on how component behaviour can be brought together to consider systems as a whole).
- d) Where numeric values are given in Table E.1, these are intended only to be indicative as to the possible influence the particular factor might have in a risk-based appraisal.

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:

- 1) calorific value is an indicator of how much heat could be produced by a product if it burns, but it is 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 some products can be sandwiched between other products that would prevent or inhibit combustion (e.g. insulation within SFS);
- 2) 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
- 3) 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 take into account the importance of system components as a function of the system typology (see also Annex H). For example:

- i) the fire resistance of the substrate is important in cavity wall construction, but the importance of adequacy of cavity barriers is low;
- ii) the fire resistance of the substrate is not important for compartment continuation, but the adequacy of fire stopping is highly important; and
- iii) 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 8414-1 or BS 8414-2 test and classified to BR 135 [6] with the same build-up, but is not an exact match, these could be considered for the “Positive” column. However, for the avoidance of doubt, this is not implying that it can be regarded as meeting the benchmark in ADB; only if the system has been subject to a technical assessment in accordance with BS 9414 could such a conclusion be drawn.

The relevance of the factors in Table E.1 can vary on different elevations or different parts of the same elevation. Consideration needs to be given as to how significant such variations are when appraising the fire risk of the building as a whole. Equally, the factors in Table E.1 are focused on external walls and therefore materials that are vertically oriented. Where attachments are being appraised, the person conducting the FRAEW might need to adapt the risk factors to account for whether materials are oriented horizontally, vertically or both.

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

Table E.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.		
E.1 General		
Materials with a calorific value (gross heat of combustion) of ≤ 3 MJ/kg	Materials with a calorific value (gross heat of combustion) between >3 MJ/kg and ≤ 35 MJ/kg	Materials with a calorific value (gross heat of combustion) of >35 MJ/kg
NOTE 1 Calorific values are to be based on BS EN ISO 1716 test results. NOTE 2 This is a broad indicator only and needs to be seen in the context of the particular component to which it relates, how that component interacts with other materials, the quantity of the material, its location and the extent to which it covers the building. The boundaries between the different ranges need not be seen as rigid in this context. Depending upon this, judgement made by the 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.		

Table E.1 – Fire performance risk factors (*continued*)

Positive	Neutral	Negative
External wall materials, components/systems and configurations that are combustible, but known to provide adequate fire performance in certain circumstances [Based on knowledge of fire behaviour from fire tests. For example: - any combination or system that has been classified to BR 135 [6] for the same build-up, albeit not an exact match; or - any combination or system that has passed an alternative large-scale test (e.g. LPS 1181, Part 1 [12]).] NOTE 1 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. NOTE 2 BS 9414 has 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).	External wall materials, components/systems and configurations that are combustible, but with the potential to provide adequate fire performance in certain circumstances [Knowledge of fire behaviour from only limited fire tests. For example: - subject to intermediate-scale tests (e.g. ISO 13785-1, NFPA 285 [13]) and/or ad hoc fire tests, but not large-scale tests; or - components classified to BS EN 13501-1 but not complete system/configuration.]	External wall materials, components/systems and configurations that are combustible, but with no knowledge of fire behaviour [No evidence available from fire testing. For example: - not tested in large-scale or intermediate-scale fire tests (e.g. BS 8414); - not classified to BS EN 13501-1; or - no ad hoc testing.]
E.2 External surfaces: reaction to fire classes		
Class A1/A2* Class B	Class C	Class D, Class E, Class F
NOTE 1 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. NOTE 2 The relationship between national and European reaction to fire classes is addressed in L.2.1.		

Table E.1 – Fire performance risk factors (*continued*)

Positive	Neutral	Negative
E.3 Facings/cladding panels		
Low HRR	Neither low nor high	High HRR
NOTE 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.		
Mechanically fixed	—	Adhesive fixed
Solid metal panels with high melting point (for example >800 °C) (Typically, steel, solid copper) NOTE Some paint finishes can result in a Class B or lower rating.	Solid metal panels with low melting point (for example <800 °C) (Typically, aluminium, zinc)	Metal faced panels with a combustible backing (Typically, aluminium on plywood)
Category 1 ACM or other MCM (At least Class A2)	Category 2 ACM or other MCM (Typically, a combustion modified polyethylene core, also referred to as FR type)	Category 3 ACM or other MCM (Typically, an unmodified polyethylene core)
Other rigid non-combustible facings (Typically: • brick; • ceramic; • stone; • clay tile; • concrete; • stone wool cladding boards; and • cement fibre boards) Masonry or concrete at least 75 mm thick*	Brick slip with organic mortar Brick slip with inorganic mortar*	Brick slip and other similar facing/cladding panels supported by thermoplastic materials

Table E.1 – Fire performance risk factors (*continued*)

Positive	Neutral	Negative
Glazing and glazed curtain walling (See E.11 for infill panels) NOTE 1 Glass type might not be Class A2 or better, but glazing is nonetheless considered positive. NOTE 2 Based on experience of laminated glass in fires, replacement of laminated glass is not, at the present time, considered necessary in relation to existing blocks of flats. NOTE 3 Laminated glass is discussed further in Annex O.	—	—
Glass rainscreen panels, either: • at least Class A2; or • incorporating organic resins, binders, etc., where a similar combination has been subject to BR 135 [6] classification	Glass rainscreen panels, with organic resins, binders, etc.	—
HPL, combustion modified (not lower than Class B), when used in combination with non-combustible insulation NOTE Class B products are sometimes also referred to as an “FR” HPL.	HPL (Class C or lower), when used in combination with non-combustible insulation* NOTE 1 Class C or lower products are sometimes also referred to as a “standard” HPL. HPL, combustion modified (not lower than Class B), when used in combination with combustion modified polymeric foam insulation NOTE 2 Class B products are sometimes also referred to as an “FR” HPL.	HPL, combustion modified (not lower than Class B), when used in combination with polymeric insulation* NOTE 1 Class B products are sometimes also referred to as an “FR” HPL. HPL (Class C or lower), when used in combination with polymeric foam insulation NOTE 2 Class C or lower products are sometimes also referred to as a “standard” HPL.
—	Timber, direct on non-combustible substrate* Timber, in combination with non-combustible insulation	Timber, in combination with combustible insulation or other major combustible components, e.g. oriented strand board (OSB) sheathing on the inside face of a cavity

Table E.1 – Fire performance risk factors (*continued*)

Positive	Neutral	Negative
—	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)
E.4 Panel construction		
No gaps between panels	Limited size of gaps between panels (Typically <10 mm)	Gaps between panels of 10 mm to 20 mm* Gaps between panels of >20 mm
NOTE 1 Gap sizes can be highly influential in terms of performance in large-scale tests, and the values given here are intended only 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 N. NOTE 2 Gaps might result from loss of integrity of sealant during fire exposure.		
E.5 Cavities		
Facings into the cavity at least Class A2	Facings into the cavity combustible, but at least Class B	Facings into the cavity combustible, but Class C or lower
Cavities closed by barriers/fire stopping located in line with all the following: • compartment floors; • compartment walls; • around openings, e.g. windows, doors; and • ventilation ducts, grilles and other openings for services NOTE Suitable protection for ventilation ducts, grilles or other openings for services could take other forms, e.g. intumescent collars where passing through the walls, steel sleeves around the ducts and duct extensions to the cladding panels.	Cavity barriers present with only minor workmanship defects	Cavities closed at least at compartment floors and walls but not: • around windows and other openings*; or • at ventilation ducts, grilles or other openings for services* No cavity barriers present, or cavity barriers ineffective through poor installation/maintenance

Table E.1 – Fire performance risk factors (*continued*)

Positive	Neutral	Negative
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 is expected to be provided if the following are present: • steel at least 0.5 mm thick; • timber at least 38 mm thick; • polythene-sleeved mineral wool, or mineral wool slab, installed under compression in the cavity; or • calcium silicate, cement-based or gypsum-based boards at least 12 mm thick. Fire stopping that is present to close gaps in compartmentation provides a higher standard of fire resistance than a cavity barrier/stop. 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 (a) where a cavity terminates at ground or floor level, (b) at the top of any wall (including at roof level), (c) where cavities reach the corners of buildings and (d) at the interfaces between different external wall constructions. In relation to (a), the ground or floor provides the function of a cavity barrier. In relation to (b), 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 min fire resistance (e.g. a compartment floor). In relation to (c), 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 (d), 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. NOTE 3 While some national guidance only refers to these forms of cavity barrier construction in relation to stud partitions and around openings, for the purpose of this PAS, these forms of construction may still be treated as providing encapsulation in external wall construction. NOTE 4 Cavity barriers around compartment floors and walls (not openings) might be adequate to reduce the risk of fire spread and could fall into the Neutral category. This can be accepted where the façade is robust, such as brick, and the junctions are resilient from the compartment line to the external face of the outer material.		

Table E.1 – Fire performance risk factors (*continued*)

Positive	Neutral	Negative
E.6 Insulation		
No insulation	—	—
Class A1/A2, Class B	Class C	Class D, Class E, Class F
<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>		
Mineral/glass insulation	Thermoset polymeric foams that form a stable char on fire exposure, e.g. phenolic foams and some PIR foams	Thermoplastics [e.g. EPS/ extruded polystyrene (XPS)] or thermoset polymeric foams that do not form a stable char on fire exposure (e.g. PUR)
	<i>NOTE The impact of the thickness of these insulations 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>	
E.7 Substrate		
Masonry, >75 mm thick* Masonry, <75 mm thick SFS with cement, calcium silicate or magnesium oxide-based sheathing of Class B or better and non-combustible (Class A1/A2) insulation	SFS with sheathing of Class B or better and combustible insulation Timber frame, cross laminated timber (CLT), structural insulated panels (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 No sheathing board present
E.8 Sheathing boards		
Class A1/A2 Cement, calcium silicate or magnesium oxide-based Class B	Other Class B Class C	Class D, Class E, Class F OSB, hardboard or similar
E.9 Insulated core panels		
Combustible insulation, but with panels that either: - are classified to BR 135 [6]; or - met success criteria in alternative large-scale fire testing (e.g. LPS 1181, Part 1 [12] and LPS 1208 [14]) Non-combustible insulation encapsulated in metal	Readily combustible insulation, but fully encapsulated in steel	Readily combustible insulation, but not fully encapsulated Readily combustible insulation, but only encapsulated in aluminium or other low melting point metal

Table E.1 – Fire performance risk factors (*continued*)

Positive	Neutral	Negative
E.10 ETICS		
Thin organic render or inorganic render on Class A1/A2 insulation	Inorganic render on thermoset polymeric foams that form a stable char on fire exposure, e.g. phenolic foams and some PIR foams Thick inorganic render on thermoplastic polymeric foams (e.g. EPS/XPS) Thermoset polymeric foams that do not form a stable char on fire exposure (e.g. PUR) with fire breaks through the full depth of the insulation at each floor level	Any other render system
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 [6] 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 [6] and intrusive inspection has revealed potential installation issues, for example, that could be critical to performance in the particular application.		
E.11 Infill/spandrel panels		
Glazed (excluding vision glazing), with Class A1/A2 core Metal faced, with Class A1/A2 core Thermoset polymeric foams that form a stable under fire exposure (e.g. phenolic and some PIRs) encapsulated with steel	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) Other polymeric foams fully encapsulated with steel	Panels with either combustible facing materials and/or thermoplastic cores not fully encapsulated by steel
NOTE The thickness and sizes of these panels cannot be taken into account here, but these are 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.		
E.12 Internal finishes		
—	—	—
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 taken into account.		

Table E.1 – Fire performance risk factors (*continued*)

Positive	Neutral	Negative
E.13 Balconies		
Balconies constructed entirely of non-combustible construction with an imperforate deck or soffit* Balconies where combustible construction is limited to timber decking and that are protected on the underside by an imperforate non-combustible soffit	Balconies where combustible elements are limited to timber decking at floor level (not protected by an imperforate non-combustible soffit) and the overall width of the timber decking parallel to the face of the building is less than 2 m and the overall depth of the timber decking perpendicular to the face of the building is less than 1 m Balconies constructed entirely of non-combustible construction where decking with gaps is not protected from beneath*	Balconies where timber decking is not protected by an imperforate non-combustible soffit, and the overall width of the timber decking parallel to the face of the building is equal to or greater than 2 m or the overall depth of the timber decking perpendicular to the face of the building is equal to or greater than 1 m Balconies featuring vertical combustible elements (whether balustrades or other elements providing vertical connectivity between balcony decks)
NOTE 1 The manner in which balconies are used can have a significant bearing on the risk they pose. These risk factors are based on an assumption of a typical amount of fuel being present on a balcony (equating to discrete cushions on garden furniture which is otherwise non-combustible, or a single clothes horse of drying clothes) as well as dutyholders monitoring the use of balconies as part of ongoing FRAs. Where balconies are being used inappropriately and controls cannot be imposed, the risk is more negative and needs to be considered as part of the FRA as well as the FRAEW. NOTE 2 Where decking or other components are formed of synthetic materials including composites, the specific fire performance of these needs to be ascertained by the appraiser. NOTE 3 All decking which does not have a soffit beneath will be installed with gaps between boards to allow for drainage and movement/shrinkage; these gaps will provide a route for flames to penetrate the balcony deck.		

Annex F (informative)

Façade configuration 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:

- a) the extent to which the building is covered by combustible cladding;
- b) the presence or otherwise of continuous cavities;
- c) the extent of openings in the external building envelope; and
- d) the location of the external wall construction.

The following principles apply to the contents of Table F.1.

- 1) No single row in Table F.1 gives a definitive answer on risk.
- 2) Whether an entry is considered positive, negative or neutral is purely indicative of the potential influence it might have. A description of the influences is given in item f)2) of the Commentary on Clause 6.
- 3) 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.
- 4) Where numeric values are given in Table F.1, these are intended only to be indicative as to the possible influence the particular factor might have in a risk-based appraisal.

The relevance of the factors in Table F.1 can vary on different elevations or different parts of the same elevation. Consideration needs to be given as to how significant such variations are when appraising the fire risk on the building as a whole. Equally, the factors in Table F.1 are based on the extent to which certain configurations can give rise to fire spread. Where the fire performance of external wall construction has been determined as being positive or low risk, it is unlikely to promote fire spread and accordingly its presence anywhere on a building is not negative; it is neutral at worst.

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

- i) building height might not be important if combustible construction is limited to the lower storeys only;
- ii) 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
- iii) proximity to the 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 F.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.		
F.1 Maximum vertical distance from main access, egress and firefighting access level (s)		
<11 m 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	<18 m 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	18 m to 30 m* >30 m
NOTE These values relate to commonly used trigger heights, but it is important that they are considered, along with all other pertinent factors, in the round. The height thresholds 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.		
F.2 Proximity to external ignition sources		
Combustible construction is more than 5 m from any likely external ignition source NOTE 1 At this distance, the likelihood of a fire originating externally (e.g. in a parked vehicle or waste skip, started either accidentally or deliberately) and igniting the cladding is highly unlikely. NOTE 2 Physical barriers might be a means by which ignition sources are kept away from the external wall, but they can be overcome (e.g. certain physical barriers might block vehicles and skips but not pedestrians).	Combustible construction is 2 m to 5 m from an external ignition source Low hazard construction at any distance from the ignition source 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) and igniting the cladding is possible, but not likely at an early stage in the development of the fire.	Combustible construction is within 2 m of an external ignition source 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) and igniting the cladding is highly likely.

Table F.1 – Façade configuration risk factors (*continued*)

Positive	Neutral	Negative
F.3 Extent of cladding		
Limited in extent and not vertically aligned, such as to delay significantly fire spread to windows and other openings on upper levels	Limited in extent such as to delay fire spread over the external walls and/or limit the number of secondary fires 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)
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 has combustible cladding only on a limited number of lower floors, a fire involving that cladding could impact on fire protection measures, such as smoke control systems, installed to protect the upper floors (see also Annex G).		
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
F.4 Extent of cavities		
No cavity	—	—
Cavity not continuous, due to façade being only partially clad or broken by building features Examples include: - projecting floor slabs that divide part of the wall and isolate sections of cavity from each other; and - walls that project out or are set back, such as to limit the vertical extent of cavities Continuous vertically running cavity with cavity barriers or fire stops as appropriate	Cavity limited in vertical extent, e.g. ventilated rainscreen that spans more than one floor level but not many floor levels Cavity limited in extent and running horizontally only	Continuous vertically running cavity without cavity barriers or fire stops

Table F.1 – Façade configuration risk factors (*continued*)

Positive	Neutral	Negative
Limited or no windows or openings in façade	Openings in façade limited to ventilation outlets	Windows and other openings in line with vertical cavity
F.5 Infill/spandrel panels		
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 can only spread by cascading up panels* Continuous vertical sections but sufficiently remote from windows such that fire and smoke spread into the building, causing secondary fires, is unlikely Isolated areas of panels that do not cross compartment boundaries or cause a fire to cross a compartment boundary	Adjacent to, but not in a vertical continuous line with, windows	In a vertical continuous line with windows such as to increase the likelihood of secondary fires Spanning a compartment boundary and in particular a compartment floor
NOTE 1 These factors relate 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. NOTE 2 This 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.		

Table F.1 – Façade configuration risk factors (*continued*)

Positive	Neutral	Negative
F.6 Setbacks		
Combustible cladding is set back from the wall edge, such that direct flame impingement on the cladding from a fire on a lower level is highly unlikely (An example would be a penthouse flat constructed on the roof of an existing building) NOTE 1 This depends upon the distance from the wall edge, the nature of the construction of the external wall below the setback 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 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. 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.	—	—

Table F.1 – Façade configuration risk factors (*continued*)

Positive	Neutral	Negative
F.7 Overhangs and projections		
Projecting floor slabs that divide combustible cladding such as to divert flames away from the walls and protect the cladding above or slow the speed of fire spread	Minor projections/overhangs that are expected to only have a limited impact on flame propagation across the façade	Fire spread under an overhang could give rise to extended flame lengths over the soffit and up the external wall beyond NOTE This depends upon the size of the overhang and the distance for flames to spread before reaching the wall edge. It can occur whatever the construction of the overhang, but is exacerbated where this construction is combustible.
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. NOTE 2 Balconies are distinct from projections and are addressed at F.13. NOTE 3 The potential beneficial contribution of projections in terms of dividing cavities is referred to earlier in this table at F.4. NOTE 4 Depending on the external wall construction that exists above an overhang, it might be necessary to consider the impact of burning droplets and pooling of burning material beneath the overhang, particularly if the overhang occurs above a means of escape or firefighting access route.		
F.8 Re-entrant corners		
—	Re-entrant corners are present but do not span more than two storeys Re-entrant corners are present but all of the external wall construction that 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)

Table F.1 – Façade configuration risk factors (*continued*)

Positive	Neutral	Negative
F.9 Dual aspect flats		
—	—	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
NOTE It is possible that flats might have more than two aspects; where this is the case, the potential implications for multiple elevations becoming involved in fire need to be considered.		
F.10 Proximity to windows and other openings to the accommodation		
Remote from windows and openings, such that fire and smoke spread into the building, causing secondary fires, is not possible (Typically, this occurs when a façade has no openings for windows and other unprotected openings; see F.11.)	Horizontally adjacent to windows and openings, but not vertically in line with such openings, such that fire and smoke spread into the buildings causing secondary fires, as a result of direct flame impingement, is possible, but only under adverse wind conditions Horizontally adjacent to windows and openings, and vertically in line with such openings, but the fire performance is such that the external walls are not expected to propagate fire spread (i.e. fire performance is positive)	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

Table F.1 – Façade configuration risk factors (*continued*)

Positive	Neutral	Negative
F.11 Presence of vents or other openings for services in the façade		
Where vents pass through a cavity, either: - they are protected by cavity barriers (including ADB “deemed to satisfy” alternatives); or - the cavity is not a medium for fire spread between compartments (e.g. because it has adequate cavity barriers on compartment lines or does not connect multiple compartments)	Where vents pass through a cavity, either: - the cavity does not include combustible materials; or - the cavity is faced on either side by brick or concrete at least 75 mm thick and any combustible insulation in the cavity is not thermoplastic	Any other circumstances where vents pass through a cavity
Vents pass through solid construction that is either: - non-combustible; or - fire-resisting, such that a fire involving the vent would not be able to ignite combustible materials making up the external wall construction (if present)	Vents pass through solid construction that is Class B or Class C	Vents pass through solid construction that is Class D, Class E or Class F
F.12 Proximity of combustible elements of a façade to escape route windows and other openings		
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) Remote from windows and openings, such that fire spread into the escape routes to give rise to untenable conditions is unlikely (Typically, when a façade has openings onto escape routes, but these are sufficiently separated by construction that would not support combustion)	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)	Adjacent to windows and openings, such that fire and smoke spread into the escape routes to give rise to untenable conditions is likely (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) Above doorways forming final exits from escape routes, such that burning material or debris from a fire involving the external walls above poses a danger to escaping occupants NOTE In this situation, burning material and debris from the fire above can also pose a danger to firefighters entering or leaving the building.

Table F.1 – Façade configuration risk factors (*continued*)

Positive	Neutral	Negative
F.13 Attachments		
[Covers: • a balcony attached to an external wall; • a device for reducing heat gain within a building by deflecting sunlight, which is attached to an external wall (brise soleil); • a solar panel attached to an external wall; • any other attachment that could present a fire risk] <i>NOTE A balcony approach to flats could potentially be treated as an attachment if it is combustible, but other constraints regarding construction and combustibility apply where the balcony is part of 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>		
Balconies with positive fire performance (Where these extend along a façade, they have the potential both to: • interrupt a cavity; and • deflect flames away from the building and away from the façade)	Balconies with neutral fire performance across any number of storeys Balconies with negative fire performance but no more than two storeys stacked, or within reach of the local fire and rescue service (see Annex D)	Balconies with negative fire performance, stacked over three or more storeys and not within reach of the local fire and rescue service (see Annex D) Balconies with neutral or negative fire performance, with aggravating features (for example, adjacent to timber or other combustible wall panelling) Combustible features such as brise soleil incorporating combustible material Photovoltaic (PV) installations, especially if incorporating combustible elements <i>NOTE PV installations present an ignition hazard as well as a potential fire load.</i>

Table F.1 – Façade configuration risk factors (*continued*)

Positive	Neutral	Negative
F.14 Proximity of combustible elements of a façade to a neighbouring building		
—	—	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 NOTE <i>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>

Annex G (informative)

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

Table G.1 gives a non-exhaustive list of examples of common factors influencing:

- a) the ability of occupants to escape once fire occurs and spreads via the external wall construction to other parts of the building; and
- b) the ability of the fire and rescue service to intervene effectively.

The following principles apply to the contents of Table G.1.

- 1) No single row in Table G.1 gives a definitive answer on risk.
- 2) Whether an entry is considered positive, negative or neutral is purely indicative of the potential influence it might have. A description of the influences is given in item f)3) of the Commentary on Clause 6.
- 3) 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.
- 4) Where numeric values are given in Table G.1, these are intended only to be indicative as to the possible influence the particular factor might have in a risk-based appraisal.

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 G.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.		
G.1 Occupancy		
—	General housing NOTE 1 <i>In general housing, occupants are expected to represent a cross-section of the general population, and there might well be occupants with disabilities that slow down their own evacuation but do not prevent it. Such a population remains a neutral risk factor unless people requiring assistance to escape in a fire become predominant.</i> NOTE 2 <i>There might be occupants with disabilities in the general population who identify themselves as being unable to self-evacuate, but this risk factor remains neutral where there are adequate measures in place for all occupants to evacuate if they need or choose to do so (e.g. PEEPs for those who require them, places of relative safety and a credible means of assistance for those who might require assisted evacuation, firefighting lifts suitable for use in evacuation or dedicated evacuation lifts).</i>	Specialized housing: • sheltered/retirement; • extra care; and • supported NOTE 1 <i>These housing types are indicative; terminology applying to specialized housing varies. See also BS 9991 and NFCC publication Fire safety in specialised housing – Guidance [15].</i> Other accommodation in which there are long evacuation times NOTE 2 <i>This refers to accommodation that is predominantly occupied by people who are likely to require assistance to escape in a fire. It does not apply to general housing or student accommodation, in which there is likely to be at least a proportion of such people but not a predominance.</i>
NOTE <i>This relates to the predominant occupant type within the building, recognizing that the occupancy might be mixed.</i>		

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

Positive	Neutral	Negative
G.2 Evacuation strategy		
Immediate, total evacuation (or with simultaneous evacuation and a suitable investigation time) NOTE 1 For example, this could 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 is expected to confirm that this is the case. Phased evacuation NOTE 2 Phased evacuation could be positive or neutral depending on the extent of the phased evacuation protocol and how it is managed (e.g. in student accommodation).	Stay put Phased evacuation (see Note) NOTE Phased evacuation could be positive or neutral depending on the extent of the phased evacuation protocol and how it is managed (e.g. in student accommodation).	—
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, this needs to be recorded in the FRAEW report (see 15.7 and 15.8). Depending on the circumstances, it might be prudent for 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 to be recorded in the FRAEW report. Alternatively, the FRAEW might be updated when normal operation resumes.		

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

Positive	Neutral	Negative
G.3 Escape route design		
Access to more than one staircase for escape, where it is not possible for the same fire to affect all escape routes* Access to more than one staircase for escape, but see Note 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.	Single staircase, with lobby approach Extended travel distances ≤ 15 m (with supporting smoke control) NOTE Although generally this is considered as neutral, as with all risk factors, whether it is appropriate needs to be considered in the context of the actual building under consideration.	Single staircase for escape, with staircase rather than lobby approach Extended travel distances ≤ 15 m (without supporting smoke control) Extended travel distances > 15 m (with or without supporting smoke control) Open balcony approach to flats, where it could be compromised by fire involving the external wall construction NOTE 1 An open balcony approach is permitted for blocks of flats under building regulations, and it is not implied that such an arrangement is unsatisfactory. Open balcony approach to flats, with aggravating features such as combustible decking 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 NOTE 2 In this situation, burning material and debris from the fire above can also pose a danger to firefighters entering or leaving the building.
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.		

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

Positive	Neutral	Negative
G.4 Compartmentation		
—	Adequate compartmentation in line with the expectations for a block of flats <i>NOTE Minor issues in compartmentation are normally discovered as part of the fire risk assessment process (e.g. minor defects arising from modifications to buildings or wear and tear to fire-resisting doors). Where these occur, the most proportionate approach is invariably to address these issues rather than treating them as a permanent feature of a building to be incorporated into the FRAEW. Such minor issues, and the need to address them, falls within normal management of fire compartmentation and can be treated as a neutral risk for the purpose of the external walls.</i>	Inadequacies in compartmentation, e.g. between flats, that have not been addressed by other compensatory measures, or those compensatory measures can be overwhelmed by external fire spread <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>
G.5 Smoke control		
—	—	Arrangements in which openable windows, AOVs or inlets and outlets of mechanical systems are in close proximity to combustible cladding or otherwise exposed to fire and smoke spread from the external envelope that could compromise the effectiveness of the smoke control system or allow a route for fire to spread back into the building
<i>NOTE Whether smoke control arrangements are positive or negative depends upon the context. For example, vents passing through external wall construction which, given its fire performance and façade configuration, could become involved in fire, create a risk of the smoke control system significantly worsening conditions in the means of escape in the event of fire. Where due to the remoteness of the vents or their being positioned through low risk wall construction, 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 can 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 be considerably less prone to being affected by an external wall fire than, for example, AOVs or other vents on the elevations.</i>		

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

Positive	Neutral	Negative
G.6 Fire detection and fire alarm system		
System with automatic detection throughout the building (including within flats) capable of initiating immediate full evacuation, configured as: • common area coverage, also with detectors at least inside flat entrance halls (local warning within flat from domestic smoke/heat alarms); or • common areas and throughout flats provided this is compatible with the evacuation strategy*; or • monitored by staff on a 24 h basis or by an alarm receiving centre (ARC)*	Domestic smoke and heat alarms within flats, Category LD1* Domestic smoke and heat alarms within flats, Category LD2 or LD3 NOTE 1 LD1, LD2 and LD3 are categories of fire detection and fire alarm systems in domestic premises defined in BS 5839-6:2019+A1 ADB [1] 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 5839-6:2019+A1. 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. Evacuation alert system for use by the fire and rescue service NOTE 2 These systems are provided to enable the fire and rescue service manually to evacuate a building operating a stay put strategy. Such systems include those conforming to BS 8629, or a fire detection and fire alarm system conforming to BS 5839-1 (or BS 5839-6:2019+A1, 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 over-reliance on the fire and rescue service. This can be a positive risk factor if present in conjunction with a fire detection and fire alarm system monitored at an ARC.	—

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

Positive	Neutral	Negative
G.7 Fire suppression		
Sprinkler system throughout building, conforming to BS EN 12845* Domestic sprinkler/watermist system in each flat: - conforming to BS 9251 for sprinklers; or - conforming to BS 8458 (withdrawn) or BS EN 14972-17 for watermist	Local protection within flats, e.g. cooker hood protection or other partial protection system No sprinklers, but their absence is in accordance with guidance relevant to the design and construction of the building in question	—
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.		
G.8 Firefighting facilities		
Ample access for firefighting vehicles NOTE This is where access exceeds benchmark guidance on access for firefighting vehicles, taking into account the size of the building (floor area), height of the building and whether fire mains are present in the building. This might be the case where access is possible to all elevations of the building.	Adequate access for firefighting vehicles NOTE This is where access is possible in line with benchmark guidance on access for firefighting vehicles, taking into account the size of the building (floor area), height of the building and whether fire mains are present in the building.	Inadequate access for firefighting vehicles NOTE This could include where access is severely restricted or there is no access directly adjacent to the building, or where there is no access for high-reach appliances.
NOTE 1 Access for firefighting vehicles is only one aspect relevant to effective fire and rescue service intervention. Annex D gives broader consideration to fire and rescue service intervention and the limitations that can apply to achieving this. NOTE 2 A source of benchmark guidance that could be used is ADB [1], but advice might need to be taken from the fire and rescue service. 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 D).		

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

Positive	Neutral	Negative
G.9 Fire mains		
—	Suitable fire main present 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. NOTE 2 “Suitable” refers to a main meeting current standards. It is recognized that the standard of fire main present depends 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.	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 D 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 G.1 – Risk factors arising from fire strategy/fire hazards (including limitations of fire and rescue service intervention) (*continued*)

Positive	Neutral	Negative
G.10 Lifts for use by firefighters		
—	Suitable lift for use by firefighters present <i>NOTE While lifts for use by firefighters 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>	Absence of lift for use by firefighters in buildings above 18 m
NOTE 1 Lifts for use by firefighters are only one aspect relevant to effective fire and rescue service intervention. Annex D 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 lifts for use by firefighters 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 can 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 G.1 – Risk factors arising from fire strategy/fire hazards (including limitations of fire and rescue service intervention) (*continued*)

Positive	Neutral	Negative
G.11 Specific fire hazards		
—	Vehicle parking on roadways adjacent to building	Vehicle parking under overhangs Open-sided car parking directly underneath the accommodation
—	—	Balconies that have combustible elements, and that are of such a size that it is foreseeable they will be used for significant items of furniture, for holding storage or waste, or for inherently hazardous activities such as holding barbecues Outbuildings of combustible construction, such as sheds, motorized buggy charging rooms or storage buildings, in close proximity (e.g. <2 m) to the external walls Permanent refuse storage in close proximity to the external walls Buildings or spaces containing relevant persons who, given their proximity to the building being appraised, might be exposed to the effect of an external wall fire given the fire performance and façade configuration

NOTE 1 The items set out here are just examples; appraisers are expected to identify and review any potential additional hazards in and around the building being appraised that might be relevant to external fires.

NOTE 2 It is expected that 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, will be factored into the FRAEW. Further guidance on fire performance considerations is given in Annex P.

NOTE 3 Hazards that can arise in day-to-day activities (e.g. the placing of a waste skip close to a building) are matters for ongoing control by the building's management and is 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 H (informative)

Hazard contextualization

H.1 General

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

H.2 Methodology

H.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, speed and extent of fire spread specific to each system; and
- b) location and coverage: location on a building and extent of coverage of a system, including:
 - 1) continuity with other systems: whether fire spread via one system can lead to fire spread over another;
 - 2) likelihood of ignition: whether there are credible ignition sources adjacent to the construction;
 - 3) likelihood of fire spread: how far and over what parts of the building fire could spread via the construction in question; and
 - 4) 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 (e.g. 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 (e.g. rainscreen infill panels within a brick cavity wall).

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

H.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 can exist in isolation or in combination and typically comprise:

- a) unprotected routes for fire spread between flats and other compartments via external walls (e.g. poorly installed structural framing systems);
- 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 located only on an elevation with no window or vent openings through which fire could spread from outside to inside).
- 2) Encapsulation (see H.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 H.3.2): there are no cavities and the hazard of fire spread via materials and surfaces is adequately low.
 - 4) Compartmentation continuation (see H.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 H.3.4): the combustibility of materials is such that they would not be a medium for fire spread.
 - 6) Subdivision (see H.3.5): combustible materials and/or cavities are subdivided by construction that adequately resists fire spread.

H.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 of the system.
- 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.

H.2.4 Documentation

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

H.3 Hazard mitigation

H.3.1 Encapsulation

H.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).

H.3.1.2 Total encapsulation

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

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

H.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 [1] 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.

H.3.1.4 Assessing adequacy

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

Table H.1 – Typical indicators of level of encapsulation

Level of encapsulation	Equivalence	Direct risk assessment
Total encapsulation	Fire resistance of encapsulation is equal to fire resistance of internal compartmentation	Risk of flame penetration to combustible materials or the cavity is expected to be very low
Partial encapsulation	Fire resistance of encapsulation is equivalent to Diagram 8.2 in ADB Volume 1:2019 [1], 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.

H.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.

H.3.1.6 Uncertainty

Areas of uncertainty for existing constructions are likely to include:

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

H.3.1.7 Deficiencies

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

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

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

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

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

H.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.

H.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 H.2.

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

Reaction to fire class in accordance with BS EN 13501-1	Characteristic behaviour	Acceptability
a) Class A1 and Class A2 b) Class B where all constituent materials each achieve Class B without fire retardants c) Class C charring thermosetting insulations	Heat of combustion is sufficiently low that fire spread is likely to require an external heat source; as such, fire spread is likely to be limited to the vicinity of any heat source (e.g. external flaming)	Acceptable regardless of location and extent of coverage
Class B only when any composite components (e.g. CP board) retain the characteristics of the composite component under fire	Whether the composite product adequately resists fire spread depends on whether it remains composite under real building fire exposure	Acceptable regardless of location and extent of coverage provided that the product remains composite under credible worst-case fire exposure
Class B due to use of fire retardants (e.g. fire-retardant treated HPL)	Whether the composite product adequately resists fire spread depends on whether the fire retardant is effective under real building fire exposure	Acceptable regardless of location and extent of coverage provided that fire retardant remains effective under credible worst-case fire exposure
Class C and Class D	Self-sustaining fire spread (i.e. no external heat source required for continued burning) is likely, but the speed 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 speed 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 H.3.

Table H.3 – Relevance of heat of combustion by mass in the absence of a cavity^{A)}

Heat of combustion ^{B)}	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 speed 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 speed of fire spread is likely to be fast	Only acceptable where location and extent of coverage is such that the likelihood of ignition and/or consequences of fire spread are sufficiently low
^{A)} Heats of combustion might be provided in product literature, but typical examples can also be obtained from texts such as PD 7974-1 and the University of Queensland database (https://claddingmaterialslibrary.com/). ^{B)} 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 speed 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 H.4.

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

Heat of combustion ^{A)}	Characteristic behaviour	Acceptability
<4 MJ/m ²	Heat produced per unit area is sufficiently low that the consequences of fire spread are likely to be low	Acceptable regardless of location and extent of coverage
2 MJ/m ² to 10 MJ/m ²	Heat produced per unit area might be sufficiently low that fire spread is not likely to be a risk to health or safety	Acceptable unless located such as to create a risk beyond flats (e.g. adjacent to common escape routes)
>8 MJ/m ²	Heat produced per unit area is sufficiently likely to be a risk to health and safety to require detailed assessment	Only acceptable as part of detailed assessment
^{A)} There is deliberate overlap in the heat of combustion values between categories to avoid a “binary” risk classification process.		

H.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, being able 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.

H.3.2.4 Uncertainty

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

H.3.3 Compartmentation continuation

H.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 as the internal compartmentation);
- 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 is 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).

H.3.3.2 Assessing adequacy

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

Table H.5 – Compartmentation continuation assessment

Element of construction	Equivalence	Direct risk assessment
Fire barriers	Fire resistance of fire barriers is equal to fire resistance of internal compartmentation	Fire resistance of fire barriers has to be sufficient to adequately resist fire spread
Outermost cladding component	Outermost cladding component cannot be readily combustible and needs to provide adequate resistance to fire spread around the fire barriers	Outermost cladding component has to provide a barrier against which the fire barriers can close and has to remain intact during fire for a sufficient time and not be a medium for fire spread around the fire barriers

H.3.3.3 Competence

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

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

H.3.3.4 Uncertainty

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

H.3.3.5 Deficiencies

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

H.3.4 Limiting combustibility

H.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 often referred to as the “linear route”.

H.3.4.2 Assessing adequacy

Assessment of adequacy of limiting combustibility involves 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.

H.3.4.3 Competence

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

- a) material combustibility: being able to assess 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: being able to assess whether the cladding presents any significant risk for fire spread.

H.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.

H.3.4.5 Deficiencies

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

H.3.5 Subdivision

H.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 external wall construction into sufficiently small sections by fire-resisting construction.

H.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.

H.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: being able to assess whether combustible materials will ignite and, if so, the resulting rate and extent of burning;
- b) fire dynamics: understanding the 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: being able to assess changes in thermodynamic response of materials/products with respect to time and temperature; and
- d) thermomechanical material/product response: being able to assess changes in mechanical response of materials/products with respect to time and temperature.

H.3.5.4 Uncertainty

Areas of uncertainty for existing constructions are likely to include:

- a) adequately determining the 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 of different components to resisting fire and smoke spread.

H.3.5.5 Deficiencies

Typical deficiencies that might need to be taken into account 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.

H.4 Mitigation of risk

H.4.1 Principles

The conventional means of mitigating risk is 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 where 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, as commented upon in the HSE publication *Reducing risks, protecting people* [16] (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 a tolerable level by reducing the probability of fire spread to the external wall construction.

In this context, consequences are the function 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.

Where mitigation involves ongoing action or the use of active systems that incur ongoing costs and require ongoing maintenance, the cost of these over the life of the building (or, for example, until such time that the external wall construction might reach the end of its life and need replacement in any event) needs to be compared against the cost of remediation.

For example, risk can be evaluated using Table H.6, which provides example circumstances and the impact they have on risk factor for a rainscreen type system; these fall within the subdivision approach to risk mitigation (see H.3.5).

Table H.6 – Subdivision risk evaluation

Number of people at risk from hazard	Severity of hazard	Speed of exposure	Factor
Many	Combustible cladding panels and insulation	No fire barriers or significant deficiencies in fire barriers	High
—	Combustible cladding panels or insulation	Fire barriers at floors only and deficiencies are minor	Medium
Few	Limited combustibility	Fire barriers at floors and walls and deficiencies are minor	Low

H.4.2 Practical application of principles

H.4.2.1 Probability reduction

Certain measures reduce the risk of fires involving the external walls but have no bearing on the speed or extent of fire spread should this occur. For 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.

H.4.2.2 Consequence reduction

H.4.2.2.1 General

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

Table H.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

H.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.

H.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 involves 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.

H.4.2.2.4 Filling cavities

Filling cavities (e.g. by pumping in non-combustible insulation) can reduce the likelihood and/or speed 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 involves 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.

H.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 involves 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.

H.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.

H.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.

H.4.2.2.8 Fire and rescue service intervention

Where the speed 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 D).

H.4.2.2.9 Firefighting shafts

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 appraised.

H.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 I (informative)

Use of BS 8414 and BR 135

I.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 [6] classification or BS 9414 assessment) that are most relevant when appraising risk.

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 subject 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 [6] 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 [6] 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 H.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.

I.2 Interpreting BR 135 classifications

I.2.1 Performance criteria

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

1.2.2 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 [6]. While the BR 135 [6] 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.
- c) While 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.
- d) Mechanical performance, in particular falling debris, might be significant, but this depends on both the extent to which the system needs to become involved in fire to produce such debris, and the extent to and speed at which fire is expected to spread across the system. If the issue of mechanical performance is found to be relevant for a system, then the significance of this needs to be considered in terms of where the system is located relative to means of escape and firefighting access.

Therefore, when using BS 8414 test data to appraise 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 [6] performance criteria (data from systems which failed to meet BR 135 [6] criteria can also be used to inform an appraisal of risk).

1.2.3 Field of application

BR 135 [6] classification reports include a field of application. The main purpose of the field of application is in respect of system certification and compliance; it does not necessarily relate to system performance in a real fire. That is to say, while 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.

I.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 new buildings; it is not intended for the purpose of defining the limits of application of the results of a tested system for appraising 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 [6] 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.

I.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 (e.g. 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 [6] 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 [6] performance criteria if it were to be tested in accordance with BS 8414.

I.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 I.1 shows some combinations of critical success factors that are likely (but not guaranteed) to result in adequate resistance to fire spread.

Table I.1 – Typical examples of critical success factors

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

Annex J (informative)

Tools for more detailed analysis

J.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 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 E, Annex F and Annex G).

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 examples of tools that can be used to undertake a more detailed analysis.

J.2 Overarching principles

It is not necessary nor practicable 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 speed of fire spread between compartments (or flats) would be sufficiently low that:
 - 1) the probability of multiple secondary fires occurring simultaneously is also low; and
 - 2) there would be sufficient time for the fire and rescue service to manage the incident (in terms of both managing evacuation and preventing or controlling further fire spread);
- c) fire spread over the walls of the building would 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 would be sufficiently limited as to limit the probability of fire spread to any adjacent buildings.

NOTE The risk of spread of fire arising from space separation between buildings is outwith the scope of this PAS.

J.3 Fire performance

J.3.1 Principles

The fire performance is a measure of the potential:

- a) speed at which fire or smoke could spread via the system;
- b) extent to which fire or smoke could spread via the system; and
- c) total heat released as a result of fire spread via the system.

Tools used for more detailed analysis can provide additional information and inform conclusions on each of these factors.

J.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 speed 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 (e.g. comparing key features of the external wall in question to a known performance of a similar external wall system).

Regardless, any tool needs to be capable of treating the thermodynamic and thermomechanical performance of external wall systems as an assembly. In so doing, issues that might need to be taken into account 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 a detailed understanding both of the test methods and of the outputs and classifications (see Annex I and Annex L).
- b) Ad hoc fire tests: these 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: any material degradation, such as loss of strength and stiffness, delamination, spalling and 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.

J.3.3 Fire testing

While it is not generally expected that FRAEWs will require testing to be undertaken, there will be instances where it is the only means by which risk can be quantified (e.g. if a particularly novel material or system is encountered for which there are no existing fire performance data). Further information on testing is provided in Annex L, while the specific interpretation of data from BS 8414 tests and BR 135 [6] classification is addressed in Annex I.

J.4 Façade configuration

J.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 fire spread via the external walls to result in fire spread from one part of a building to another.

Tools used for more detailed analysis can provide additional information and inform conclusions on each of these factors.

J.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.

J.5 Fire strategy factors

J.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 firefighting operations.

Tools used for more detailed analysis can provide additional information and inform conclusions 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.

J.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.

J.6 Balconies

Balconies can have significant impacts on the likelihood of fire spreading across the exterior of a building, whether via the external walls or the balconies themselves. They might also impact the building's fire strategy, particularly where they are the means of access to and/or escape from flats.

Where a balcony's contribution to fire performance is not obviously positive or negative (see item **E.13** within Table E.1 for examples), it might be necessary to conduct detailed analysis of the likelihood of fire spread via the balconies.

Such analysis needs to recognize and evaluate in isolation the two different conditions under which balcony-to-balcony fire spread can occur:

- a) within reach of a fire plume emitting from a compartment fire [so that heat flux is a combination of heat flux from the compartment fire and the balcony fire(s) at the compartment fire level and within reach of the plume]; and
- b) beyond the reach of a fire plume emitting from a compartment fire (so that heat flux is limited to what a balcony fire alone can generate).

Being horizontal projections, balconies can be in the path of the rising plume of flame and hot gases that emit from fires. Any combustible material, whether forming part of the balcony construction or the materials placed on the balconies, can be assumed to ignite when:

- 1) these materials are not protected by an imperforate non-combustible soffit or deck; and
- 2) the balcony is less than 5 m above the origin of a plume from a fully involved compartment fire.

Beyond this distance, whether or not balconies contribute towards continuing external fire spread depends upon:

- i) the combined fuel load of combustible balcony construction and combustible materials placed on the balconies (impacting the heat output);
- ii) the size of the balconies (impacting the maximum size of the radiant surface emitting heat upwards); and
- iii) the distance between balconies (impacting the “view factor” from one balcony to the next).

The analysis needs to determine whether, given these variables, there is a significant probability of balcony-to-balcony fire spread occurring at distance from a compartment fire source.

Further information on a potential analytical approach can be found online⁷⁾.

⁷⁾ Available at https://www.researchgate.net/publication/410844154_Fire_spread_between_balconies_with_exposed_timber_decks_for_the_fire_risk_appraisal_of_external_walls.

Annex K (informative)

Case studies with working examples illustrating the use of the methodology

K.1 General

The case studies in this annex are based on the real-life experiences of the authors, but are ultimately fictitious and are intended solely 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.

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

K.2.1 Background

An FRAEW of a mixed-use building with residential accommodation 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 [3].

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

K.2.2 External wall construction

Details of the manufacturer and the ACM product were stamped on the back of the panels removed for testing and it was a product referred to as an "FR" version within its range. The cladding formed side and head panels to large expanses of window glazing, which meant the panels were rarely wider than 1 m.

Some timber panelling was also present on the upright sections between windows, and timber decking was used on the roof terraces.

The external walls of the offices below comprised brick and, from the age of the building (1950s), it was expected that the walls were 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).

K.2.3 Findings from investigations

Given the lack of information on the wall build-up 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. In addition, 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.

K.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 following.

- a) 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.
- b) As the flats were side by side, there was no scope for vertical fire spread from one flat to another.
- c) 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.
- d) 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 could further 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.
- e) 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.

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

Given that 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/fire hazard factors; a person completing the FRAEW could simply have proceeded to prepare a report. However, given the “what-if” scenarios set out in K.2.7, the fire strategy factors/fire hazard have also been considered here.

There were a number of positive risk factors arising from consideration of the fire strategy/fire hazards. Of particular note were the following.

- a) Both flats had access from the roof terrace 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.
- b) 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.

K.2.6 Outcome of the analysis of the risk and possible remedial action

Based on the low risk rating, it was concluded that, under the circumstances:

- a) 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;
- b) 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;
- c) 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
- d) there appeared to be no scope for the communal means of escape to be compromised by an external fire before occupants could safely use them to escape.

The risk outcome was therefore also “low” and, accordingly, no remedial action was considered necessary.

K.2.7 What if? – how would the risk outcome be affected by differences in the wall build-up or risk factors

Differences in the wall build-up or risk factors would affect the risk outcome 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 rating. 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 would still be considered, given 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, and therefore the risk outcome 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 rating being no higher than as set out above. Provided that 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, given the limited cost involved, 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 the risk rating would remain between low and medium. Provided that it was possible to access the external walls of the flats without the use of 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 and outcome.

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

K.3.1 Background

An FRAEW of an eight-storey building, measuring approximately 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 prerequisite 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 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 each 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.

K.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 CP 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" risk outcome owing to the possibility of both rapid and extensive fire spread. The façade configuration risk factors would not provide mitigation (see K.3.5) and while the fire strategy risk factors would provide some mitigation, the risk rating and outcome would be assumed as being no worse than "medium".

K.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 necessary to determine, in particular:

- a) whether the drawings were essentially accurate (notwithstanding the vague material information);
- b) the nature of the polymeric insulation;
- c) the presence or otherwise of cavity barriers at key locations, such as at floor levels and around window and other openings; and
- d) 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.

- 1) 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.
- 2) 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.
- 3) Insulation within the SFS was also polymeric, but of unknown type, and was lined internally with two layers of 12.5 mm plasterboard.
- 4) The sheathing board was suitably fixed with close fitting joints and in good condition.
- 5) Effective cavity barriers were in place, at locations where they would be expected, and were suitably fixed and in good condition.
- 6) The brickwork was 100 mm thick and had a full fill of mineral fibre insulation in the cavity behind it.
- 7) There was no continuous cavity between the brick walls and the rainscreen cladding system; the soffit was concrete.

K.3.4 Fire performance risk factors

The following notable positive and neutral risk factors were established during the FRAEW.

- a) The cladding panels comprised a low melting point metal and were mechanically fixed on a low melting point metal support system.
- b) The manufacturer of the panels published evidence of it achieving a Class A2 rating in relation to the European classification for reaction to fire.
- c) The panels were flat, and gaps that were present between panels were less than 10 mm.
- d) 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 [6]. The manufacturer of the insulation had published details of a combination of aluminium with its insulation product, which had been classified to BR 135 [6] for a similar build-up, although not an exact match.
- e) The facing of the insulation was fully protected by a foil covering, in line with the manufacturer's recommendations.
- f) Cavity barriers appeared to be present, fully in line with expectations for a block of flats of this age.
- g) 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 had, 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 speed of fire spread and the temperatures reached met the criteria in BR 135 [6].

The above was sufficient for the risk rating, based on fire performance factors alone, to be placed in the medium risk 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 outcome band given a minor risk of fire spread exceeding benchmark expectations.

To fully conclude this, the person conducting the FRAEW considered that further and more detailed investigation into the quality of construction was 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.

K.3.5 Façade configuration risk factors

The FRAEW 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 following.

- a) The cladding started at a height that reduced the scope for ignition by external fires.
- b) There was no scope for fire spread into the ground floor wall cavity to then spread, via that cavity, into the metal cladding system.
- c) Ventilation systems in the flats did not include ductwork penetrating the cladding system.
- d) 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.

K.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.

- a) 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.
- b) 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.
- c) 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 was expected that most firefighting operations would be carried out internally.

Overall, these factors were sufficient to reposition the risk rating and therefore the risk outcome into the “low” band, without any further consideration of, or investigation into, the fire performance of the external wall construction and cladding.

K.3.7 Outcome of the analysis of the risk and possible remedial action

Based on the “low” risk outcome, it was concluded that unduly rapid external fire spread was not anticipated, but, in any case:

- a) it was unlikely that occupants would be unduly harmed from secondary fires before escaping or prevented from escaping; and
- b) 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.

K.3.8 What if? – how would the risk outcome be affected by differences in the wall build-up or risk factors

Differences in the wall build-up or risk factors would affect the risk outcome 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 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; some such panels can fail relatively early in a 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 K.3.4), to the low risk band, unless this coincided with the system becoming very similar to a system classified to BR 135 [6]. It would therefore remain necessary to consider façade configuration factors and, given the impact of these on this building, fire strategy factors.

- 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 HRR?

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 rating into the lower end of the medium risk band. While this scenario gives rise to a risk of significant fire spread, the building already supporting simultaneous evacuation would mean 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 so was disproportionate. Further analysis in accordance with Clause 13 could be conducted, 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 the 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 outcome 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 are 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 that is the key mitigator of risk in this building. 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.

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

K.4.1 Background

An FRAEW of a 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, was 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 provided, in line with guidance at the time of construction. There were no issues with access for firefighting vehicles and access was possible for firefighters around the building.

The block was occupied as general 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.

K.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 that 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. If that were 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 an assumption 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.

K.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.

- a) The zinc panels were supported on timber battens within a rainscreen cavity system.
- b) There was insulation which bore manufacturer's markings clearly identifying it as a PIR foam.
- c) The insulation was fixed to a masonry wall comprising a double skin brick cavity wall, the brick skins each being 100 mm thick.
- d) Cavity barriers were present behind the zinc, as expected, but the condition of a small proportion was poor; some appeared to have moved or fallen away, being held in place only by compression, although this might have been as a result of the opening up works to investigate the cladding.
- e) There was a continuous cavity in the masonry wall all the way up the building.

K.4.4 Fire performance risk factors

A mixture of both positive and negative risk factors was established during the FRAEW, including the following.

- a) The cladding panels comprised a low melting point metal and were mechanically fixed, although onto timber battens.
- b) Gaps were present between panels, but were less than 10 mm.
- c) The PIR insulation was not of a type specifically formulated to improve its behaviour in fire.
- d) A small proportion of cavity barriers were in poor condition.
- e) 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 band, as it was not considered to present the potential for extremely rapid fire spread.

K.4.5 Façade configuration risk factors

The FRAEW noted significant positive risk factors in relation to the configuration of the façade, including the following.

- a) The cladding started at a height that reduced the scope for ignition by external fires.
- b) The building was only 10.5 m high.
- c) The extent to which fire could spread horizontally was also limited and fire could not involve more than half the building.

Balconies 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 at the lower end of the medium risk band. A "tolerable" risk outcome was therefore possible prior to consideration of the fire strategy factors. These needed to be considered to determine whether the risk rating could be moved into the low risk band.

K.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 risk band, this nonetheless reinforced the view that the risk outcome was “tolerable”.

K.4.7 Outcome of the analysis of the risk and possible remedial action

Based on the “tolerable” risk outcome, it was concluded that, under the circumstances:

- a) 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;
- b) it was unlikely that occupants would be unduly harmed from secondary fires before escaping or being prevented from escaping;
- c) it was unlikely that the communal means of escape would be compromised before occupants could safely use them to escape; and
- d) 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 fire 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.

K.4.8 What if? – how would the risk outcome be affected by differences in the wall build-up or risk factors

Differences in the wall build-up or risk factors would affect the risk outcome 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 the risk outcome 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 be introduced would need to be considered, so as to avoid unduly intrusive works to mitigate the risk. It might be acceptable to conduct more limited works to reduce the speed 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 fire performance risk rating being 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 the risk outcome was therefore “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 to include scaffolding the entire building), it might be appropriate to conduct additional work to further reduce risk, provided that it is proportionate to do so (e.g. checking and, as necessary, remediating all cavity barriers given that these will be exposed in any event).

K.5 Case study 4: Seven-storey block of flats with HPL panels and polymeric foam insulation

K.5.1 Background

An FRAEW of a seven-storey building, measuring 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 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.

K.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 that the block was only 4 years old. As-built records suggested that lightweight SFS walls spanned the concrete floors, onto which there was an external wall build-up comprising a 9 mm Class B CP 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 FRAEW they had been commissioned to undertake would 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 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 [6] 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 conduct the site survey and inspection, as planned, to be able to present the fire engineer conducting the detailed analysis with all necessary information.

K.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 from those anticipated, including the following.

- a) 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.
- b) The insulation was 100 mm PUR foam.
- c) The cavity was narrower than anticipated.
- d) 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.

K.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:

- a) unduly rapid external fire spread was highly likely, even despite the full and effective cavity barrier protection in place;
- b) 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;
- c) 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
- d) the speed 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 "high" risk outcome, 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.

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

K.6.1 Background

An FRAEW of a 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 strategy, limiting the need for only those at immediate risk to evacuate initially.

The social housing provider of these rented 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.

K.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 broken in vertical alignment only 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).

K.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, met the criteria within LPS 1181, Part 1 [12] and LPS 1208 [14], 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 conduct 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 fire 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 a need for more detailed analysis of the cladding system in accordance with Clause 13.

K.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 [6], 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 [6]. 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 [6].

Overall, the findings were sufficient for the risk rating to be placed in the high risk band, with a significant potential for rapid fire spread. The potential necessity for a detailed analysis of the cladding system in accordance with Clause 13 by a fire engineer with specialist knowledge was one possible outcome from this.

K.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 placed 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.

K.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 could be 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 accommodation 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 not be reasonable to expect 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.

K.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 necessity for the external wall construction to be addressed in the building's FRA. However, based on the high risk rating for the rendered EPS system, it was concluded that, under the circumstances:

- a) unduly rapid external fire spread was anticipated;
- b) 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
- c) it was possible that the communal means of escape could be compromised before occupants could all safely use them to escape.

Accordingly, the risk outcome was also "high", 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.

K.6.8 What if? – how would the risk outcome be affected by differences in the wall build-up or risk factors

Differences in the wall build-up or risk factors would affect the risk outcome 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 would not be considered sufficient to move the risk rating out of the high risk band.

- b) What if a fire detection and fire alarm system were to be fitted?

While not reducing the likelihood of secondary fires occurring 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 practicability 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 flats, would bring into question whether it was 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 (see 6.8). 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 is 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.

K.7 Case study 6: Ten-storey block of flats which has undergone remediation

K.7.1 Background

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

It was a building with 40 flats, occupied as general 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).

K.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 classified as Class B-s1,d0 in accordance with BS EN 13501-1, and there was no insulation within the SFS construction.

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

K.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.

K.7.4 Fire performance risk factors

The only major component within the external wall construction that 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.

K.7.5 Outcome of the analysis of the risk and possible remedial action

Given the low risk rating and “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 addressed as part of the building’s FRA.

K.7.6 What if? – how would the risk outcome be affected by differences in the wall build-up or risk factors

Differences in the wall build-up or risk factors would affect the risk outcome 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 conforming to Clause 14 to document this, but not a full FRAEW conforming to Clause 15.

Annex L (informative)

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

COMMENTARY ON ANNEX L

This annex provides information concerning laboratory work that is conducted fully in accordance with a relevant standard. Situations where laboratory work is to be carried out on some variation away from a standard, or in an entirely ad hoc way, are addressed in Annex E and Annex J.

This annex contains summary information regarding standard tests. Users commissioning tests are expected to consult the specific standards in their entirety.

Standard testing is, as its name suggests, carried out to a prescribed method. The particular method of each test is related to a particular reference scenario that the test seeks to reproduce, but they also need to be repeatable and reproducible so that different products can be ranked against each other. Accordingly, standard tests are not intended to reproduce the complex range of conditions that could impact any given fire incident. They are also not produced with the intention of creating a direct link from one test to another.

Standard test methods are kept under review and regularly updated, so appraisers are advised to stay informed of research and updates relating to standard testing. Some of the national standards summarized in this annex have been withdrawn, but remain relevant as they might have been relied upon in the design and construction of existing buildings.

L.1 Small-scale reaction to fire tests

COMMENTARY ON L.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 [1], ADB has only recommended European tests, but existing buildings might rely upon national tests.

L.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 L.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 L.2.

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

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

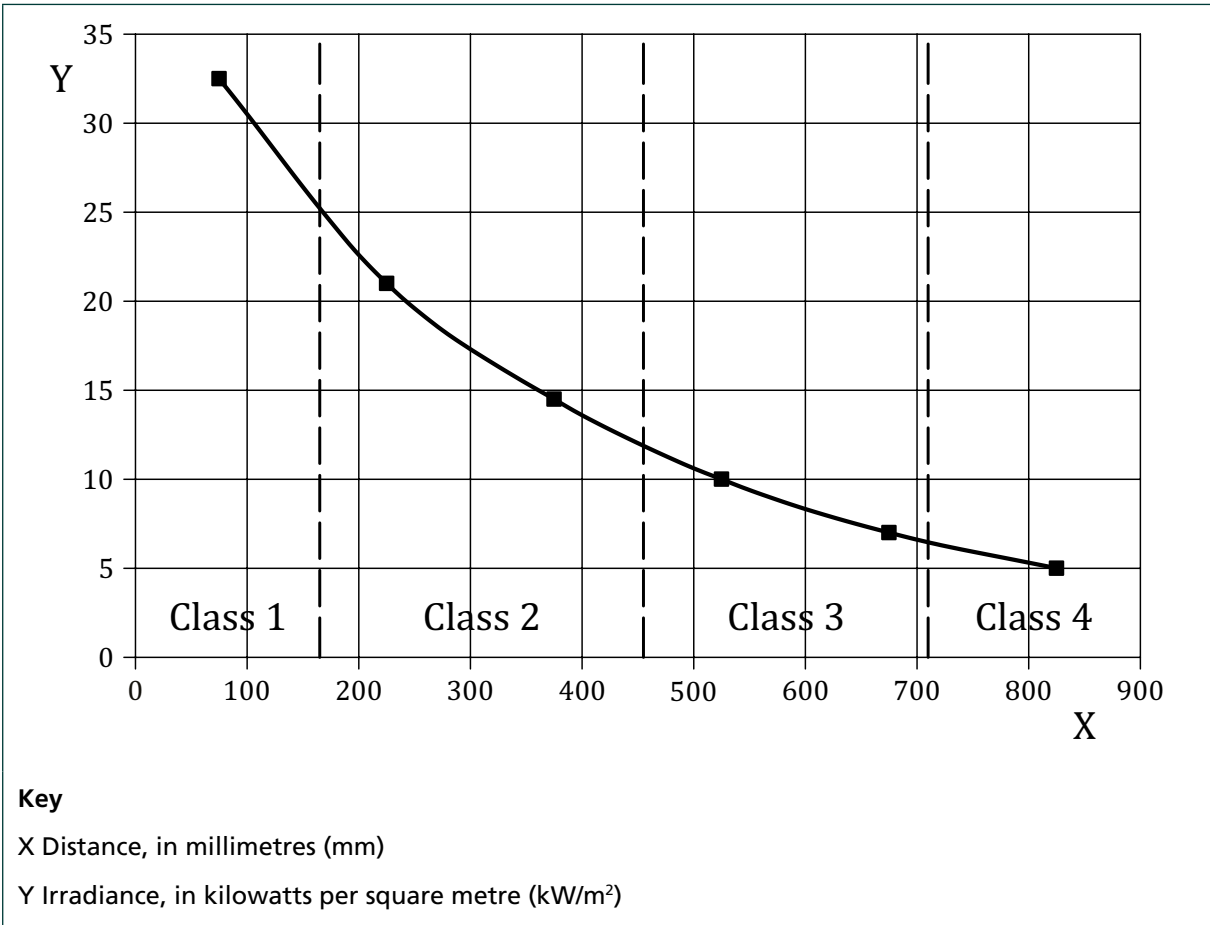


Key

1 Pilot flame

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Figure L.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 L.1 sets out the classification criteria. One specimen in a sample is permitted to exceed the limits by the distances set out in Table L.1 with the sample still being classified to that class.

Table L.1 – Classification of spread of flame

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

Achieving Class 1 can go towards achieving Class 0, although this is not defined within this PAS but within various editions of ADB until publication of the 2019 edition [1].

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. The results of BS 476-7 tests, when applied to external wall construction, therefore need to be treated with caution (see L.1.6).

L.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 that is then mounted onto the front of the furnace, at which time the furnace is cold (see Figure L.3). The furnace is then switched on and the temperature of gases leaving the furnace through a flue at the top is 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 a sub-index (i_1) of 6 or less can go towards achieving Class 0, although this is not defined within this PAS but within various editions of ADB until publication of the 2019 edition [1].

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. The results of a BS 476-6 test, when applied to external wall construction, therefore need to be treated with caution (see L.1.6).

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



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L.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:

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

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 are recorded and any sustained flaming (flames that are continuous for more than 5 s) is also recorded.

The test does not have any classification or pass/fail criteria. Various editions of ADB until publication of the 2019 edition [1] stated that materials subjected to this test can be deemed to be of limited combustibility, provided that they either:

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

ADB also stated in editions up until publication of the 2019 edition [1] that materials subjected to this test can be deemed to be non-combustible provided that they:

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

The BS 476-11 test is intended only for the testing of homogenous materials that 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.

L.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.

BS 476-4 states that materials subjected to this test can be deemed to be non-combustible provided that they:

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

The BS 476-4 test is intended only for the testing of homogenous materials that 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.

L.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 L.4).

The test measures whether:

- a) ignition of the product occurs;
- b) the flaming of the product exceeds 150 mm above the application point;
- c) any flaming droplets or particles are produced that cause ignition of the filter paper; and
- d) 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 (e.g. 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 L.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 used for classification to BS EN 13501-1 (see L.2.2).

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



NOTE 1 The aluminium foil tray beneath the specimen is used to hold the filter paper for establishing d2 subclass (see L.2.2), and the mirror to the right so that the operator can observe flaming to the rear of the specimen.

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L.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, but 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. However, with regard to assemblies, the exposure to flames is on the outer face only and any flame attack to layers behind it is achieved through joints and/or penetration through the outer layer only.

The burner is situated in the corner at the base of the assembly (see Figure L.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 used for classification to BS EN 13501-1 (see L.2.2).

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



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L.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 used for classification to BS EN 13501-1 (see L.2.2).

L.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 L.6). The temperature of the furnace is recorded via thermocouple, and the test is run for up to 1 h.

Figure L.6 – BS EN ISO 1182 test apparatus



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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 used for classification to BS EN 13501-1 (see L.2.2).

L.2 Classification of test results

L.2.1 Class 0

Class 0 was defined within various editions of ADB until publication of the 2019 edition [1]. If a product achieves Class 1 in a BS 476-7 test and an index (I) of 12 and sub-index (i_1) of 6 in a BS 476-6 test, then the product is deemed, according to the preceding editions of ADB and the Building Regulations 1976 [17], 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 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 [18].

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

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

Class 0, and the BS 476-6 and BS 476-7 tests, are all concerned with surfaces. From 2002 until publication of the 2019 edition [1], ADB treated Class 0 and Class B (under BS EN 13501-1) as equally acceptable.

Materials (truly homogenous materials, see 3.1.31) that achieve Class 0 are likely to be comparable to those that achieve Class B under BS EN 13501-1 (first introduced in 2002).

Products that achieve Class 0 can only, and only for the purpose of this PAS, be assumed as being commensurate with Class B if:

- 1) every material component forming the product can independently achieve Class 0; or
- 2) any non-Class 0 material component is fully encapsulated in material components that 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 that might be tested to BS EN 13823) can also reasonably be assumed as achieving Class B if they are formed:

- i) only of materials or products that achieve Class B (save for minor components; see “Sundry items” in Annex O); or
- ii) only of materials or products that can be assumed as achieving Class B in accordance with a) and b) above.

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

BS EN 13501-1 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 L.2.

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

Class	Tests required	Criteria ^{A)}
A1	BS EN ISO 1182	$\Delta T \leq 30\text{ }^{\circ}\text{C}$ $\Delta m \leq 50\%$ $t_f = 0\text{ s}$
	BS EN ISO 1716	PCS $\leq 2.0\text{ MJ/kg}$
A2	BS EN ISO 1182 or BS EN ISO 1716	$\Delta T \leq 50\text{ }^{\circ}\text{C}$ $\Delta m \leq 50\%$ $t_f \leq 20\text{ s}$
	BS EN 13823	No lateral flame spread to edge of specimen FIGRA (= FIGRA _{0.2MJ}) $\leq 120\text{ W/s}$ THR _{600s} $\leq 7.5\text{ MJ}$
B	BS EN 13823	No lateral flame spread to edge of specimen FIGRA (= FIGRA _{0.2MJ}) $\leq 120\text{ W/s}$ THR _{600s} $\leq 7.5\text{ MJ}$
	BS EN ISO 11925-2	30 s flame exposure No flame spread in excess of 150 mm within 60 s
C	BS EN 13823	No lateral flame spread to edge of specimen FIGRA (= FIGRA _{0.4MJ}) $\leq 250\text{ W/s}$ THR _{600s} $\leq 15\text{ MJ}$
	BS EN ISO 11925-2	30 s flame exposure No flame spread in excess of 150 mm within 60 s
D	BS EN 13823	FIGRA (= FIGRA _{0.4MJ}) $\leq 750\text{ W/s}$
	BS EN ISO 11925-2	30 s flame exposure No flame spread in excess of 150 mm within 60 s
E	BS EN ISO 11925-2	15 s flame exposure No flame spread in excess of 150 mm within 20 s
F	BS EN ISO 11925-2	15 s flame exposure Flame spread in excess of 150 mm within 20 s <i>NOTE Historically, it was possible to declare Class F without undertaking any testing.</i>

^{A)} The criteria are expressed as follows:

- ΔT is the change in temperature;
- Δm is the change in mass or mass loss;
- t_f is the final temperature recorded;
- PCS is the gross heat of combustion;
- FIGRA is an index determined from the maximum quotient of heat release rate (HRR) from the specimen at the time of its occurrence using a total heat release (THR) of either 0.2 MJ or 0.4 MJ; and
- THR_{600s} is the total heat released from the specimen in the first 600 s of exposure.

In addition to the classes in Table L.2, there are subclasses that are added to Class A2 to Class D for smoke production and flaming droplets or particles, the criteria for which are shown in Table L.3 and Table L.4, respectively.

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 L.3 – Smoke production classification for products classified A2 to D

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

Table L.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	BS EN 13823	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	—

L.3 Large-scale cladding test and classification – BS 8414-1, BS 8414-2 and BR 135 [6]

There are two parts to BS 8414.

- a) 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.
- b) 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 of BS 8414-1 and BS 8414-2). The rig 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 test rig, with details (fixings, brackets, insulation, cavity sizes, rainscreen, gaps between components, etc.) that are representative of those that will be used when the system is fitted onto the building.

Thermocouples are installed into the cladding system at set intervals on levels 1 and 2 of the test rig, as shown in Figure L.7, both external to the system and within the system, embedded at the mid-depth of each layer of the system and any cavity (prior to 2015 this was only each combustible layer). (A set of additional thermocouples at a new level 3 has been incorporated as part of the test rig in the 2020 editions of BS 8414-1 and BS 8414-2.) Figure L.8 illustrates the locations of thermocouples in the various layers of a simple rainscreen system applied to a masonry substrate.

The heat source, typically a large timber crib, is placed into the hearth at the base of the wall. 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 HRR of between 2.5 MW and 3.5 MW with a nominal heat output of 4 500 MJ over a 30 min period.

NOTE Historically, other fuel sources were permitted as an alternative to the large timber crib, but these were rarely used.

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).

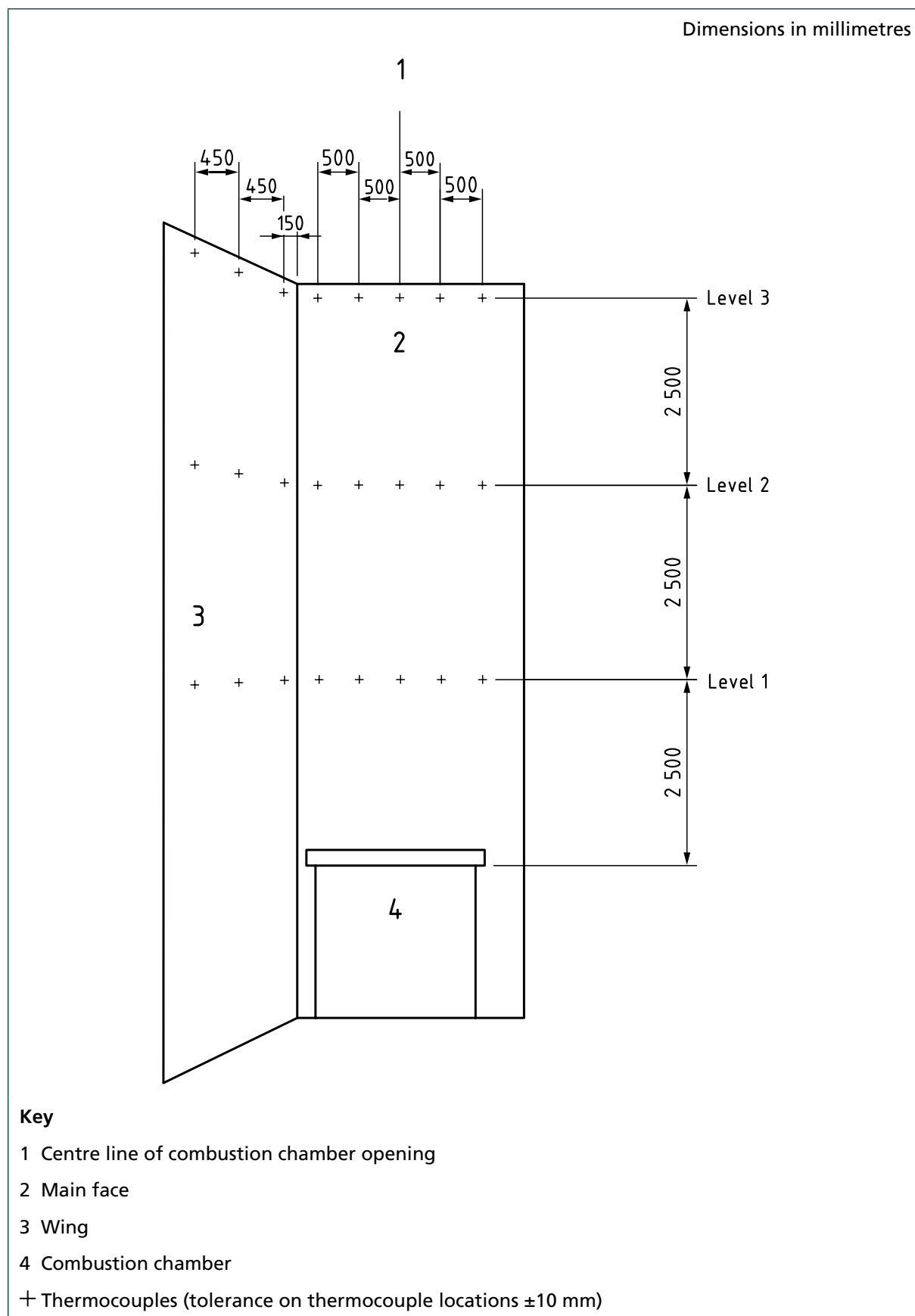
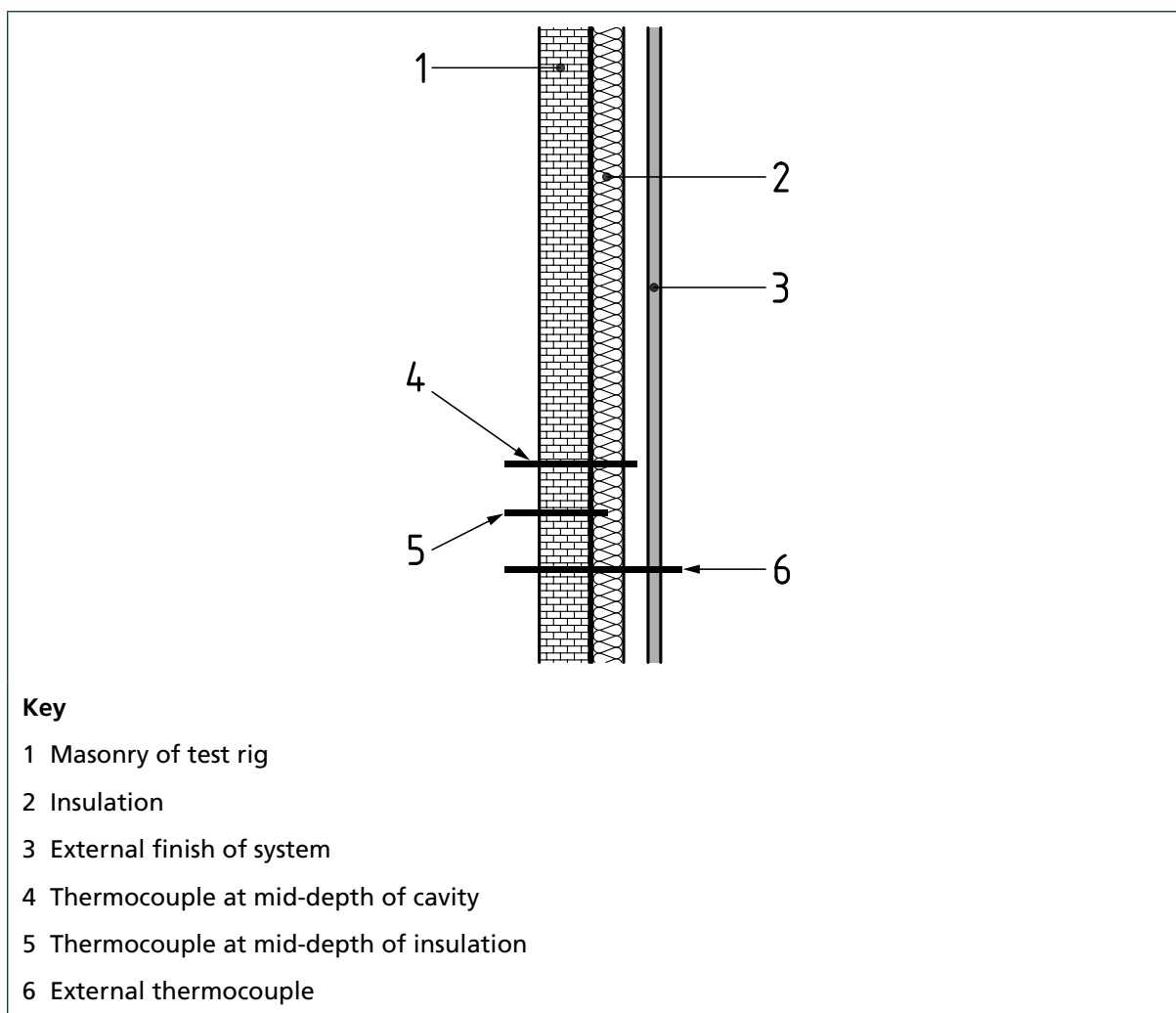
Figure L.7 – Location of thermocouples for a cladding test

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

Early termination criteria for the test are:

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

BR 135 [6] provides both guidance and the classification criteria for a cladding system that has been tested to BS 8414-1 or BS 8414-2. The performance criteria and classification method are as follows.

- i) The system has to have been tested to the full test duration without any early termination of the full fire load exposure period.
- ii) 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, t_s , is deemed to be a failure due to external fire spread.
- iii) 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, t_s , is deemed to be 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 8414-1 and BS 8414-2, and it is recommended in BR 135 [6] that significant forms of mechanical performance, such as system collapse, spalling and flaming debris, which are recorded in the classification report, be considered as part of the overall risk assessment when specifying the system. Any FRAEW that relies upon a BS 8414 test needs to establish whether any such collapse, spalling or flaming debris did occur, and to take this into account as part of the assessment.

BS 9414 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 8414-1 or BS 8414-2.

L.4 Fire resistance tests

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

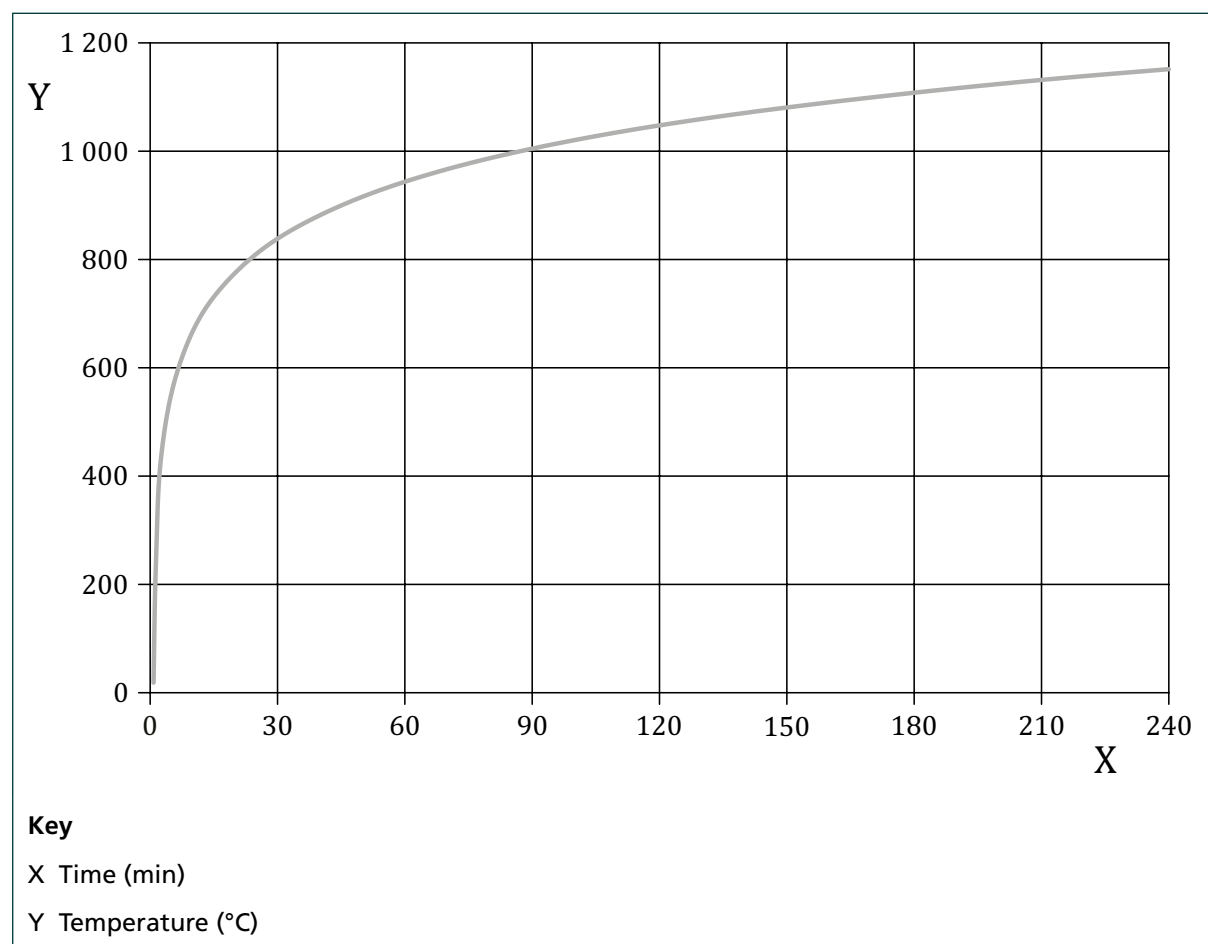
- a) resistance to collapse (loadbearing capacity), which applies to loadbearing elements only, denoted R in the European classification of the resistance to fire performance;
- b) resistance to fire penetration (integrity), denoted E in the European classification of the resistance to fire performance; and
- c) 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:

- 1) BS 476-20, BS 476-21, BS 476-22 and BS 476-23;
- 2) BS EN 1363-1 and BS EN 1363-2;
- 3) BS EN 1364-1, BS EN 1364-2, BS EN 1364-3, BS EN 1364-4 and BS EN 1364-5; and
- 4) BS EN 1365-1, BS EN 1365-2, BS EN 1365-3 and 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 834-1:2025⁸⁾. The temperature profile over a 4 h period is shown in Figure L.11.

Figure L.9 – Time temperature curve defined in ISO 834-1:2025



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

- i) **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 that 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.
- ii) **Specimen temperatures:** The thermocouples used for measuring surface temperatures on the unexposed face of the specimen are broadly identical in the equivalent national and European tests, although there are some minor differences in the specification as to where these are to be located.

⁸⁾ Implemented in the UK as BS ISO 834-1.

Annex M (informative)

Aspects of information gathering

M.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 appraised 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: this is outline information provided for consideration and approval by the employer and planning authorities.
- b) Detail design: this is 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 connects and interfaces. 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 [4] requires to be given to the responsible person. In Scotland, the Fire safety design summary [19] records key information relating to the design and construction of buildings.

M.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 N.

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.

M.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 conformity to 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.

However, 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.

M.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 in accordance with BS 8414-1 and BS 8414-2 where these demonstrate that the product meets the performance requirements set out in BR 135 [6]. 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 often forms part of a detailed analysis, as described in Clause 13.

Annex N (informative)

Site survey and inspection considerations

N.1 Methods of construction and workmanship

N.1.1 General

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

N.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 that 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:

- a) installed with gaps that impair their performance;
- b) obstructed from intumescent by support framework;
- c) removed or distorted by following trades; or
- d) 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.

N.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.

N.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.

N.2 Invasive investigation and sampling

Site surveys and investigations generally involve the removal of external components of the system, such as cladding panels, trims and decorative features, to expose the internal components. It is possible to inspect external wall construction using a borescope, but the images these generate tend to be of limited value, confirming the presence or absence of components only and usually providing only a very narrow view within the wall. 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 persons 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:

- a) damaging water-resisting elements of the wall, thereby impairing its watertightness;
- b) impairing the continuity of thermal insulation, thereby reducing the environmental performance of the wall;
- c) damaging cavity barrier installations, thereby impairing the fire performance of the wall;
- d) weakening the structural integrity of the cladding system and its supports;
- e) causing inconvenience to residents; and
- f) 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 conduct 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 is 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 to 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 O (informative)

Generic fire properties of external wall materials, systems and configurations

O.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 necessarily takes precedence over the generic information in this annex.

There are also various instances in this annex that relate to expectations arising from construction in accordance with ADB (e.g. cavity barriers around openings and in line with every compartmenting element of structure).

Buildings can be subject to alternative solutions that justify how the functional requirement of building regulations has been achieved in an alternative manner to following the provisions in ADB (e.g. cavity barriers omitted from around windows on the basis of the proximity of windows to compartment line cavity barriers).

O.2 Common components across all system types

Table O.1 to Table O.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 O.1 – Fire properties of common elements – Structural elements

Element	Property
Masonry (brickwork, blockwork, reinforced concrete)	Loadbearing masonry, provided that it is in good condition, can generally be regarded as providing a substrate that is both non-combustible (Class A1) and has a fire resistance 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 (Class A1) 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 of 30 min or more.
SFS	Cold-drawn light gauge SFS steel studs are generally used to form non-loadbearing external walls that infill between floor slabs. Provided that 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.

Table O.1 – Fire properties of common elements – Structural elements (*continued*)

Element	Property
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 that can continue to maintain the loadbearing function, 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 that it is afforded by being encased, usually using plasterboard.
Cross-laminated timber (CLT)	CLT, provided that 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 gives rise to a risk of delamination, which in turn could give rise to collapse, whether in fire or generally.
Other engineered timber (including joists and 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 O.2 – Fire properties of common elements – Plasterboard and sheathing boards

Element	Property
Plasterboard	The core material of plasterboard is non-combustible (Class A1), 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. Notwithstanding the above, plasterboard can be regarded as providing an adequate cavity barrier within wall or floor construction provided that 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 that it is well built.
Cement-based boards	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 also be used. 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 (Class A1) cement. CP board can be regarded as providing an adequate cavity barrier within wall or floor construction provided that it is at least 12 mm thick.
Calcium silicate board	Calcium silicate board is a fire protection board that is non-combustible (Class A1) 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. Calcium silicate board can be regarded as providing an adequate cavity barrier within wall or floor construction provided that it is at least 12 mm thick.
Magnesium oxide board	Magnesium oxide board uses magnesium oxide as a cement replacement and aggregate. Magnesium oxide board is non-combustible (Class A1) 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 typically 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. Magnesium oxide board can be regarded as providing an adequate cavity barrier within wall or floor construction provided that it is at least 12 mm thick.
Hybrid boards	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 need to be sought.

Table O.3 – Fire properties of common elements – Insulation

Element	Property
Insulation materials previously classified as non-combustible/limited combustibility (now Class A1 or Class A2): • Stone wool • Ceramic fibre • Glass fibre • Foamed glass • Exfoliated vermiculite	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, 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 FRAEW, 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 retain their shape whereas quilt can slump in a cavity).
Rigid (thermoset) foam insulations: • PUR • PIR • Phenolic	Thermoset foam insulations are combustible, but can offer a wide range of fire performance, depending upon the specific product in question. 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). Phenolic foams are generally similar to PIR foams in terms of their fire performance, though their underlying chemistry is different. 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. 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 that the cavity barrier is not reliant upon the foam itself for support.

Table O.3 – Fire properties of common elements – Insulation (*continued*)

Element	Property
Thermoplastic insulation: • EPS foam • XPS foam • “Multifoil insulation” (e.g. layers of reflective foil and thermoplastic fibre wadding or bubble-wrap type material) • Importance of cavities being formed on heating	Thermoplastic insulation typically has a high energy content and so is reliant upon encapsulation to achieve good fire performance. Thermoplastic insulation, by definition, melts on heating, so any space that 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. It is generally accepted that thermoplastic insulation is 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.

Table O.4 – Fire properties of common elements – Cavities

Element	Property
Ventilated versus unventilated cavities	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. 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. 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.

Table O.4 – Fire properties of common elements – Cavities (*continued*)

Element	Property
Differentiating cavity barriers, fire stopping and fire barriers	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). All editions of ADB up to and including the 2019 edition [1] and its amendments have recommended 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: • steel 0.5 mm thick; • timber 38 mm thick; • mineral wool, provided that it is in slab form or sleeved in polythene; or • calcium silicate, cement-based or gypsum-based (plaster) board at least 12 mm thick. Cavity barriers need to be fixed in such a way that 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 (e.g. stud wall construction lined with minimum 12.5 mm standard plasterboard) can be considered sufficient for this purpose. 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 that has been successfully tested in accordance with the relevant part of BS 8414 and classified to BR 135 [6]. 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.

Table O.4 – Fire properties of common elements – Cavities (*continued*)

Element	Property
Cavity barriers	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 that there are cavity barriers where the cavity passes across a compartment line and to the extent set out previously in this table). 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. There are various types of cavity barrier that are commonly encountered in external wall construction. 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. 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 proven to perform only 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 [20], issued by the Association for Specialist Fire Protection (ASFP), sets out a method for testing the fire resistance of open state cavity barriers. 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. Proprietary cavity barriers might only be suitable for installation in a particular orientation: • vertical cavity barriers might not be suitable for use as horizontal cavity barriers; and • horizontal cavity barriers (particularly those which are open state) are unlikely to be suitable for use as vertical cavity barriers, and also need to be installed both the right way up and the right way round.

Table O.5 – Fire properties of common elements – Glazing

Element	Property
Glass	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. While these polymeric interlayers are combustible, experience has indicated that these are unlikely to contribute significantly to external fire spread. 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. Fire-resisting glazing also comes in a variety of forms offering varying degrees of fire resistance. The two most common types are: • integrity-only glass, which remains in situ when exposed to fire, acting as a barrier to flame spread, but transmits thermal radiation through it; and • insulating glass, which acts as a barrier both to heat and to thermal radiation, usually by turning opaque on heating. If fire-resisting glazing is required to achieve satisfactory levels of safety as part of an appraisal, then specialist advice needs to be sought.
Frames (window and door)	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.

Table O.5 – Fire properties of common elements – Glazing (*continued*)

Element	Property
Spandrel/infill panels	The terms “spandrel panel” and “infill panel” are used interchangeably throughout the industry to refer to panels that 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 protected only by the frame into which they are installed. They are sometimes protected with aluminium foil tape, but this cannot be assumed. Spandrel and infill panels are typically some form of composite, such as: • metal skins with an insulating core; • metal skins with an insulating and timber (typically plywood) core; • metal external face with insulating core and timber (typically plywood) internal face; • HPL skins with an insulating core; and • solid HPL. 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. • Panels that are installed in such a way as to cross compartment lines (e.g. to conceal the edges of floor slabs) need to be considered in light of the potential route they provide for fire to spread from one compartment to another. • Panels that are installed entirely within the confines of a compartment (as it meets the external wall) are unlikely to have a significant impact on fire spread, unless their performance is such that they are likely to contribute to substantial flame extension.

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

Element	Property
Membranes • Breather membrane • Vapour membrane • EPDM • DPC	Some membranes are available that achieve Class A2 (limited combustibility). Membranes used on existing buildings are more commonly comprised of combustible thermoplastic material. 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.

Table O.6 – Fire properties of common elements – Other generic components (*continued*)

Element	Property
Paint/coatings	Paints and coatings can have a significant impact on the extent to which a surface supports and spreads 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. External walls sometimes have paints or coatings applied to them that 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.
Fixing methods	Mechanical fixings are invariably the most reliable means of fixing together the various components of external wall construction. Metals, depending upon their softening/melting temperature, might remain in situ or might soften, melt, or even rapidly oxidize, exposing the underlying construction to fire. 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).
Movement joints	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 that 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.
Thermal breaks	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.
Acoustic breaks/inserts	In a similar manner to thermal breaks, acoustic breaks are provided to limit sound transmission through external wall construction. These might be combustible, but they are generally provided at discrete locations, so do not provide an opportunity for significant fire spread.

Table O.6 – Fire properties of common elements – Other generic components (*continued*)

Element	Property
Cavity trays	Cavity trays, which can be of either metallic (non-combustible or Class A1) 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. 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.
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 IEC 62305-1, it is expected that they 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 appraisal of risk, provided that they do not form a continuous network of combustible materials throughout the external wall construction.
Photovoltaic systems	Photovoltaic systems pose both an ignition and fuel source; at the time of revising 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: • the general external wall construction (are the panels integrated with or stood off from the system?); • whether the external wall construction is likely to be fire-resisting; • windows onto accommodation; • windows onto means of escape; and • any other routes that might allow fire and smoke spread into the building.
Green walls	The fire performance of green walls is highly reliant upon the survival and irrigation of the vegetation incorporated into it. If vegetation dies or becomes dried out then there is a heightened risk of fire spread; conversely, a healthy green wall is unlikely to pose a substantial risk of fire, although it is important to note that many systems incorporate plastic components that are also not of limited combustibility. Green walls are a specialist subject supported by specialist guidance. Maintenance of green walls is particularly important to maintain their fire performance at an adequate level throughout the seasons.

Table O.6 – Fire properties of common elements – Other generic components (*continued*)

Element	Property
Balconies	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 the following three categories. a) Those that fall entirely within the curtilage of the building structure (i.e. they are built on the slab and appear inset into the building when observed from outside). They might be enclosed to an extent and might effectively be made fully enclosed (sometimes referred to as a “winter garden”). The extent of enclosure needs to be considered in light of whether, from a fire perspective, the space can be treated as part of the outside or whether it is in effect a compartment (i.e. subject to compartment fire behaviour). b) Those that 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. c) Those that 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. 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. 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. 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.
Solar shading systems	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 that might be combustible and aid propagation of flame or might be non-combustible (Class A1) and deflect fire/smoke plumes away from the structure.
Terraces	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 that 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), it can be treated as a roof. As with balconies, the materials used to line terraces, and storage by residents, both need to be taken into account.

O.3 Common system types

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

Table O.7 – Fire properties of common system types – Masonry/concrete systems

Element	Property
Masonry/concrete outer skin	When appraising a building that appears to have masonry or concrete external wall construction, the following issues need to be taken into account. a) Is the masonry/concrete loadbearing or simply providing a façade? b) Is the masonry/concrete traditional (i.e. full bricks laid in courses using sand/cement mortar or concrete exceeding 75 mm thick), or is it merely providing the appearance of masonry/concrete, for example: 1) brick slip (tiles) fixed to a substrate; or 2) factory produced (typically panellized) brickwork? If either item 1) or item 2) above, then treat as other form of cladding depending upon underlying construction (most likely rainscreen). c) What is the underlying construction? For example: 1) second leaf of masonry/concrete forming a cavity; 2) timber frame; 3) steel structure and frame; 4) concrete structure and SFS; 5) concrete structure and concrete panels; or 6) insulated build-up (this is typically used where historic façades are retained over more modern construction and can come in a variety of forms).

Table O.7 – Fire properties of common system types – Masonry/concrete systems (*continued*)

Element	Property
Double masonry/concrete skin with cavity	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. This form of construction constitutes the lowest risk form of construction that might be used for external walls, for the following reasons. • Each leaf of the wall, provided that it is formed of masonry/concrete at least 75 mm thick and is generally well constructed, is likely to provide at least 30 min fire resistance. • The masonry/concrete is likely to be of limited combustibility or better. Given the above, this form of construction is invariably accepted as: • not requiring cavity barriers generally, except that cavity closers are needed so that there is no free flow of air through the cavity; and • being able to accommodate combustible materials within the cavity irrespective of building height. This is illustrated in Diagram 8.2 in ADB Volume 1:2019 [1].

Table O.8 – Fire properties of common system types – Rainscreen systems

Element	Property
Types of rainscreen system	Rainscreen systems come in various forms, generally defined by the cold cavity arrangement they incorporate (see Table O.4): • ventilated and drained; or • pressure equalized. 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. 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. Table O.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.

Table O.9 – Fire properties of common system types – Rainscreen facing materials^{A)}

Element	Property
Non-combustible (Class A1) and limited combustibility (Class A2) materials	These materials can be subdivided into two categories; those which retain their shape when exposed to fire and those which do not. • Natural stone, terracotta and non-combustible boards all generally remain in situ for a significant period of time when exposed to a fire plume emitting from a building (though they might eventually shatter), thus affording some protection to the underlying construction. • Metals, depending upon their softening/melting temperature, might remain in situ or might soften, melt, or even rapidly oxidize, exposing the underlying construction to fire.
Combustible materials	
Engineered/reconstituted stone	Engineered/reconstituted stone cannot be assumed to be non-combustible (Class A1) (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.

Table O.9 – Fire properties of common system types – Rainscreen facing materials^{A)} (*continued*)

Element	Property
Metal composite panels	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. Core materials might contribute to fire or might enhance the performance of the metal, as follows. • Untreated polyethylene cored metal composite panels are unlikely to be acceptable in most circumstances but, if there is a specific justification based on a risk assessment, it might be possible to retain them (e.g. shop signs that are suitably sized and located). • 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 appraised. The fire performance of combinations of such panels with combustible insulation in large-scale tests has been shown to be sensitive to relatively minor differences between wall build-ups, such as in the size of gaps between panels. • Class A2 rated ACM panels (i.e. with core material achieving at least limited combustibility) are likely to provide performance similar to non-combustible (Class A1) 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. 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.

Table O.9 – Fire properties of common system types – Rainscreen facing materials^{A)} *(continued)*

Element	Property
HPL	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. 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.
Timber	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. Timber can be treated to improve its reaction to fire characteristics up to national Class 0 or 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.
Plastics	Plastics are infrequently used as the outer surface of cladding due to their poor long-term durability; they tend to degrade under prolonged exposure to UV light and heating/cooling cycles. Where plastics are encountered and there is a desire to retain them, 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.

Table O.9 – Fire properties of common system types – Rainscreen facing materials^{A)} (*continued*)

Element	Property
Geometry of rainscreen (cassettes vs flat panels)	
Cassettes	Cassettes are generally used for both their aesthetic performance (reducing angles at which it is possible to see into cavities) and weather performance (minimizing water ingress to cavities), particularly where the material being used is relatively thin (e.g. metal sheets and composites). 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, making it vulnerable to attack 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 that are separated from fixing points by these folds, exposing more of the underlying material. 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. 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. Where cassettes have a 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. 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.
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 O.6).
^{A)} The rainscreen itself can be formed of any number of materials in a variety of geometries. Both the material and the geometry can have a significant bearing on fire performance.	

Table O.10 – Further considerations for specific system types

System type	Notes
External thermal insulation composite systems (ETICS)	These systems are sometimes referred to as rendered systems, as they feature an externally applied render coat as their weatherproof surface. The level of risk that might potentially be posed by these systems is generally dictated by the type of insulation they incorporate, as follows. • Mineral wool-based systems are likely to be low-risk. • Rigid thermoset foam-based systems can be low-risk if fire barriers and cavity barriers (if a cavity exists behind the insulation) are properly provided and correctly installed. If there are gaps or other deficiencies then the level of risk might increase to medium or, in extreme cases, high. • Thermoplastic foam-based systems might in certain circumstances be considered low-risk if fire barriers and cavity barriers (if a cavity exists behind the insulation) are properly provided and correctly installed, 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. In particular regard to thermoplastic systems, there are historic systems that 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.
Sandwich panel systems	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 O.2 and Table O.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. 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.

Table O.10 – Further considerations for specific system types (*continued*)

System type	Notes
Curtain wall systems	There are two principal forms of curtain wall system. • Stand-off systems are built beyond the edges of floor slabs and run continuously across the height and width of a building. Unless a strategy has been devised to negate this need, fire stopping needs to be provided between slab edges and the inside face of the curtain wall system. • Infill systems (now more commonly referred to as window assemblies) are built inboard of slab and/or wall edges, although they might pass across particular floor and/or wall lines to achieve a particular architectural objective. Where the system is broken up by lines of compartmentation, this limits the extent/speed at which fire can spread across the system. 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. 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. • Steel framed systems can provide good edge protection to the panels in the curtain wall (provided that the geometry actually covers and protects edges), as well as good resistance to collapse in the event of fire. • uPVC framed systems are combustible; they might offer some edge protection and resistance to collapse if steelwork is embedded within them, but this would need to be confirmed. • Aluminium framed systems are non-combustible (Class A1) 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). The other components of curtain wall systems are covered in Table O.5.

Annex P (informative)

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

P.1 General

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. Some forms of construction, such as modular building systems, timber frame or novel construction techniques, need appraisers to understand the strengths and vulnerabilities/failure mechanisms of the specific system under consideration when it is exposed to fire, as the fire performance and need for fire protection might differ from that of traditional construction types. For the purpose of this PAS, the focus is necessarily on external fire spread, but appraisers need to be aware of, and might need to alert others to, potential wider consequences of fire spread (e.g. fire spreading into cavities more generally and affecting the structure).

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 speed 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 [6] classification using the data from a BS 8414-1 or BS 8414-2 test was the benchmark referred to in MHCLG's 2020 Consolidated Advice Note (withdrawn) [21] 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 [6] 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 conduct 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 are simply insufficient BS 8414 test data to apply the rules set out in BS 9414 to determine 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 8414-1 or BS 8414-2; it is not intended as a means of reverse engineering an

applicable BS 8414 test based upon site observations.

P.2 Types of systems

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 [22]). 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 [12]) 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 C, 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 fire spreading more rapidly than the benchmark criteria.

This is, fundamentally, why, even prior to the amendment of Regulation 7 of the Building Regulations 2010 [4], 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 speed of fire spread that presents a risk to the safety of occupants. It led to the referencing of the first edition of BR 135 [23] as a source of useful information regarding the performance of various forms of external wall construction when tested at large scale, and later the adoption of classification to the second edition of BR 135 [24], 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.

P.3 System performance

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.

- a) **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.

- b) Reaction to fire: this concerns the way in which a material responds to fire attack in terms of flaming, release of energy, and 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 (although the former have now largely been withdrawn). 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 L.

The difference between fire resistance and reaction to fire can be demonstrated by the following examples.

- 1) 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.
- 2) 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.

P.4 Sources of information

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 was 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 (withdrawn) [21], 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 [6]. Early termination of the tests was also used as an indicator that the speed 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 [6], 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 (documented in an article in *Fire and Materials* [25]) 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 HRR 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 [26] carried out by BRE based on an experimental programme investigating the comparative performance of different products used as facings in a cladding system, including:

- i) brick slip;
- ii) reconstituted stone panels;
- iii) aluminium honeycomb;
- iv) ZCM;
- v) copper composite material;
- vi) various forms of HPL; and
- vii) timber.

Category 1, Category 2 and Category 3 ACMs (see 3.1.1) were also used as reference sources for comparison of the results.

HRRs 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.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 476-4:1970 (withdrawn), *Fire tests on building materials and structures – Part 4: Non-combustibility test for materials*

BS 476-6 (withdrawn), *Fire tests on building materials and structures – Part 6: Method of test for fire propagation for products*

BS 476-7 (withdrawn), *Fire tests on building materials and structures – Part 7: Method of test to determine the classification of the surface spread of flame of products*

BS 476-11 (withdrawn), *Fire tests on building materials and structures – Part 11: Method for assessing the heat emission from building materials*

BS 476-20, *Fire tests on building materials and structures – Part 20: Method for determination of the fire resistance of elements of construction (general principles)*

BS 476-21, *Fire tests on building materials and structures – Part 21: Methods for determination of the fire resistance of loadbearing elements of construction*

BS 476-22, *Fire tests on building materials and structures – Part 22: Methods for determination of the fire resistance of non-loadbearing elements of construction*

BS 476-23, *Fire tests on building materials and structures – Part 23: Methods for determination of the contribution of components to the fire resistance of a structure*

BS 4422:2024, *Fire – Vocabulary*

BS 5839-1, *Fire detection and fire alarm systems for buildings – Part 1: Design, installation, commissioning and maintenance of systems in non-domestic premises – Code of practice*

BS 5839-6:2019+A1:2020, *Fire detection and fire alarm systems for buildings – Part 6: Code of practice for the design, installation, commissioning and maintenance of fire detection and fire alarm systems in domestic premises*

BS 7974, *Application of fire safety engineering principles to the design of buildings – Code of practice*

BS 8414-1, *Fire performance of external cladding systems – Part 1: Test method for non-loadbearing external cladding systems fixed to, and supported by, a masonry substrate*

BS 8414-2, *Fire performance of external cladding systems – Part 2: Test method for non-loadbearing external cladding systems fixed to, and supported by, a structural steel frame*

BS 8458 (withdrawn), *Fixed fire protection systems – Residential and domestic watermist systems – Code of practice for design and installation*

BS 8579, *Guide to the design of balconies and terraces*

BS 8629, *Design, installation, commissioning and maintenance of evacuation alert systems for use by fire and rescue services in buildings containing flats – Code of practice*

BS 8899, *Improvement of fire-fighting and evacuation provisions in existing lifts – Code of practice*

BS 9251, *Fire sprinkler systems for domestic and residential occupancies – Code of practice*

- BS 9414, *Fire performance of external cladding systems – The application of results from BS 8414-1 and BS 8414-2 tests*
- BS 9792:2025, *Fire risk assessment – Housing – Code of practice*
- BS 9991, *Fire safety in the design, management and use of residential buildings – Code of practice*
- BS 9999, *Fire safety in the design, management and use of buildings – Code of practice*
- BS EN 771-3, *Specification for masonry units – Part 3: Aggregate concrete masonry units (Dense and lightweight aggregates)*
- BS EN 1363-1, *Fire resistance tests – Part 1: General requirements*
- BS EN 1363-2, *Fire resistance tests – Part 2: Alternative and additional procedures*
- BS EN 1364-1, *Fire resistance tests for non-loadbearing elements – Part 1: Walls*
- BS EN 1364-2, *Fire resistance tests for non-loadbearing elements – Part 2: Ceilings*
- BS EN 1364-3, *Fire resistance tests for non-loadbearing elements – Part 3: Curtain walling – Full configuration (complete assembly)*
- BS EN 1364-4, *Fire resistance tests for non-loadbearing elements – Part 4: Curtain walling – Part configuration*
- BS EN 1364-5, *Fire resistance tests for non-loadbearing elements – Part 5: Air transfer grilles*
- BS EN 1365-1, *Fire resistance tests for loadbearing elements – Part 1: Walls*
- BS EN 1365-2, *Fire resistance tests for loadbearing elements – Part 2: Floors and roofs*
- BS EN 1365-3, *Fire resistance tests for loadbearing elements – Part 3: Beams*
- BS EN 1365-4, *Fire resistance tests for loadbearing elements – Part 4: Columns*
- BS EN 12845, *Fixed firefighting systems – Automatic sprinkler systems – Design, installation and maintenance*
- BS EN 13501-1:2018, *Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests*
- BS EN 13823, *Reaction to fire tests for building products – Building products excluding floorings exposed to the thermal attack by a single burning item*
- BS EN 14972-17, *Fixed firefighting systems – Water mist systems – Part 17: Test protocol for residential occupancies for automatic nozzle systems*
- BS EN IEC 62305-1, *Protection against lightning – Part 1: General principles*
- BS EN ISO 1182, *Reaction to fire tests for products – Non-combustibility test*
- BS EN ISO 1716, *Reaction to fire tests for products – Determination of the gross heat of combustion (calorific value)*
- BS EN ISO 11925-2, *Reaction to fire tests – Ignitability of products subjected to direct impingement of flame – Part 2: Single-flame source test*
- CP 3 Chapter IV Part 1:1962 (withdrawn), *Code of basic data for the design of buildings – Chapter IV: Precautions against fire*
- CP 3 Chapter IV Part 1:1971 (withdrawn), *Code of basic data for the design of buildings – Chapter IV: Precautions against fire*
- ISO 834-1:2025⁹⁾, *Fire-resistance tests – Elements of building construction – Part 1: General requirements*
- ISO 13785-1, *Reaction to fire tests for facades – Part 1: Intermediate scale test*

⁹⁾ Implemented in the UK as BS ISO 834-1.

PAS 8673, *Built environment – Competence requirements for the management of safety in residential buildings – Specification*

PD 7974-1, *Application of fire safety engineering principles to the design of buildings – Part 1: Initiation and development of fire within the enclosure of origin (Sub-system 1)*

PD 7974-5, *Application of fire safety engineering principles to the design of buildings – Part 5: Fire and rescue service intervention (Sub-system 5)*

Other publications

NOTE Legislation might become out of date during the lifespan of this document. No reliance can be placed on this document as being a definite statement of a user's legal responsibilities or potential liabilities under legislation.

- [1] MINISTRY OF HOUSING, COMMUNITIES AND LOCAL GOVERNMENT. *The Building Regulations 2010 – Approved Document B: Fire safety – Volume 1: Dwellings*. 2019 edition for use in England (and subsequent amendments). Crown Copyright 2019.
- [2] SCOTTISH GOVERNMENT. *Standards for single building assessments and additional work assessments*. Crown Copyright 2025.
- [3] GREAT BRITAIN. Regulatory Reform (Fire Safety) Order 2005 as amended. London: The Stationery Office.
- [4] GREAT BRITAIN. Building Regulations 2010 and subsequent amendments. London: The Stationery Office.
- [5] EUROPEAN COMMUNITIES. 96/603/EC. Commission Decision of 4 October 1996 establishing the list of products belonging to Classes A 'No contribution to fire' provided for in Decision 94/611/EC implementing Article 20 of Council Directive 89/106/EEC on construction products. Luxembourg: Office for Official Publications of the European Communities, 1996.
- [6] BUILDING RESEARCH ESTABLISHMENT (BRE). *Fire performance of external thermal insulation for the walls of multistorey buildings*. BR 135. Third Edition. Watford: BRE Electronic Publications, 2013.
- [7] COMPETENCE STEERING GROUP. *Setting the bar: A new competence regime for building a safer future*. Final report of the Competence Steering Group for Building a Safer Future. London: Construction Industry Council, October 2020.¹⁰⁾
- [8] GREAT BRITAIN. Fire Safety (England) Regulations 2022. London: The Stationery Office.
- [9] ASHTON, L.A. and MALHOTRA, H.L. *External walls of buildings – Part 1. The protection of openings against spread of fire from storey to storey*. Fire Research Note 436. Borehamwood, Herts: Department of Scientific and Industrial Research and Fire Offices' Committee, Joint Fire Research Organization, 1960.
- [10] LANGDON-THOMAS, G.J. and LAW, M. *Fire and the external wall*. Fire Research Note 8. Borehamwood, Herts: Department of Scientific and Industrial Research and Fire Offices' Committee, Joint Fire Research Organization, 1966.
- [11] HOLLAND, C., CROWDER, D. and SHIPP, M. *External fire spread – Part 1: Background research*. London: BRE Global, April 2016.
- [12] BUILDING RESEARCH ESTABLISHMENT (BRE). *Series of fire growth tests for LPCB approval and listing of construction product systems – Part one: Requirements and tests for built up cladding and sandwich panel systems for use as the external envelope of buildings*. LPS 1181, Part 1: Issue 1.2. Watford: BRE Global Ltd., 2014.

¹⁰⁾ Available for download at <https://cic.org.uk/admin/resources/setting-the-bar-9-final-1.pdf>.

- [13] NATIONAL FIRE PROTECTION ASSOCIATION (NFPA). *Standard fire test method for evaluation of fire propagation characteristics of exterior wall assemblies containing combustible components*. NFPA 285. Massachusetts: NFPA, 2025.
- [14] BUILDING RESEARCH ESTABLISHMENT (BRE). *LPCB Fire resistance requirements for elements of construction used to provide compartmentation*. LPS 1208. Issue 2.2. Watford: BRE Global Ltd., January 2014.
- [15] NATIONAL FIRE CHIEFS COUNCIL (NFCC). *Fire safety in specialised housing – Guidance*. London: NFCC, 2017.¹¹⁾
- [16] HEALTH AND SAFETY EXECUTIVE (HSE). *Reducing risks, protecting people*. Crown Copyright 2001.
- [17] GREAT BRITAIN. Building Regulations 1976. London: HMSO.
- [18] GREAT BRITAIN. Building Regulations 1965. London: HMSO.
- [19] SCOTLAND. *Fire safety design summary 2017*. Edinburgh: CEU, 2017.
- [20] ASSOCIATION FOR SPECIALIST FIRE PROTECTION (ASFP). *Fire resistance test for open state cavity barriers*. Technical Guidance Document 19. Coventry: ASFP, 2017.
- [21] MINISTRY OF HOUSING, COMMUNITIES AND LOCAL GOVERNMENT. *Advice for building owners of multi-storey, multi-occupied residential buildings*. (Consolidated Advice Note.) London: MHCLG, January 2020 (withdrawn).
- [22] HARWOOD, J. and HUME, B. *Fire safety of sandwich panels, summary report*. Fire Research and Development Group, Research report no. 76. Crown Copyright 1997.
- [23] BUILDING RESEARCH ESTABLISHMENT (BRE). *Fire performance of external thermal insulation for the walls of multistorey buildings*. BR 135. First Edition. Watford: IHS BRE Press, 1988.
- [24] BUILDING RESEARCH ESTABLISHMENT (BRE). *Fire performance of external thermal insulation for the walls of multistorey buildings*. BR 135. Second Edition. Watford: IHS BRE Press, 2003.
- [25] GUILLAUME, E., FATEH, T., SCHILLINGER, R., CHIVA, R. and UKLEJA, S. Study of fire behaviour of façade mock-ups equipped with aluminium composite material-based claddings, using intermediate-scale test method. In: *Fire and Materials* [online]. Wiley. May 2018, **42**(5), 561-577.¹²⁾
- [26] BUILDING RESEARCH ESTABLISHMENT (BRE). *Fire performance of cladding materials research*. Report number: P111324-1019 (M9D12V4). Watford: BRE Global Ltd., 2020.

¹¹⁾ Available for download at https://www.nationalfirechiefs.org.uk/write/MediaUploads/NFCC%20Guidance%20publications/NFCC_Specialised_Housing_Guidance_-_Copy.pdf.

¹²⁾ Available at doi.org/10.1002/fam.2635.

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